COST REPORT ANALYSIS PADA MATERIAL DAN PROSES MANUFAKTUR *FRAME* KENDARAAN *FORMULA GARUDA* 2016 (FG16) *GARUDA UNY RACING TEAM*

(Sebagai Pengembangan Materi Mata Kuliah Manajemen Industri Otomotif)

TUGAS AKHIR SKRIPSI

Diajukan Kepada Fakultas Teknik
Universitas Negeri Yogyakarta
Untuk Memenuhi Persyaratan
Guna Memperoleh Gelar Sarjana S-1 Pendidikan Teknik Otomotif

Disusun oleh:
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PROGRAM STUDI PENDIDIKAN TEKNIK OTOMOTIF

FAKULTAS TEKNIK

UNIVERSITAS NEGERI YOGYAKARTA

2018

HALAMAN PERSETUJUAN

Tugas Akhir Skripsi dengan Judul

COST REPORT ANALYSIS PADA MATERIAL DAN PROSES MANUFAKTUR _FRAME_ KENDARAAN _FORMULA GARUDA_ 2016 (FG16) _GARUDA UNY RACING TEAM_

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telah memenuhi syarat dan disetujui oleh Dosen Pembimbing untuk pelaksanaan Ujian Akhir Tugas Akhir Skripsi bagi yang bersangkutan.

Yogyakarta, 06 Maret 2018

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Tugas Akhir Skripsi

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HALAMAN MOTTO

وَاللَّهُ مَعَ الصَّابِرِينَ

"*...Dan Allah bersama orang-orang yang sabar.*"

(QS. Al-Anfal 8:66)

MAN JADDA WA JADDA

"Barangsiapa yang bersungguh-sungguh maka akan berhasil"

"Hidup adalah perjuangan"

"Jadilah lelaki yang bertanggungjawab"

(Deni Restu Widodo)

HALAMAN PERSEMBAHAN

Atas segala rahmat dan hidayah dari Sang Pencipta, Yang Maha Kuasa,

Allah Subhanahu Wata'ala

Saya persembahkan karya ini untuk :

Ibu Turmi Yatiningsih yang telah menjadi wanita terhebat dalam hidup saya, Bapak Sugeng Budi Santoso yang telah menjadi lelaki terhebat dalam hidup saya, Kakak saya Ery Setiawan beserta isterinya Puji Rahayu dan Victor Nur Wijiyanto beserta isterinya Dewi yang menjadi kakak-kakak hebat saya, dan semua keluarga saya yang luar biasa selalu memberikan semangat dan mendidik saya sejak kecil hingga sekarang.

Seorang wanita yang telah tertulis di lauhul mahfudz, yang kelak akan bertemu dan bersama di kemudian hari sesuai rencana-Nya.

Sahabat satu kos saya Satrio Sigit Purnomo, sahabat dekat saya Suratijo, Rizky Arumingtyas, sahabat daerah saya yang ada di kontrakan Sambisari, Ryan Kuntoro, Rahmat Mubarok, Muhammad Harits, Ari Budiono, Teguh Arifin, Nurul Huda, Muhammad Ali, Muhammad Ihsanudin dan sahabat-sahabat lainnya yang selalu memberikan motivasi untuk terus maju.

Bapak Zainal Arifin selaku advisor tim Garuda UNY & pembimbing tugas akhir skripsi saya yang telah sabar membimbing, memotivasi, dan mendidikan saya selama menyeleseikan tugas akhir ini.

Advisor Garuda UNY Racing Team, Bapak Moch. Solikin, Bapak Sutiman, Bapak Muhkamad Wakid, Bapak Sutopo, Bapak Amri yang telah memberikan semangat dan motivasi serta ilmu yang bermanfaat.

Teman seperjuangan saya kelas A angkatan 2014, Mochammad Amin Fitrianto, Muhammad Dzaky Firdaus, Putra Timur Romadoni, Irmanto, Nur Irwan Saputra, Ari Tri WIjaya, Bakti Andika Alfiraq Fajri, Rahmat Mubarok, Ryan Kuntoro, Muhammad Kurnia Alfiannizar, Tri Martanto, Fredi Nurhidayat, Muhammad Rizki, Yulius Ronaldo, Suratijo, Prianto, Abdurrazaq Ghafari, Elga Fajar Kurniawan, Panji Andiko Putro, Lalu Teguh Kurniawan, Ajie Budi Nugroho, Anggit Wahyu, Rifqi Ardiyanto, Enggar Dista, Enggar Dwi Dermawan, Ery Setiawan, Ahmad Faisal Murfi, Wahyu Saputra, Boby Purnomo, Syahril Farkhan Abidi, Dwi Suhartoyo, Indra Setiawan, yang selalu kompak, solid, yang dapat menghibur saya, dan yang telah menjadi tempat untuk belajar bersama dan selalu memberikan semangat kepada saya.

Bapak/Ibu Dosen, Gurud, Staff, dan karyawan Universitas Negeri Yogyakarta khususnya Jurusan Pendidikan Teknik Otomotif yang telah mendidik saya selama kuliah.

Kakak-kakak senior hebat dari Garuda UNY Team (GUT) yang pernah berjuang bersama saya, Bondan Prakoso, Teguh Arifin, Ninda Kurniadi, Naufal Annas

Fauzi, Dimas Bima Nur May, I Gede Indra Widana, Widhihastu Dharma Setiawan, Muhamad Zaini, I Wayan Adiyasa, Yohanes Aji Pmungkas, Cahyo Handoko, Anwar Dwi Murwanto, Juni Noor Rohman Ilham Surfani, Wawan, Roni Suprapto, Hasbi Brilian Kumara, Brian Rifki Alfinsa, Andri Janarko, Bayu Aji, Dwi Agung Yulianto, Gunawan Sugiyanto, Komara, Riza Lukman, Peppy Dwi Indranata, Yusuf Mulyadi, Muflih Fathoni, Aan Yudiyanto, Agung Supriyanto, Ryan Hananta, Novia Nuraini, Merya Wulansari, Laila Wahyu Trimartani, Anis Nur Fatimah, Nurdiana, Rahma Fitriana, , Dyah Nurul Hajar, Denny Asprilla, Nur Himawanto, Rahmat Hidayat Asri.

Teman dan adik-adikku yang hebat Garuda UNY Team (GUT) Suratijo, Rizki Arumningtyas, Agung Priyono, Ardi Maulana Mubarok, Erwin Hanari, Mifta Saputra, Een Juliani, Sultan Gunawan, Elga Fajar Kurniawan, Prabasta Berlian Putra, Irmanto, Wahyu Saputra, Mustafit Septian, Bekti Febriarti, Robi Febrianto, Gea Lurudancang, Yudha hindrawan, Abdul Rosyid, Nur Khamdan, I Wayan Yogi Arta, Indra Susila, Muhammad Zadin, Rizal Hardyanto, Unyix, Arya, Anggun, Galih, Yoga, Dicky, Angel, Inggi, Budiman, Rouful, Fasta, Afandi, Diyon, Robi Wahyu, Alfian, Ravi.

Semua teman dekatku yang kusayangi, yang menjadi penyemangat, pendorong, penghibur, dan pendorong untuk menjadi manusia yang lebih baik yang mungkin belum saya sebutkan.

Almamater tercinta, Universitas Negeri Yogyakarta.

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Oleh :

Deni Restu Widodo
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ABSTRAK

Penelitian ini bertujuan untuk menganalisa *cost report* khususnya dalam biaya material dan biaya proses manufaktur *frame* kendaraan *Formula Garuda* 2016 (FG16) *Garuda UNY Racing Team*. Analisa terfokus pada besar kontribusi biaya material dan biaya proses manufaktur *frame* kendaraan FG16 terhadap total *cost report* serta sebagai pengembangan materi mata kuliah Manajemen Industri Otomotif.

Penelitian menggunakan penelitian deskriptif dengan pendekatan kuantitatif yang dilakukan di *workshop* dan *basecamp Garuda UNY Racing Team* dengan objek berupa *frame* kendaraan FG16 dan FG15. Pengambilan data dengan pengamatan & mencatat hasil data. Terdapat 3 tahap penelitian yaitu perhitungan biaya berdasarkan jenis, ukuran material dan proses pembuatan *frame* FG16, kedua adalah perhitungan prosentase kontribusi biaya material dan proses manufaktur *frame* FG16 terhadap *cost report* FG16, ketiga adalah analisa peran pembuatan *cost report* dalam kompetensi abad 21 serta dalam pengembangan mata kuliah Manajemen Industri Otomotif. Hasil biaya material dan biaya proses manufaktur *frame* kendaraan FG16 dianalisa tingkat kontribusinya terhadap total *cost report* dan peran pembuatan *cost report* dalam kompetensi abad 21 serta dalam pengembangan mata kuliah Manajemen Industri Otomotif.

Berdasarkan hasil penelitian yang didapatkan, kontribusi biaya material *frame* FG16 terhadap *cost report* FG16 sebesar 0.92%, kontribusi biaya proses manufaktur *frame* FG16 terhadap *cost report* FG16 sebesar 5.89%, dan pembuatan dokumen *cost report* merupakan salah satu bentuk keterampilan abad 21 dan dapat digunakan sebagai bentuk pengembangan materi mata kuliah Manajemen Industri Otomotif.

Kata kunci: material, proses manufaktur, *cost report*, *frame*, pengembangan.

KATA PENGANTAR

Segala puji syukur kehadirat Allah SWT, atas limpahan rahmat dan hidayah-Nya, sehingga Tugas Akhir Skripsi dalam rangka untuk memenuhi sebagian persyaratan agar mendapatkan gelar Sarjana Pendidikan Teknik Otomotif dengan judul "*Cost Report Analysis* Pada Material dan Proses Manufaktur *Frame* Kendaraan *Formula Garuda* 2016 (FG16) *Garuda UNY Racing Team* (Sebagai Pengembangan Materi Mata Kuliah Industri Otomotif)", dapat disusun sesuai harapan. Tugas Akhir Skripsi ini dapat diselesaikan tidak lepas dari bantuan dan kerjasama dengan pihak lain. Berkenaan dengan hal tersebut, penulis menyampaikan ucapan terimakasih yang sebesar-besarnya kepada yang terhormat :

1. Dr. Zainal Arifin, M.T. selaku Dosen Pembimbing Tugas Akhir Skripsi, Ketua Jurusan Pendidikan Teknik Otomotif, dan *Advisor Garuda UNY Team* yang telah membimbing, memotivasi, dan mendukung proses penyelesaian Tugas Akhir Skripsi.
2. Drs. Kir Haryana, M.Pd. selaku penguji utama tugas akhir skripsi dan Prof. Dr. Herminarto Sofyan, M.Pd. selaku sekretaris penguji yang telah memberikan pengalaman dan bimbingan serta motivasi.
3. Dr. Widarto, M.Pd., selaku Dekan Fakultas Teknik Universitas Negeri Yogyakarta yang memberikan persetujuan Tugas Akhir Skripsi ini.
4. Muhkamad Wakid, S.Pd., M.Eng. selaku Dosen Pembimbing Akademik yang telah memberikan bimbingan selama menempuh perkuliahan.

5. Kedua orang tua, kakak kandung, dan seluruh keluarga saya yang luar biasa telah mendukung, memberikan semangat dan doa nya selama ini.
6. Seluruh *Advisor* dan anggota *Garuda UNY Team* yang memfasilitasi dan mendukung penuh sehingga dapat terselesaikannya Tugas Akhir Skripsi ini.
7. Teman-teman kelas A Otomotif 2014, yang selalu memberikan dukungan serta semangat.
8. Teman dan sahabat dekat yang selalu memberikan semangat.
9. Semua pihak yang telah membantu sehingga terselesaikannya Tugas Akhir Skripsi ini.

Akhirnya, semoga segala bantuan yang telah diberikan berbagai pihak diatas dapat menjadi amal dan barokah serta mendapatkan balasan dari Allah SWT. Semoga dengan adanya Tugas Akhir Skripsi ini, dapat menjadi manfaat bagi setiap yang membacanya serta pihak yang lain yang membutuhkannnya.

Yogyakarta, 12 Maret 2018

Penulis,

Deni Restu Widodo

NIM 14504241011

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GLOSARY

Autocross

Kategori *dynamic event* dalam kompetisi *Student Formula Japan* dengan bentuk sirkuit (*track*) sama dengan *Endurance* dengan pengambilan waktu hanya 2 kali *race* (1x Race = 1 Lap).

Bill of Material

Daftar keseluruhan part dari kendaraan beserta biayanya.

Bussines Logic Case

Dokumen dari skenario permasalahan perencanaan bisnis dalam *Bussiness Logic Plan Event*.

Bussines Logic Plan

Kategori static event dalam kompetisi *Student Formula Japan* berupa pembuatan perencanaan bisnis sesuai permasalahan yang diberikan oleh juri dalam bentuk *Bussiness Logic Case* kemudian dipresentasikan.

Endurance

Kategori *dynamic event* dalam kompetisi *Student Formula Japan* dengan bentuk sirkuit (*track*) sama dengan *Autocross* dan hanya dilakukan untuk 1 kali *race* yang berisi 20 Lap wajib ditempuh.

FCA Input

File perhitungan biaya *part* atau *assembly* untuk dokumen *cost report*.

General Inspection

Inspeksi umum terhadap keseluruhan sistem kendaraan terhadap regulasi.

***Over-Head* Pabrik**

Segala bentuk pengeluaran biaya pabrik yang tidak terduga dan tidak termasuk dalam biaya bahan baku maupun biaya tenaga kerja langsung.

Real Case

Dokumen dari skenario permasalahan yang diberikan juri untuk cost and manufacturing event yang harus dipecahkan dan dipresentasikan.

Rigidity

Tingkat kekakuan dari struktur rangka (*frame*).

Skidpad

Kategori *dynamic event* dalam kompetisi *Student Formula Japan* yang memiliki sirkuit (*track*) membentuk angka 8 dengan aturan tempuh 2 putaran ke kanan (searah jarum jam) awal, kemudian terakhir 2 putaran ke kiri (berlawanan jarum jam).

Structural Equivalency Spreadsheet (SES)

Dokumen structural dari rangka kendaraan untuk kompetisi *Student Formula Japan* yang wajib dikumpulkan ke panitia sebagai syarat perlombaan.

BAB I

PENDAHULUAN

A. Latar Belakang

Student Formula Japan (SFJ) adalah kompetisi yang diselenggarakan setiap tahun oleh *Japanese Society of Automotive Engineering* (JSAE) yang merupakan salah satu seri kompetisi dari *Formula SAE*. Pada kompetisi ini terdapat 2 perlombaan yaitu *static event* dan *dynamic event*. Pada *static event* terbagi menjadi 4 kategori yaitu *Technical Inspection*, *Cost & Manufacturing Event, Business Logic Plan*, serta *Design Event*. Pada *dynamic event* terbagi menjadi 5 kategori lomba yaitu *acceleration*, *skidpad*, *autocross*, *endurance*, dan *efficiency*. Setiap tim yang mengikuti kompetisi *Formula SAE* juga harus membuat laporan perencanaan bisnis (*bussines logic plan*), laporan desain (*design report*), dan laporan biaya (*cost report*). *Design report* berisi tentang semua aspek desain pada kendaraan yang akan dibuat. *Design report* dan *cost report* akan dipresentasikan pada *static event*. *Cost report* berisi tentang seluruh biaya bahan (*material*), biaya proses pembuatan (*process*), biaya pengencangan (*fastener*), dan biaya perkakas (*tooling*). Seluruh laporan yang dibuat harus dikumpulkan kepada panitia sesuai format dan waktu yang telah ditentukan sebagai syarat mengikuti kompetisi. Mahasiswa dituntut untuk mampu bersaing dalam membuat laporan. Diperlukan sumber-sumber belajar yang lebih banyak untuk memenuhi tuntutan tersebut. Hal ini menjadi tantangan bagi mahasiswa untuk mencari

sumber-sumber belajar yang tidak dipelajari pada bidangnya agar mampu memenuhi tuntutan tersebut.

Untuk dapat mengikuti kompetisi *Formula SAE* mahasiswa juga dituntut untuk mampu merancang, menganalisa, membuat, dan menguji kendaraaan. Agar mampu mengatasi tantangan tersebut mahasiswa juga harus mampu menerapkan ilmu yang dipelajari pada perkuliahan dan meningkatkan pengetahuan yang dipelajari secara khusus pada bidang merancang, menganalisa, membuat, dan menguji kendaraan. Pada tahun 2015 *Garuda UNY Team* mengikuti kompetisi SFJ untuk pertama kali. Kendaraan yang dirancang dan dibuat oleh tim pada tahun 2015 diberi nama FG15. Kompetisi ini diselenggarakan di Ecopa Stadium (Ogasayama Sport Park), Shizouka, Japan pada tanggal 1-5 September 2015. Prestasi yang diraih oleh Garuda UNY Team pada kompetisi *Formula SAE* tahun 2015 adalah sebagai berikut : peringkat 25 *Business Logic Plan*, peringkat 49 *Cost And Manufacturing Event*, peringkat 41 *Design Event*, peringkat 28 *Endurance Event*, peringkat 5 *Efficiency Event*, dan peringkat 29 *Overall* dari 84 tim yang mengikuti kompetisi 2015 *Student Formula Japan*.

Untuk kompetisi selanjutnya tim dituntut untuk mampu mempersiapkan kendaraan dan melakukan *self inspection* dengan lebih teliti. Pada dasarnya masalah-masalah tersebut terjadi karena kurangnya proses pengujian dan pengukuran sebelum kompetisi. Hal ini dikarenakan keterbatasan alat dan tempat untuk melakukan pengujian kendaraan. Dampak yang diperoleh tim akibat permasalahan yang dialami pada saat

melakukan *technical inspection* yaitu tim tidak bisa mengikuti *acceleration* dan *skidpad* pada *dynamic event*. Namun *Garuda UNY Team* masih memiliki kesempatan untuk mengikuti *autocross*, *endurance* dan *efficiency event*. *Garuda UNY Team* mampu meyelesaikan ketiga *event* tersebut dengan lancar.

Pengembangan (*improvement*) pada kendaraan *formula student* milik *Garuda UNY Team* harus terus dilakukan dan siesuaikan dengan regulasi yang berlaku. Salah satu pengembangan utama dalam segi teknis yaitu di bagian rangka yang harus berganti setiap tahun karena disesuaikan dengan regulasi kompetisi *Student Formula Japan* yang menggunakan aturan pada pasal A6.8 *First Year Vehicles* menurut 2016 *Formula SAE Rules* yang mengharuskan setiap kendaraan harus menggunakan rangka baru atau berubah di setiap tahunnya. Pengembangan di semua sistem lain pada kendaraan *formula student* juga menjadi sebuah keharusan agar tim dapat memperoleh hasil kompetisi yang maksimal.

Kemudian di tahun 2016 *Garuda UNY Team* kembali mengikuti kompetisi yang sama yaitu *Student Formula Japan* dengan merancang dan membuat kendaraan baru yang diberi nama FG16. *Garuda UNY Team* melakukan perubahan pada sistem rangka dan suspensi, mengembangkan sistem pemindah tenaga, mereduksi berat kendaraan dan meningkatkan faktor keselamatan dan keamanan. Dengan melakukan pengembangan yang dilakukan berdasarkan evaluasi dari kendaraan tahun sebelumnya *Garuda UNY Team* berharap dapat meraih prestasi yang lebih baik pada kompetisi

2016 *Student Formula Japan*. Kompetisi 2016 *Student Formula Japan* diselenggarakan di Ecopa Stadium (Ogasayama Sport Park), Shizouka, Japan pada tanggal 6-10 September 2016. Pada tahun 2016 prestasi yang diraih adalah peringkat 18 *Business Logic Case*, peringkat 35 *Cost & Manufacturing Event*, peringkat 53 *Design Event*, peringkat 26 *Skidpad*, peringkat 16 *Acceleration*, peringkat 24 *Autocross*, peringkat 33 *Endurance Event* dan peringkat 14 *Efficiency*.

Pengembangan di bidang teknis juga mempengaruhi dari setiap laporan dokumen yang akan dinilai oleh juri. Setiap desain *part* kendaraan, setiap proses pengerjaannya, kuantitas *part*, ukuran *part* dan jenis bahan yang digunakan akan mempengaruhi biaya yang dikeluarkan tim. Pembiayaan yang harus dilaporkan adalah biaya bahan (*material*), proses pembuatan/perakitan (*process*), pengikatan (*fastener*) dan perkakas (*tooling*). Semakin tinggi nilai harga total dari kendaraan dimulai dari harga bahan, harga pembuatan/perakitan, harga pengikatan dan hraga peralatannya, maka akan semakin rendah point yang akan didapatkan. Karena harga kendaraan yang dibuat akan mempengaruhi tingkat prosentase pemasaran. Sebagai salah satu variabel pemasaran di *Business Logic Case*, tingkat biaya yang dikeluarkan untuk membuat kendaraan yang semakin rendah dengan performa yang baik maka kendaraan akan semakin mudah terjual, dengan kata lain tingkat pemasaran yang tinggi.

Pada tahun 2015, total biaya kendaraan FG15 yang ternilai juri adalah $21,062.59. *Cost & manufacturing event* tahun 2015 mendapat point

16.4 dari total point 100 dengan urutan peringkat 49. Pada tahun 2016 total biaya kendaraan FG16 turun menjadi $16,971.81. *Cost & manufacturing event* tahun 2016 mendapat point 25.4 dari total point 100 dengan urutan peringkat meningkat menjadi peringkat 35. Pada tahun 2017, pengembangan kendaraan dari semua sistem lebih diperhitungkan dari segi fungsional setiap part, desain, pemilihan bahan, proses, dan ketelitian dari pembuatan cost report agar mendapat point tinggi. Karena dari penilaian juri ada 3 bagian utama yang dinilai yaitu total biaya, akurasi (ketepatan & ketelitian), dan skenario pembuatan sebuah *part* per-tahun (*real case*).

Pertimbangan dalam pembuatan desain, pemilihan bahan, dan ukuran bahan setiap *part* kendaraan akan menentukan nilai harga dari part tersebut. Setiap desain memiliki tingkat kesulitan pengerjaan dan ukuran yang berbeda serta memiliki harga yang berbeda pula. Desain yang sederhana namun kuat dan fungsional dengan bahan yang sudah mencukupi untuk kegunaan fungsional part tersebut akan memberikan performa yang baik dan nilai harga yang efisien. Maka dengan harga yang semakin rendah maka point yang akan didapatkan akan semakin tinggi.

B. Identifikasi Masalah

Berdasarkan latar belakang yang sudah dijabarkan diatas, bahwa masih banyak permasalahan yang masih harus diperbaiki pada kendaraan FG16. Permasalahan pertama kendaraan FG16 pada saat *general inspection* di kompetisi *Student Formula Japan* 2016 yaitu: (1) posisi leher tangki bahan bakar yang keluar dari struktur utama rangka dan tidak sesuai regulasi,

sehingga dilakukan perbaikan dengan menambah struktur utama rangka sebagai pelindung leher tangki bahan bakar. (2) Travel suspensi yang kurang dari 50mm karena setelan suspensi yang terlalu keras, sehingga perlu disetel ulang untuk memenuhi regulasi. (3) tutup rantai bagian atas tidak ada, sehingga harus membuat tutup rantai bagian atas ketika kompetisi.

Kemudian selanjutnya permasalahan di *technical inspection* bagian *noise test*. Tingkat kebisingan suara gas buang dari knalpot (Db:*Decibel*) yang melebihi aturan. Sehingga perlu dilakukan modifikasi pada ujung *muffler* untuk mereduksi suara tersebut. Pada pengujian rem (*brake test*) juga mengalami permasalahan yaitu roda tidak mengunci secara bersamaan. Kemudian dilakukan *bleeding* pada sistem untuk menghilangkan udara dalam sistem dan penggantian ban.

Berat kendaraan yang masih tinggi juga merupakan sebuah permasalahan yang bisa diminimalisir dengan mereduksi beban untuk pengembangan kendaraan di tahun selanjutnya. Karena bobot kendaraan FG16 sebesar 220.5 kg. walaupun sudah mengalami penurunan berat dari tahun sebelumnya sebesar 20 kg, namun masih bisa direduksi lagi agar performa kendaraan bisa meningkat dan tidak membebani mesin.

Dari segi laporan, untuk *cost report* kendaraan FG16 juga masih jauh dari point maksimal. Tim Garuda UNY hanya mampu memperoleh total poin sebesar 25.4 dari 100 poin. Permasalahan yang dapat dilihat di dalam *cost report* adalah tingginya total biaya pembuatan kendaraan FG16 yang mencapai $16.971.81. Beberapa penyebab tingginya biaya pada *cost report*

dipengaruhi oleh desain, material dan proses pembuatan yang digunakan. Salah satu *part* utama yang wajib mengalami perubahan setiap tahun yaitu dari rangka. Desain rangka kendaraan FG16 masih bisa dikembangkan lagi menjadi lebih baik dan lebih ringan tanpa mengorbankan kekuatan. Desain rangka yang meliputi jenis dan ukuran material yang digunakan untuk membuat rangka serta proses pembuatannya berpengaruh pada biaya, namun dapat direduksi menjadi lebih murah. Serta pada dunia industri otomotif perhitungan biaya penggunaan material maupun biaya peroses manufaktur selalu dilakukan sebagai data untuk penentuan harga produk yang akan dipasarkan. Pembuatan *cost report* atau laporan biaya terkait material, proses manufaktur, pengikatan dan perkakas yang digunakan untuk membuat sebuah produk dapat dimasukkan ke dalam materi manajemen industri otomotif. Karena materi terkait perhitungan biaya produksi material dari bahan mentah hingga barang jadi belum secara detail terdapat pada mata kuliah manajemen industri otomotif. Permasalahan tersebut dapat menjadi bahan penelitian untuk pengembangan kendaraan FG17 yang selanjutnya dan pengembangan materi mata kuliah manajemen industri otomotif.

C. Batasan Masalah

Dari hasil identifikasi masalah yang sudah dilakukan dan dituliskan diatas, terdapat beberapa masalah yang ada pada kendaraan FG16. Penelitian ini dibatasi hanya pada analisa pengaruh *cost* pada material dan

manufaktur (proses pembuatan) *frame* terhadap total *cost report* kendaraan FG16.

D. Rumusan Masalah

Rumusan masalah dari penelitian tugas akhir ini adalah:

1. Berapa besar kontribusi biaya material *frame* kendaraan FG16 terhadap total *cost report* FG16?
2. Berapa besar kontribusi biaya proses manufaktur *frame* kendaraan FG16 terhadap total *cost report* FG16?
3. Bagaimana peran pembuatan dokumen *cost report* dalam kompetensi abad 21 dan pengembangan materi mata kuliah Manajemen Industri Otomotif?

E. Tujuan Penelitian

Tujuan penelitian tugas akhir ini adalah:

1. Untuk mengetahui pengaruh total biaya material *frame* terhadap *cost report* kendaraan FG16.
2. Untuk mengetahui pengaruh total biaya proses pembuatan *frame* terhadap *cost report* kendaraan FG16.
3. Untuk mengembangkan materi mata kuliah Manajemen Industri Otomotif dan disesuaikan dengan kompetensi abad 21.

F. Manfaat Penelitian

Manfaat penelitian tugas akhir ini adalah:

1. Untuk menambah dan memperluas ilmu pengetahuan pada studi perkuliahan.

2. Sebagai sarana riset dan pengembangan kendaraan FG16 dari segi biaya, pemilihan material, dan proses manufaktur rangka.
3. Dapat digunakan sebagai referensi untuk pembuatan *frame* kendaraan yang selanjutnya.
4. Dapat digunakan sebagai referensi untuk memilih bahan dan proses pembuatan yang tepat untuk *frame* pada kendaraan yang selanjutnya.
5. Sebagai tambahan dan pengembangan materi mata kuliah manajemen industri otomotif.

BAB II

KAJIAN TEORI

A. Deskripsi Teori

1. Rangka

Menurut Kamaraju Ramakrishna (2012:15), rangka kendaraan (*automobile frame*) adalah struktur yang menyupport semua komponen penting dari mobil. Rangka merupakan salah satu bagian penting pada mobil yang bisa dikatakan menjadi tulang punggung sebuah kendaraan dan harus mempunyai kontruksi kuat untuk menahan atau memikul beban kendaraan. Semua beban dalam kendaraan baik itu penumpang, mesin, sistem kemudi, dan segala peralatan kenyamanan semuanya diletakan di atas rangka. Oleh karena itu setiap kontruksi rangka harus mampu untuk menahan semua beban dari kendaraannya.

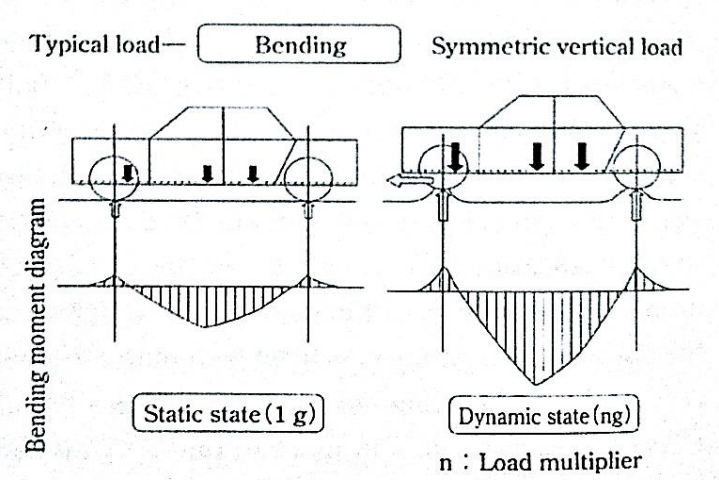
Rangka adalah bagian utama dari chassis dimana semua bagian-bagian chassis yang tersisa dipasang (R.K. Rajput, 2007:409). Rangka menopang semua bagian utama kendaraan seperti *engine*, transmisi, suspensi, kemudi, roda, dan bagian lain.

a. Fungsi utama rangka

Fungsi utama dari rangka (Kamaraju Ramakrishna, 2012:15) adalah sebagai berikut :

1) Rangka menerima beban dan dorongan dari *engine*, transmisi dan komponen lain. Beban bengkok (*bending*) ke atas dan kebawah diterima oleh rangka/*body* (Yukio Shimada, 2007:50). Beban

bengkok ini diterima ketika kendaraan diam (*static*) atau kendaraan berjalan (*dynamic*).

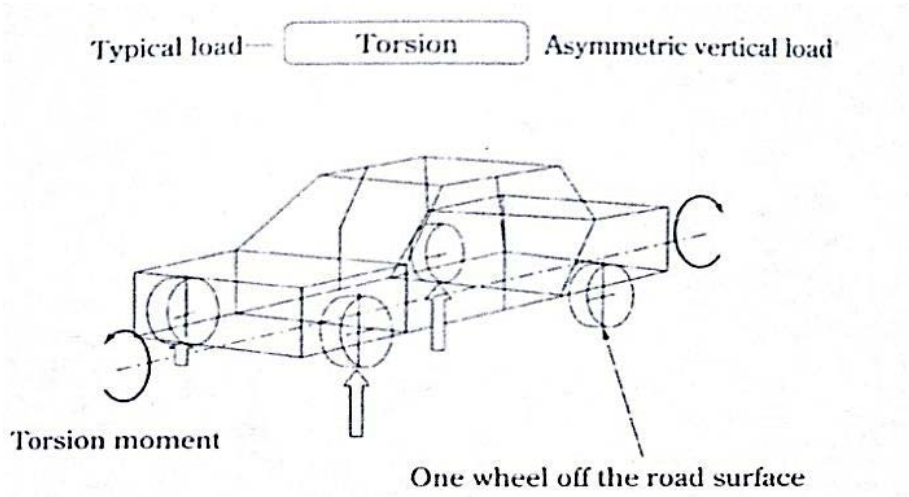


Gambar 1. *Bending Load Excerted on Body/Frame*

(Sumber : *Motor Car Development/Fabrication Guide – For Students and Junior Engineers, JSAE*, 2007:50)

2) Untuk meredam dan menyerap gaya akibat beban kejut yang diakibatkan benturan dengan benda lain.

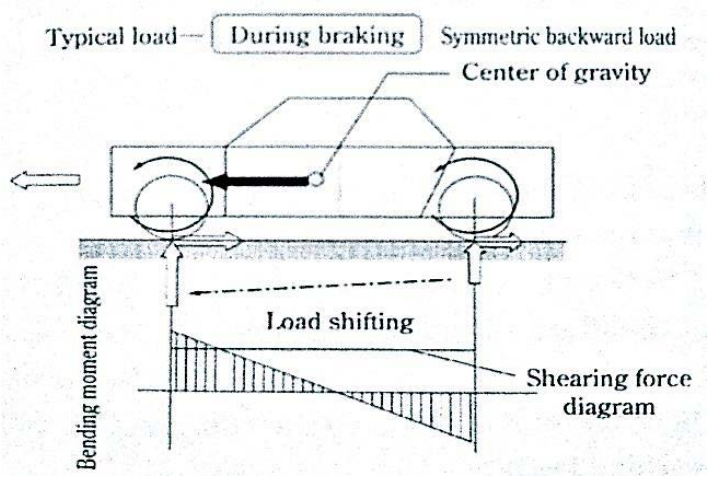
3) Untuk menahan gaya puntiran (torsi) dan menguraikannya secara keseluruhan pada tanah yang tidak rata. Ketika beban asimetris keatas dan kebawah diterima kendaraan, rangka/body mendapat beban torsi (Yukio Shimada, 2007:51). Beban ini bisa terjadi ketika kendaraan melewati jalan yang tidak rata atau tumpuan yang tidak sama dan membuat salah satu roda tidak menapak pada permukaan jalan (terangkat).



Gambar 2. *Torsion Load Exerted*

(Sumber : *Motor Car Development/Fabrication Guide – For Students and Junior Engineers, JSAE*, 2007:51)

4) Untuk menahan beban ketika aksi percepatan dan perlambatan (*braking*). Gaya inersia kendaraan digantikan oleh aksi gaya pada *center of gravity* (cg) yang memusat (Yukio Shimada, 2007:51). Dapat dilihat pada gambar dibawah ini, bahwa ketika terjadi pengereman, pergerakan *center of gravity* akan berpindah ke depan menggantikan aksi gaya inersia kendaraan. Sehingga beban pada roda depan lebih besar dibanding roda belakang ketika *braking*.



Gambar 3. *Load During Braking*

(Sumber : *Motor Car Development/Fabrication Guide – For Students and Junior Engineers, JSAE*, 2007:51)

5) Untuk meredam dan menyerap gaya akibat beban kejut yang diakibatkan benturan dengan benda lain.
6) Sebagai landasan untuk mengakomodasi/meletakkan bodi kendaraan, mesin, sistem transmisi, tangki bahan bakar dll.
7) Untuk menahan getaran dari mesin dan getaran akibat permukaan jalan.

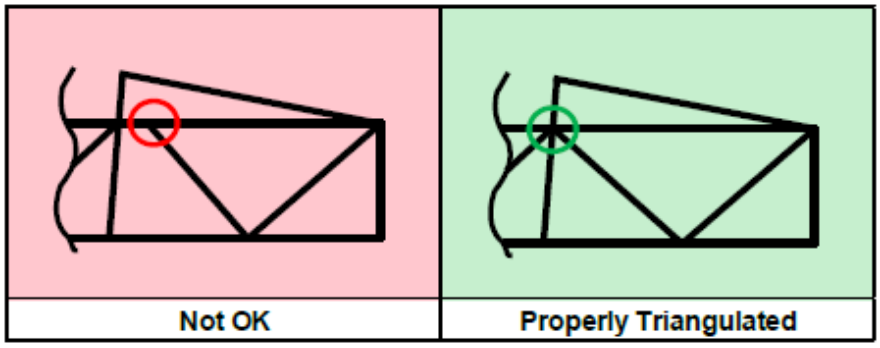
b. Regulasi Rangka berdasarkan 2016 *Formula SAE Rule*

Pada perancangan rangka kendaraan *formula student* harus dan wajib mengacu pada regulasi 2016 *Formula SAE Rule*. Dimensi dan acuan bentuk desain rangka yang diperbolehkan dapat dibaca di 2016 *Formula SAE Rule* bagian T.3. Rangka kendaraan *Formula Student* memiliki struktur utama yaitu:

- *Main hoop* : *roll bar* rangka yang berlokasi di belakang *driver.*

- *Front hoop* : *roll bar* rangka yang berlokasi di depan *driver* dan dekat dengan *steering wheel*.
- *Main hoop braces and support* : bagian rangka yang berada diantara *main hoop* dan *front hoop* dan berfungsi juga sebagai penghubung dan *support* untuk bagian *main hoop* dengan *front hoop*.
- *Side impact structure* : struktur rangka di bagian samping *driver* terhitung dari 350 mm diatas tanah.
- *Front bulkhead* : struktur rangka yang ada di bagian paling depan dan sebagai dudukan untuk *mounting* dari *impact attenuator*.
- *Front bulkhead support system*.
- *All frame member, guides dan supports.*

Penentuan *node* atau tringulasi yang baik harus memiliki satu titik temu antara satu pipa dengan pipa yang lain.



Gambar 4. Tringulasi

(Sumber : 2016 *Formula SAE Rule*, 2015:25)

Kemudian untuk bentuk bahan yang harus digunakan dalam rangka *formula student* ini adalah melingkar (pipa), *mild* atau *alloy*, atau pipa besi (minimum 0.1% *carbon*) dengan dimensi minimal sebagai berikut:

Tabel 1. Regulasi penggunaan dimensi bahan *frame*

ITEM or APPLICATION	OUTSIDE DIMENSION X WALL THICKNESS
Main & Front Hoops, Shoulder Harness Mounting Bar	Round 1.0 inch (25.4 mm) x 0.095 inch (2.4 mm) or Round 25.0 mm x 2.50 mm metric
Side Impact Structure, Front Bulkhead, Roll Hoop Bracing, Driver's Restraint Harness Attachment (except as noted above) EV: Accumulator Protection Structure	Round 1.0 inch (25.4 mm) x 0.065 inch (1.65 mm) or Round 25.0 mm x 1.75 mm metric or Round 25.4 mm x 1.60 mm metric or Square 1.00 inch x 1.00 inch x 0.047 inch or Square 25.0 mm x 25.0 mm x 1.20 mm metric
Front Bulkhead Support, Main Hoop Bracing Supports, Shoulder Harness Mounting Bar Bracing EV: Tractive System Components Protection	Round 1.0 inch (25.4 mm) x 0.047 inch (1.20 mm) or Round 25.0 mm x 1.5 mm metric or Round 26.0 mm x 1.2 mm metric
Bent Upper Side-Impact Member (T3.24.3a)	Round 1.375 inch (35.0mm) x 0.047 inch (1.20mm)

(Sumber : 2016 *Formula SAE Rule*, 2015:25)

Bahan rangka yang dibuat juga memiliki batas minimal kekuatan yang wajib terpenuhi, yaitu:

Menurut *SAE International* dalam *Formula SAE Rule* tahun 2015-2016, kekuatan tanpa pengelasan untuk perhitungan bahan kontinyu:

- *Young Modulus* (E) = 200 GPa
- *Yield Strength* (Sy) = 305 MPa
- *Ultimate Strength* (Su) + 365 MPa

Kekuatan las untuk bahan terputus-putus seperti perhitungan bersama:

- *Yield Strength* (Sy) = 180 MPa
- *Ultimate Strength* (Su) = 300 MPa.

Penjabaran desain *frame* yang rinci sudah tertulis dengan rapi di 2016 *Formula SAE Rule* bagian T3. *Rule* ini sebagai acuan utama dalam pembuatan desain rangka disamping juga dengan referensi buku-buku yang lainnya.

Untuk menguji desain dari *frame* dapat dicoba dengan beberapa jenis bahan melalui *software* seperti *Solid Work*, ANSYS, *Inventor*, atau *software* yang lain. Analisa kekuatan tersebut nanti yang akan menjadi dasar apakah bahan yang digunakan untuk struktur *frame* sudah mencukupi sesuai kebutuhan dan sesuai dengan regulasi atau tidak. setelah semua variabel untuk pembuatan rangka sudah mencukupi, maka desain *frame* dapat dilanjutkan ke tahap pembuatan. Bentuk desain rangka yang sudah ditentukan sudah mewakili jenis bahan dan ukuran bahan yang nantinya akan dihitung untuk perhitungan biaya yang dibutuhkan beserta biaya proses manufakturnya.

c. Jenis-jenis rangka

Menurut Rajput, R.K. (410:2007), ada beberapa jenis bahan rangka yang biasa digunakan. Berikut ini jenis dari bahan rangka berdasarkan jenis penampangnya :

1) *Channel section*

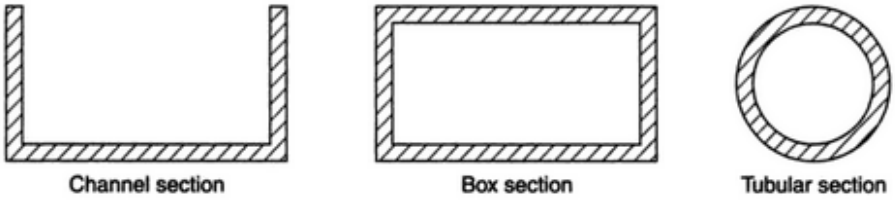
Channel section biasa digunakan di bagian yang panjang dari rangka (Rajput, R.K., 410:2007). *Channel section* baik pada *bending*.

2) *Box section*

Box section biasa digunakan di bagian yang pendek dari rangka (Rajput, R.K., 410:2007). Rangka jenis ini baik pada bending dan torsi.

3) *Tubular section*

Tubular frame biasa digunakan di kendaraan roda tiga, sepeda motor dan *scooters* (Rajput, R.K., 410:2007).



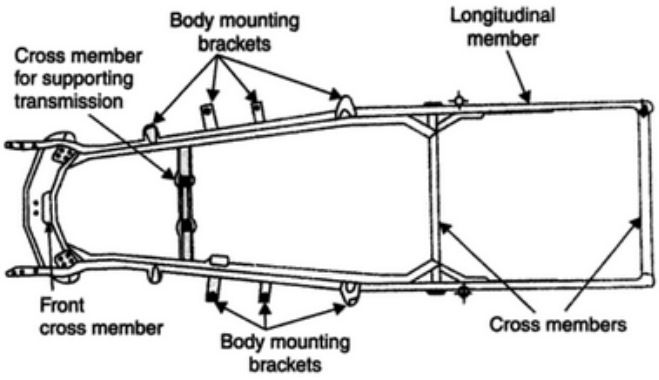
Gambar 5. Penampang bahan logam pembuat rangka

(Sumber : *A Text Book of Automobile Engineering*, 2007:410)

Sedangkan pada dasarnya ada 3 tipe *frame* rangka yang biasa digunakan pada kendaraan, yaitu :

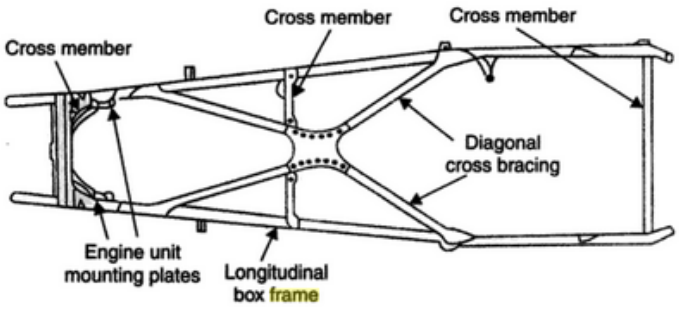
1) *Conventional Frame*

Rangka ini juga diketahui sebagai *non-load carrying frame* (Rajput, R.K., 410:2007). Rangka jenis ini memiliki dua bagian sisi panjang dan yang digabung dengan paku keling atau baut. Beban yang ada disini ditransfer dan di terima oleh sistem suspensi, yang juga menopang dari mesin, sistem pemindah tenaga dan bodi. Tipe rangka ini tidak terlalu kuat dalam menerima beban puntir.



Gambar 6. *Box-section type*

(Sumber : *A Text Book of Automobile Engineering*, 2007:411)



Gambar 7. *X-member type*

(Sumber : *A Text Book of Automobile Engineering*, 2007:411)

Pembuatan rangka menggunakan bahan penampang pipa atau kotak akan menambah tingkat kekuatan rangka. Dalam pembuatan rangka tipe ini pun menggunakan cara pengelasan menggunakan bahan pipa bulat atau pipa kotak untuk meningkatkan *torsional rigidity* dari rangka.

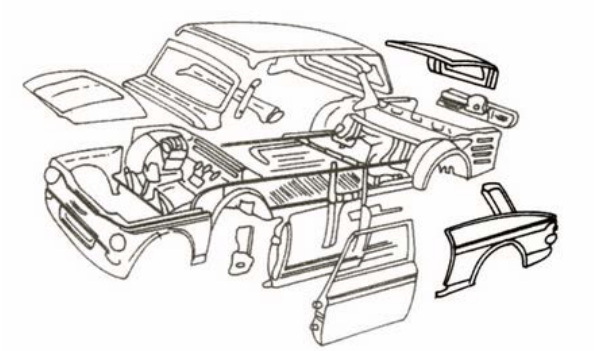
2) *Semi Integral Frame*

Rangka ini memiliki beban yang berat dan cukup popular pada kendaraan Eropa dan kendaraan Amerika. (Rajput, R.K.,

411:2007). Pada rangka ini, *mounting* karet *body* digantikan oleh *mounting* yang kaku sehingga beban juga akan tertransfer ke struktur *body*. Beban berat tersebut bisa menjadi kekurangan bagi kendaraan yang bisa membebani kendaraan itu sendiri.

3) *Integral or Unit Frame*

Konstruksi tipe ini, tidak terdapat rangka dan semua unit perakitan terpasang pada body (Rajput, R.K., 412:2007). *Integral* atau *unit frame* adalah rangka yang membentuk langsung seperti bodi dari kendaraan itu sendiri. Rangka ini sudah banyak digunakan oleh tim-tim FSAE yang biasanya disebut dengan rangka *monocoque*. Rangka yang menjadi satu dengan body atau rangka yang sudah membentuk body ini lebih ringan.



Gambar 8. *Integral Frame*

(Sumber : *A Text Book of Automobile Engineering*, 2007:412)

2. Material

Menurut Lawrence H. Van Vlack (2004:xv), material adalah bahan yang dapat diperoleh manusia dan dapat diproses untuk menampilkan sifat yang diinginkan guna membuat benda. Material banyak digunakan

sebagai bahan baku kehidupan sehari-hari seperti bahan baku pembangunan sebuah gedung, bahan pembuatan kendaraan, bahan pembuatan alat rumah tangga dan banyak contoh yang lainnya. Mobil adalah salah satu sistem yang tersusun atas banyak material, masing-masing dengan karakteristik yang cocok untuk pemrosesan, bentuk yang sesuai untuk perakitan, dan sifat yang spesifik pemakaiannya.

a. Karakteristik Material

Material memiliki sifat-sifat (karakteristik) yang berbeda-beda. Material dapat dibedakan dari sifat-sifatnya berdasarkan tabel karakteristik berikut :

Tabel 2. Karakteristik Material

SIFAT	LAMBANG	DEFINISI	SATUAN
Konduktivitas Listrik	σ	Fluks muatan pada gradien tegangan	$ohm^{-1} \cdot m^{-1}$
Koduktivitas termal	*k*	Fluks energi pada gradien termal	W/m · °C [(Btu/ft^2 · s)/ (°F/in.)]
Resistivitas	ρ	Kebalikan dari konduktivitas listrik	ohm · m
Tegangan	*s*	Gaya per satuan luas	N/m^2, atau MPa [psi]
Kekuatan	*S*	Tegangan kritis saat gagal	N/m^2, atau MPa [psi]
Regangan	*e*	Perubahan dimensi akibat tegangan	Fraksi, atau %
Keuletan	#	Regangan plastik sebelum patah	Fraksi, atau %
Modulus elastisitas	*E*	Rasio tegangan terhadap regangan elastic	N/m^2, atau MPa [psi]
Kekerasan	Hdn	Ketahanan terhadap penetrasi	#
Ketangguhan	#	Energi yang diserap sebelum perpatahan	#

Keterangan :
[ ] Satuan Inggris
Diterapkan lebih dari satu prosedur.

(Sumber : Elemen-elemen Ilmu dan Rekayasa Material, 2004:7)

b. Tipe-Tipe Material

Dengan jumlah material yang sangat banyak, material diklasifikasikan menjadi berbagai tipe yang memiliki karakteristik yang sama. Menurut Lawrence H. Van Vlack (2004:13), pengelompokan material berdasarkan inti atom dan strukturnya adalah:

1) Logam

Logam merupakan material yang memiliki konduktivitas *thermal* dan listrik yang tinggi (Lawrence H. Van Vlack, 2004:14). Logam memiliki sifat tidak tembus cahaya, dan secara umum dapat dipoles hingga mengkilap. Logam (*metal*) juga dapat dibentuk dan banyak digunakan di berbagai bidang kehidupan seperti bidang otomotif, kelautan, bangunan, dll.

2) Polimer

Polimer sering disebut sebagai plastik (Lawrence H. Van Vlack, 2004:14). Polimer memiliki densitas yang rendah dan dapat dimanfaatkan sebagai *thermal insolator* dan listrik. Beberapa jenis polimer bersifat fleksibel, dapat dibentuk, namun kurang baik dalam memantulkan cahaya.

3) Keramik

Keramik adalah senyawa yang mengandung unsur logam dan non logam (Lawrence H. Van Vlack, 2004:15). Pada umumnya sifat dari keramik ini relatif keras dan rapuh. Namun memiliki ketahanan panas (suhu tinggi) yang sangat baik dibandingkan dengan logam dan polimer. Contoh dari material keramik adalah gelas, isolator listrik, semen pada beton, keramik lantai, dll.

3. *Material Frame*

Material yang digunakan untuk rangka *chassis* bergantung pada tipe dari kendaraan dibawah beberapa pertimbangan (Kamaraju Ramakrishna, 2012:19). Beberapa jenis material yang digunakan adalah material konvensional yaitu *steel* dan *aluminum* serta material *composite*.

a. *Steel*

Steel memberikan kekuatan yang baik, namun memiliki beban yang cukup berat. Sehingga sekarang berkembang rangka yang sudah membentuk menjadi satu kesatuan dengan *body* (*monocoque*) menggunakan *sheet steel*. *Steel plates* dengan kualitas berbeda secara normal digunakan untuk *bodyshell* (Konrad Reif, 2014:1014). Ketebalan plat *bodyshell* yaitu 0.6 sampai 3mm, dan *steel sheet* sekitar 0.75 sampai 1mm. berdasarkan mekanikal property, *steel* dipandang kaku, kuat, ekonomis, dan lembut.

Steel dengan jenis pipa juga menjadi material utama rangka kendaraan *Formula* SAE. Namun dengan aturan ketebalan dan

kekuatannya sesuai regulasi 2016 *Formula SAE Rules*. Rangka yang menggunakan bahan steel pipe paling banyak digunakan, khususnya bagi para tim pemula Formula SAE.

Tabel 3. *E-Modulus* dari *Steel*

Material Group	Material Type	E-Modulus (GPa)
Steel	Unalloyed Steels	≈210
	Low-alloy Steels	≈210
	Austenitic Steels	≥190
	High-alloy Tool Steels	≤230

(Sumber : *Automotive Handbook*, 2014:198)

b. *Aluminum*

Aluminum membuat rangka lebih ringan dan kendaraan akan lebih efisien bahan bakar (Kamaraju Ramakrishna, 2012:19). *Aluminum* lebih diperuntukkan untuk panel *body*, *engine hood*, dan dapat digunakan juga sebagai rangka utama kendaraan *Formula SAE*, dengan persyaratan disesuaikan dengan 2016 *Formula SAE Rules*. *Aluminum* memang memiliki kelebihan yaitu ringan, dibanding dengan bahan *steel*. Namun *aluminum* sudah digunakan pada kendaraan mewah milik Jerman sejak tahun 1994. Rangka kendaraan dikonstruksi dari *aluminum*.

Tabel 4. *E-Modulus* dari *Aluminum*

Material Group	Material Type	E-Modulus (GPa)
Aluminum Alloys	Wrought Aluminum Alloys	65 to 75
	Casting Aluminum Alloys	65 to 80

(Sumber : *Automotive Handbook*, 2014:198)

c. *Composite*

Material komposit adalah material yang terdiri dari paling sedikit 2 komponen secara fisika atau kimiawi yang berbeda (Konrad Reif, 2014:1014). Material komposit dengan *carbon* fiber juga menambah keuntungan konstruksi *body* dan *chassis* (Kamaraju Ramakrishna, 2012:19). *Carbon* fiber memiliki sifat kuat dan ringan. Penggunaan *carbon* fiber sebagai rangka sudah digunakan oleh banyak tim *Formula SAE* khusunya dalam bentuk rangka *monocoque*.

Tabel 5. *Torsional Modulus* dan *Young Modulus* dari variasi tipe *carbon fiber*.

Carbon fiber type	*Young's modulus (GPa)*	*Torsional modulus (GPa)*
Pitch mesophase		
PM-A	184	13.5
PM-B	262	9.0
		9.2
PM-C	364	10.8
		9.7
PM-C (1700)	400	10.4
Isotropic pitch		
KCF-200	80	16.4
KCF-2700	~80	18.0
PAN		
T-400	226	21.4
AS	215	21.0
HM-S(H)	~370	20.2
Modmor I	~400	28.2
HM-S(C)	~380	35.3
Rayon		
T-11 (carbon)	79	15.3
T-12 (graphite)	83	22.8
T-25	176	12.3
T-70	390	12.3
T-75	540	13.8
T-100	680	16.9

(Sumber : *Carbon Fiber Composites*, 1994:77)

4. Manufaktur *frame*

Berdasarkan regulasi dari 2016 *Formula SAE Rule*, pengerjaan yang boleh dilakukan untuk pembuatan rangka kovensional adalah menggunakan las (*weld*) untuk menyatukan bahan pipa menjadi *frame*. Pengerjaan las yang dilakukan akan mempengaruhi total pembiayaan yang dikeluarkan dan dicantumkan dalam *cost report*. Namun seperti apapun desain rangka tersebut, pembuatan *cost report* harus tetap disesuaikan dengan barang aslinya (2016 *Formula SAE Rule* T3.3 : 24).

Pembuatan sebuah rangka kendaraan dapat dilakukan dengan berbagai macam cara sesuai dengan jenis rangka yang akan dibuat. Untuk rangka konvensional, dalam pembuatannya hanya menggunakan pengelasan saja. Pengelasan yang digunakan pun berbeda-beda, seperti SMAW dan Las TIG (argon) yang biasanya masih digunakan untuk pengelasan rangka kendaraan *formula student*.

Rangka monocoque dibuat dengan menggunakan bahan *carbon fiber* yang dicetak dan divakum bersama dengan penguatnya. Pembuatan rangka *monocoque* mirip seperti dengan pembuatan *body*, namun ditambahkan dengan penguat didalam struktur rangka. Karena rangka *monocoque* merupakan rangka jenis *integral* atau *body-on-frame* atau *unit frame* yang menjadi satu dengan *body* atau rangka

yang sudah membentuk *body* sehingga lebih ringan daripada rangka konvensional.

5. *Cost Report*

Cost report adalah laporan pembiayaan dari pembuatan kendaraan untuk semua item yang ada di kendaraan (T4 2016 *Formula SAE Rule* 2015:127). *Cost report* merupakan laporan pembiayaan yang berisi semua harga terkait harga bahan, harga proses pembuatan part, harga pembelian part, dan harga perakitan seluruh sistem. Semua *part* dikalkulasi biayanya tanpa terkecuali, baik *part* terkecil hingga *part* yang terbesar. *Cost report* memiliki nilai poin penuh yaitu 100 poin jika laporan biaya dapat memenuhi 3 bagian penilaian dari *cost report* yaitu nilai dari total biaya, nilai akurasi, dan nilai *real case*, yang terbagi menjadi:

Tabel 6. Pembagian Poin *Cost Report*

The points for the Cost and Manufacturing Event will be broken down as follows:

40x[(Pmax)/(Pyour)-1] [(Pmax)/Pmin)-1]	40 Points	Lowest cost - each of the participating schools will be ranked by total adjusted cost from the BOM and given 0-40 points based on the formula on the left.
	40 Points	Accuracy, Clarity & Event Day/Visual Inspection - The cars will be reviewed for part content, manufacturing feasibility and accuracy of the cost information. Supporting documentation will be assessed based on its quality, accuracy and thoroughness. The range for the score is 0-40 points.
	20 Points	Event Day/Manufacturing Processes - The teams must be prepared to discuss in detail the "real case" scenario distributed prior to the competition. The materials will include more specifics about the goal and scoring of the scenario. The range for the score is 0-20 points.
Total	100 Points	

(Sumber : 2016 *Formula SAE Rule,* 2015:130)

Total biaya terendah maka akan mendapat nilai penuh 40 poin, kemudian untuk *cost report* yang memiliki akurasi meliputi ketelitian, ketepatan, dan tidak ada part yang terlewat satupun didalam pembuatan

cost report maka akan mendapat poin penuh 40 poin, dan apabila tim dapat membuat analisa pembuatan sebuah part secara efektif serta efisien dalam 1 tahun dari berbagai pertimbangan, maka akan mendapat poin penuh 20 poin. Kemudian di total secara keseluruhan menjadi 100 poin.

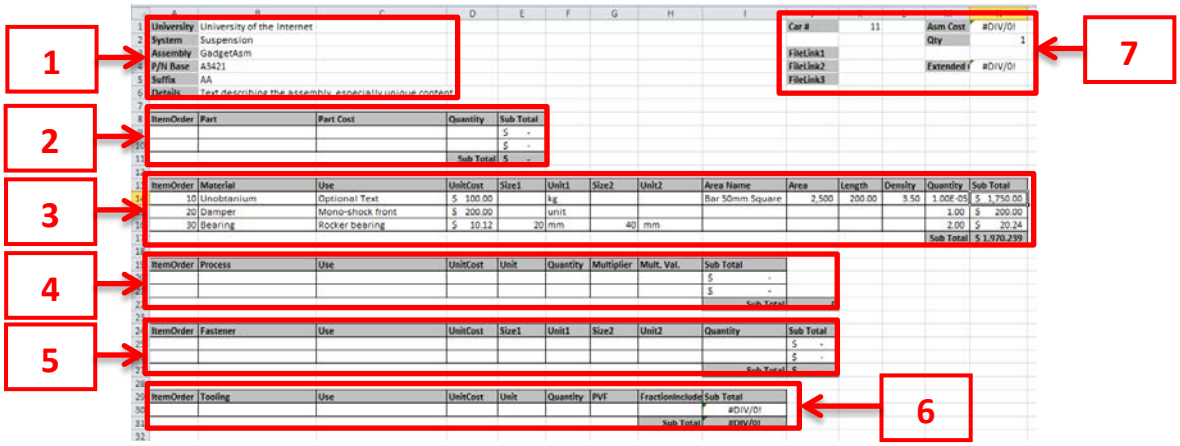
Semua bagian *part* dan *assembly* setiap sistem di kendaraan tertera didalam BOM (*Bill Of Material*). BOM (*Bill Of Material*) adalah list semua *part* yang ada di *cost report* yang nantinya berisi harga total dari setiap *part*, *assembly*, sistem dan harga total kendaraan.

Di dalam *cost report* (laporan pembiayaan) yang dibuat, terdapat 4 variabel penting yang wajib diketahui dalam membuat sebuah *part* hingga *part* tersebut fungsional terpakai di kendaraan. 4 variabel tersebut adalah jenis dan ukuran bahan yang digunakan (*material*), proses pembuatan/perakitan *part* (*process*), pengikat yang dibutuhkan (*fastener*), dan perkakas/peralatan yang digunakan (*tooling*). Semua data tersebut sudah tersedia dalam bentuk tabel harga yang terbagi sesuai masing-masing variabel yaitu: *materials table*, *processes table*, *fasteners table*, dan *toolings table*. Pengisian data *cost report* dan cara pengerjaan *cost report* memiliki aturan yang disesuaikan dengan regulasi di dalam *Formula SAE Rule*.

Untuk perhitungan *cost report* ada di dalam *FCA Input*. *FCA Input* berisi perhitungan dari keseluruhan pembiayaan yang dikeluarkan untuk membuat sebuah *part* atau merakit sebuah sistem *assembly*. Jenis

material, ukuran material, jenis proses, jenis *fastener*, dan jenis *tooling* memiliki perhitungan kalkulasi masing-masing. *Sheet* untuk perhitungan pada *file FCA input* memiliki 2 jenis yaitu *Sheet Assembly* dan *Sheet Part*.

Cara pengisian data untuk perhitungan biaya menggunakan *FCA Input* :



Gambar 9. *FCA Input*

(Sumber : *SAE International* 2016 - *www.fsaeonline.com*)

Mengisikan kolom pada *file FCA input* sesuai yang terbagi diatas:

Bagian 1

University	Universitas Negeri Yogyakarta
System	Brake System
Assembly	Brake Rotor
P/N Base	A0001
Suffix	AA
Details	Iron Brake Rotor

Gambar 10. Bagian 1 *Assembly Sheet*

University	Universitas Negeri Yogyakarta
System	Frame & Body
Assembly	Impact Attenuator
Part	Plate Structural Impact Attenuator
P/N Base	00001
Suffix	AA
Details	Impact Attenuator Made by Student

Gambar 11. Bagian 1 *Part Sheet*

(Sumber : *FCA Input*, *SAE International* – *www.fsaeonline.com*)

- *University* : Nama universitas
- *System* : Nama sistem

- *Assembly* : Nama *assembly*
- *Part* : Nama *part*
- *P/N Base* : Nomor dasar *assembly* atau *part* sesuai nomor *BOM*
- *Suffix* : Kode revisi (huruf depan = revisi desain, huruf belakang = revisi proses)
- *Details* : Deskripsi *assembly* atau *part*

Bagian 2

ItemOrder	Part	Part Cost	Quantity	Sub Total
10	Plate Structural Impact Attenuator	$ 71.92	1	$ 71.923
20	Anti-Intrusion Plate	$ 10.94	1	$ 10.940
			Sub Total	**$ 82.863**

Gambar 12. Bagian 2 *Assembly* & *Part Sheet*

(Sumber : *FCA Input*, *SAE International – www.fsaeonline.com*)

- *ItemOrder* : Nomor urut item
- *Part* : Nama *part*
- *Part Cost* : Biaya *part*
- *Quantity* : Kuantitas *part*
- *Sub Total* : Total biaya

Bagian 3

ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Unobtanium	Optional Text	$ 100.00		kg			Bar 50mm Square	2,500	200.00	3.50	0.00001	$ 1,750.00
20	Damper	Mono-shock front	$ 200.00		unit							1.00	$ 200.00
30	Bearing	Rocker bearing	$ 10.12	20	mm	40	mm					2.00	$ 20.24
												Sub Total	**$ 1,970.239**

Gambar 13. Bagian 3 *Assembly* & *Part Sheet*

(Sumber : *FCA Input*, *SAE International – www.fsaeonline.com*)

- *ItemOrder* : Nomor urut item
- *Material* : Nama material yg digunakan sesuai tabel material

- *Use* : Fungsi/Kegunaan material
- *UnitCost* : Biaya material per unit sesuai tabel material
- *Size1* : Ukuran material sesuai desain yang disesuaikan jenis ukuran *Size1* yang tertera pada tabel material
- *Unit1* : Satuan ukuran *Size1* disesuaikan pada tabel material
- *Size2* : Ukuran material sesuai desain yang disesuaikan jenis ukuran *Size2* yang tertera pada tabel material
- *Unit2* : Satuan ukuran *Size2* disesuaikan pada tabel material
- *AreaName* : Nama posisi area yang akan dimasukkan perhitungan
- *Area* : Ukuran luas area (cm^2)
- *Length* : Panjang material yang tegak lurus dengan area (cm)
- *Density* : Berat Jenis (kg/cm^3)
- *Quantity* : Kuantitas unit
- *Sub Total* : Total biaya

Bagian 4

ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Weld	Joining Plate	$ 0.15	cm	16		1	$ 2.40
20	Assemble, 3 kg, Line-on-Line	Put Impact	$ 0.38	unit	4		1	$ 1.52
30	Ratchet <= 25.4 mm	Tighten bolt	$ 0.75	unit	1	repeat 4	4	$ 3.00
							Sub Total	**$ 2.40**

Gambar 14. Bagian 4 *Assembly* & *Part Sheet*

(Sumber : *FCA Input*, *SAE International – www.fsaeonline.com*)

- *ItemOrder* : Nomor urut item
- *Process* : Nama proses yang dilakukan sesuai tabel proses
- *Use* : Fungsi/Kegunaan proses
- *UnitCost* : Biaya proses per unit sesuai tabel proses

- *Unit* : Satuan sesuai yang tertera pada tabel proses
- *Quantity* : Kuantitas unit
- *Multiplier* : Nama pengerjaan ganda sesuai tabel *multiplier*
- *Mult. Val.* : Kuantitas *multiplier*
- *Sub Total* : Total biaya

Bagian 5

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2	Unit2	Quantity	Sub Total
10	Bolt, Grade 12.9	Impact Attenuator Bolts	$ 0.422	10	mm	40	mm	4	$ 1.69
20	Nut, Grade 12.9	Impact Attenuator Nuts	$ 0.111	10	mm			4	$ 0.44
30	Washer, Grade 12.9	Impact Attenuator Washer	$ 0.020	8				8	$ 0.16
								Sub Total	$ 2.29

Gambar 15. Bagian 5 *Assembly* & *Part Sheet*

(Sumber : *FCA Input*, *SAE International – www.fsaeonline.com*)

- *ItemOrder* : Nomor urut item
- *Fastener* : Nama proses yang dilakukan sesuai tabel proses
- *Use* : Fungsi/Kegunaan pengikat (*fastener*)
- *UnitCost* : Biaya proses per unit sesuai tabel *fastener*
- *Size1* : Ukuran *fastener* sesuai desain yang disesuaikan jenis ukuran *Size1* yang tertera pada tabel *fastener*
- *Unit1* : Satuan ukuran *Size1* disesuaikan pada tabel *fastener*
- *Size2* : Ukuran *fastener* sesuai desain yang disesuaikan jenis ukuran *Size2* yang tertera pada tabel *fastener*
- *Unit2* : Satuan ukuran *Size2* disesuaikan pada tabel *fastener*
- *Quantity* : Kuantitas *fastener*
- *Sub Total* : Total biaya

Bagian 6

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FractionIncluded	Sub Total
10	Welds	Welding Fixture	$ 500	point	4	3000	1	$ 0.67
							Sub Total	**$ 0.67**

Gambar 16. Bagian 6 *Assembly* & *Part Sheet*

(Sumber : *FCA Input*, *SAE International – www.fsaeonline.com*)

- *ItemOrder* : Nomor urut item
- *Tooling* : Nama proses yang membutuhkan perkakas atau perlakukan sesuai tabel *tooling*
- *Use* : Fungsi/Kegunaan proses *tooling*
- *UnitCost* : Biaya proses perkakas per unit sesuai tabel *tooling*
- *Unit* : Satuan sesuai yang tertera pada tabel *tooling*
- *Quantity* : Kuantitas unit
- *PVF* : Faktor Volume Produksi (3000)
- *FractionIncluded* : Jumlah pecahan perkakas
- *Sub Total* : Total biaya

Bagian 7

Car #	29		**Asm Cost**	$ 88.22
			Qty	1
FileLink1				
FileLink2			**Extended Cost**	$ 88.22
FileLink3				

Gambar 17. Bagian 7 *Assembly Sheet*

Car #	29		**Part Cost**	$ 68.59
			Qty	1
FileLink1				
FileLink2			**Extended Cost**	$ 68.59
FileLink3				

Gambar 18. Bagian 7 *Part Sheet*

(Sumber : *FCA Input*, *SAE International – www.fsaeonline.com*)

- *Car#* : Nomor kendaraan
- *Asm Cost* : Biaya *assembly*
- *Part Cost* : Biaya *part*

- *Qty* : Jumlah *assembly* atau *part*
- *Extended Cost* : Total biaya *assembly* atau *part*
- *FileLink1-3* : *File hyperlink*

6. Kurikulum Prodi S1 Pendidikan Teknik Otomotif

a. Visi

1) Jangka Panjang

Pada tahun 2025 menjadi Program Studi Pendidikan Teknik otomotif yang unggul dalam bidang teknologi dan kejuruan otomotif berlandaskan ketaqwaan, kemandirian, dan kecendikiaan.

2) Jangka Pendek

Pada tahun 2025 Program Studi Pendidikan Teknik otomotif mampu berprestasi di tingkat nasional dan internasional dalam bidang teknologi dan kejuruan otomotif berlandaskan ketaqwaan, kemandirian, dan kecendikiaan.

b. Misi

1) Menyelenggarakan dan mengelola pendidikan untuk menghasilkan lulusan yang berakhlaq mulia, berkarakter nasionalisme.
2) Menyelenggarakan dan mengelola pendidikan untuk menghasilkan lulusan yang memiliki karakter entrepeneurship, mandiri, dan mampu berwirausaha.
3) Menyelenggarakan dan mengelola pendidikan untuk menghasilkan lulusan yang berprestasi dibidang akademik maupun non akademik bertaraf nasional dan internasional.

4) Menyelenggarakan dan mengelola proses pembelajaran sesuai dengan standar mutu lulusan.
5) Menyelenggarakan dan mengelola peroses penilaian dan evaluasi hasil belajar berbasis kompetensi.
6) Mengembangkan dosen dan tenaga kependidikan sesuai dengan tuntutan kompetensi dan profesionalitas.
7) Mengembangkan sarana dan prasarana pendidikan berdasarkan tuntutan kurikulum dan perkembangan ilmu pengetahuan dan teknologi.
8) Menyelenggarakan dan mengelola pendidikan berdasarkan standar nasional dan atau internasional.
9) Melaksanakan penelitian dasar, terapan, dan pengembangan dalam bidang kependidikan dan non kependidikan sesuai dengan perkembangan ilmu pengetahuan dan teknologi, perkembangan sosial ekonomi dan perkembangan lingkungan masyarakat baik lokal, nasional maupun internasional.
10) Melaksanakan pengabdian kepada masyarakat yang mendorong pengembangan potensi masyarakat sesuai dengan bidang ilmu dan teknologi otomotif.
11) Mengembangkan berbagai sumber daya dan kerjasama untuk mendukung tercapainya visi dan misi program studi.
12) Mengembangkan kegiatan kemahasiswaan dengan meningkatkan kreatifitas, inovasi, kemandirian, entrepreneurship dan

mengembangkan karakter nasionalisme, kemandirian, akhlaq mulia dan kecendikaan.

13) Mengembangkan budaya akademik dan non akademik yang kondusif.
14) Memeliharan dan menjaga kelestarian lingkungan dalam mendukung akademik.
15) Menyelenggarakan tata kelola jurusan yang transoaran dan akuntabel.

c. Profil Lulusan

1) Guru pada Sekolah Menengah Kejuruan di bidang Teknik Otomotif
2) Instruktur Diklat pada Lembaga Pendidikan Kejuruan Otomotif
3) Instruktur Diklat pada pusat-pusat Pendidikan dan Latihan di Industri bidang Otomotif.
4) Perancang Program Pelatihan dalam bidang pendidikan dan teknik otomotif

d. Capaian Pembelajaran

1) SIKAP

Setiap lulusan program studi Pendidikan Teknik Otomotif harus memiliki sikap sebagai berikut :

a) Bertakwa kepada Tuhan Yang Maha Esa dan mampu menunjukkan sikap religius;
b) Menjunjung tinggi nilai kemanusiaan dalam menjalankan tugas berdasarkan agama, moral, dan etika;

c) Berkontribusi dalam peningkatan mutu kehidupan bermasyarakat, berbangsa, bernegara, dan kemajuan peradaban berdasarkan pancasila;
d) Berperan sebagai warga negara yang bangga dan cinta tanah air, memiliki nasionalisme serta rasa tanggungjawab pada negara dan bangsa;
e) Menghargai keanekaragaman budaya, pandangan, agama, dan kepercayaan, serta pendapat atau temuan orisinal orang lain;
f) Bekerja sama dan memiliki kepekaan sosial serta kepedulian terhadap masyarakat dan lingkungan;
g) Taat hukum dan disiplin dalam kehidupan bermasyarakat dan bernegara;
h) Menginternalisasi nilai, norma, dan etika akademik;
i) Menunjukkan sikap bertanggung jawab atas pekerjaan di bidang otomotif secara mandiri.
j) Menginternalisasi semangat kemandirian, kejuangan, dan kewirausahaan;

2) PENGUASAAN PENGETAHUAN

Lulusan akan memiliki:

a) Menguasai pengetahuan prinsip-prinsip dasar dan pengembangan teknologi pembelajaran bidang teori dan praktik teknik otomotif.

b) Menguasai pengetahuan tentang teknologi otomotif, teori dan praktik yang meliputi: kendaraan ringan, alat berat, desain dan perbaikan bodi, dan sepeda motor,

c) Mempunyai kemampuan merencanakan dan mendesain strategi dan model pengembangan pembelajaran bidang teknik otomotif secara berkelanjutan.

d) Menyelenggarakan pembelajaran pendidikan teknik otomotif yang mendidik melalui pemahaman karakteristik pesertadidik, merencanakan, melaksanakan, mengevaluasi dan merefleksi proses pembelajaran sistemik dan sistematik dalam lingkup lingkungan terbatas.

e) Mempunyai kemampuan mengelola sarana dan prasarana praktek bengkel dan laboratorium.

3) KETERAMPILAN KHUSUS

Secara Khusus Lulusan akan mampu:

a) Mampu merencanakan, melaksanakan, dan mengevaluasi proses pembelajaran yang mendidik, aktif, inovatif, kreatif, dan menyenangkan melalui penggunaan model dan media pembelajaran dalam bidang teknik otomotif.

b) Mampu mengaplikasikan strategi dan metode pembelajaran sesuai dengan perkembangan IPTEKS, sehingga dapat membekali peserta didik untuk memiliki pengetahuan, keterampilan dan kecakapan hidup.

c) Mampu mengaplikasikan dan mengembangkan teknologi otomotif, merawat, memperbaiki, dan memodifikasi kendaraan bermotor.

4) KETERAMPILAN UMUM

Secara Umum Lulusan akan mampu:

a) Menerapkan pemikiran logis, kritis, sistematis, dan inovatif dalam konteks pengembangan atau implementasi ilmu pengetahuan dan/atau teknologi otomotif,

b) Mengkaji implikasi pengembangan atau implementasi ilmu pengetahuan, teknologi otomotif berdasarkan kaidah, tata cara dan etika ilmiah untuk menghasilkan solusi, gagasan, desain, serta menyusun deskripsi saintifik hasil kajiannya dalam bentuk skripsi atau laporan tugas akhir;

c) Mengambil keputusan secara tepat dalam konteks penyelesaian masalah di bidang otomotif, berdasarkan hasil análisis terhadap informasi dan data;

d) Mengelola pembelajaran secara kelompok dan/atau mandiri.

e) Mengembangkan dan memelihara jaringan kerja dengan pembimbing, kolega, sejawat baik di dalam maupun di luar lembaganya.

7. Mata Kuliah Manajemen Industri Otomotif

Dalam mata kuliah MIO (Manajemen Industri Otomotif), berisi dengan pembelajaran terkait cara memanajemen atau mengatur sebuah perusahaan industri khususnya di bidang otomotif. Mata kuliah MIO

berada pada semester 5. Berdasarkan kurikulum mata kuliah MIO dengan kode OTO6229, beban materi yang diberikan kepada mahasiswa dan terkait manajemen industri otomotif adalah sebagai berikut:

a. Pengertian dan Perkembangan Manejemen
b. Proses Manajemen
c. Organisasi Kerja
d. Perusahaan dan Badan Perusahaan
e. Syarat dan Prosedur Ijin Usaha
f. Manajemen Produksi
g. Teknik dan Proses Produksi
h. Penetapan Biaya Produksi
i. Manajemen Material
j. Manajemen Pemasaran
k. Manajemen SDM
l. Modal dan Dana Perusahaan
m. Analisis BEP

Dalam 13 materi pokok yang diajarkan pada mata kuliah MIO, terdapat satu materi yang berhubungan dengan materi *cost report* yaitu materi penetapan biaya produksi. Berikut adalah isi materi penetapan biaya produksi yang menjadi bahan ajar mata kuliah MIO:

a. Penetapan Biaya Produksi

1) Pengertian Biaya

Biaya dapat didefinisikan sebagai nilai uang yang dikeluarkan untuk menggantikan manfaat yang diperoleh (Kir Haryana, 2007:1). Biaya yang digunakan sebagai ongkos untuk produksi di dalam sebuah perusahaan. Biaya dapat digunakan untuk berbagai istilah seperti biaya pembelian material, biaya upah pegawai, biaya administrasi, dan banyak lainnya. Pengumpulan, presentasi dan analisa tentang biaya berguna bagi perusahaan untuk :

- ❖ Perencanaan keuntungan, dengan membuat bidgeting;
- ❖ Pengendalian biaya melalui catatan akuntansi;
- ❖ Mengukur keuntungan tahunan, termasuk biaya persediaan;
- ❖ Penetapan harga penjualan suatu produk;
- ❖ Untuk keperluan analisis biaya-biaya relevan, guna pengambilan keputusan oleh manajemen.

2) Penggolongan Biaya

Menurut Kir Haryana (2007:1), penggolongan biaya menurut proses suatu produk sejak dibuat sampai pada penjualan produk dikenal menjadi dua bagian, yaitu biaya manufakturing dan biaya komersial. Untuk biaya manufakturing disebut juga dengan biaya produksi yang terdiri penjumlahan tiga jenis biaya yaitu biaya material langsung, upah pekerja langsung dan *overhead* pabrik.

Biaya komersial digolongkan menjadi dua macam biaya, yaitu: biaya administrasi dan biaya pemasaran & distribusi. Biaya pemasaran adalah biaya yang diperlukan untuk memasarkan produk sejak keluar dari pabrik sampai diterima oleh pelanggan. Biaya administrasi mencakup biaya untuk pengarahan, pengendalian, administrasi dan organisasi.

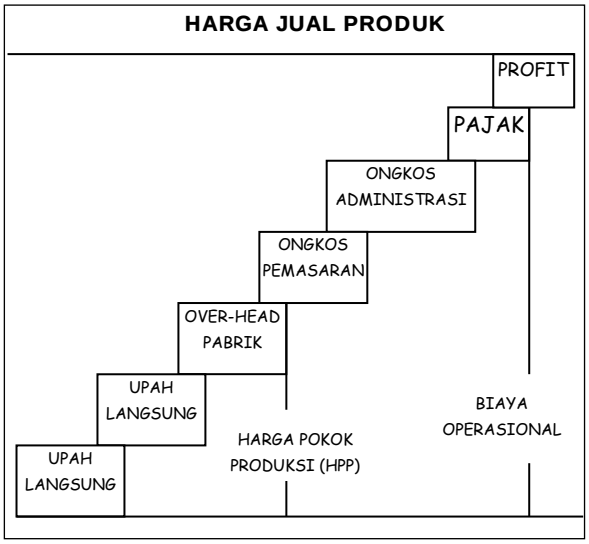
3) Penetapan Harga Pokok Produksi

Harga pokok produksi adalah biaya yang timbul selama produk ada di lantai produksi (Kir Haryana, 2007:1). Berikut ini adalah persamaan untuk menentukan HPP (Harga Pokok Produksi) suatu produk:

HPP = (Biaya Material + Upah langsung) + Biaya *Overhead*

Biaya komersial = (biaya administrasi + biaya marketing)

Harga jual = HPP + Biaya komersial + % profit + Pajak.



Gambar 19. Struktur harga pokok penjualan

4) Biaya Tetap dan Biaya Berubah

Penggolongan biaya bisa juga didasarkan pada perubahan volume produksi, yaitu biaya tetap dan biaya berubah (Kir Haryana, 2007:3). Karena volume produksi pada suatu jenis produk dapat berbeda-beda dan tidak selalu sama dari periode ke periode. Namun yang menjadi dasar untuk biaya tetap dan biaya berubah adalah hanya pada volume produksi, bukan lama waktunya. Biaya berubah adalah biaya yang perubahannya berbanding secara proporsional dengan volume produksi. Yang termasuk kelompok biaya berubah pada *overhead* pabrik diantarannya :

- ✓ Pasokan
- ✓ Daya listrik
- ✓ Biaya reklamasi
- ✓ Royalti
- ✓ Bahan bakar
- ✓ Peralatan kecil
- ✓ Biaya penerimaan
- ✓ Biaya komunikasi

Biaya tetap adalah biaya yang tidak berubah dan bukan fungsi dari perubahan volume produksi. Biaya ini timbul saat pabrik berproduksi maupun tidak berproduksi. Yang termasuk kelompok biaya tetap dalam *overhead* pabrik diantaranya:

- ✓ Gaji eksekutif produksi
- ✓ Pajak *property*
- ✓ Gaji keamanan/satpam
- ✓ Asuransi *property*
- ✓ Depresiasi
- ✓ Patent
- ✓ Perawatan dan perbaikan gedung
- ✓ Sewa

Biaya semi berupah merupakan jenis biaya campuran, dimana bersifat tetap dan juga bersifat berubah menurut volume produksi, sebagai contoh daya listrik. Daya listrik yang digunakan di pabrik besarnya berubah menurut volume produksi, sedangkan listrik juga dimanfaatkan untuk penerangan dan air condition yang tidak berhubungan dengan volume produksi. Biaya semi berubah dalam *overhead* pabrik diantaranya:

- ✓ *Supervise*
- ✓ pemeriksaan
- ✓ penanganan material
- ✓ biaya persediaan
- ✓ gaji personel humas
- ✓ energi
- ✓ perawatan dan perbaikan peralatan/mesin
- ✓ kompensasi asuransi
- ✓ asuransi kesehatan
- ✓ iuran asosiasi

5) Akuntansi Biaya Produksi

Dalam kegiatan produksi pengeluaran biaya disesuaikan dengan kebutuhan, jadi waktunya tidak serempak tidak. Namun, catatan akuntansi harus dilakukan sistematis dengan tujuan memudahkan dalam pengendalian biaya dan menentukan pos biaya. Langkah-langkah penyusunan biaya adalah :

a) urutkan menurut klasifikasi biaya masing-masing;

- material
- upah langsung
- biaya tak langsung pabrik
- komersial

b) urutkan menurut tanggal pengeluaran uang;

c) pisahkan biaya menurut tempat kerja, ada pula yang di gabungkan dari semua departemen;

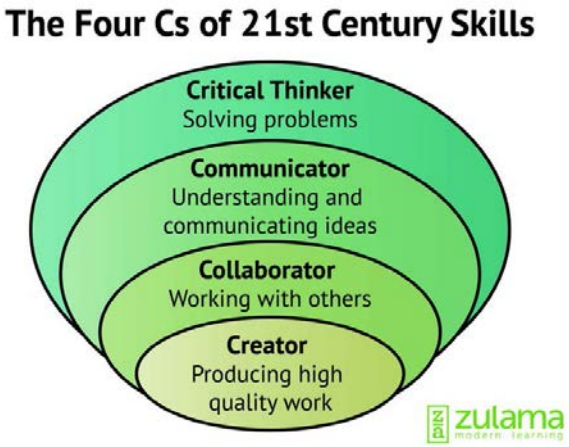
d) cantumkan keterangan tentang;

- waktu pekerjaan dimulai
- waktu pekerjaan diselesaikan
- no order/pesanan
- jumlah yang diproduksi
- spesifikasi produk

Materi *cost report* terkait pembuatan laporan pembiayaan produksi dapat menjadi sebuah pengembangan untuk materi MIO (Manajemen Industri Otomotif). *Cost report* ini sudah diperuntukkan untuk bidang otomotif seperti pada kompetisi *Student Formula Japan*. Pembuatan *cost report* sudah mendetail dari biaya material bahan baku yang digunakan, biaya proses manufaktur yang digunakan dengan nilai pengaliannya (pengalian untuk proses yang sama), biaya pengikatan, dan biaya perkakas.

8. Keterampilan "4C" Abad 21

Pada abad 21 sekarang ini, terdapat 4 keterampilan wajib yang harus dimiliki oleh setiap orang, apalagi oleh seorang siswa. terdapat 4 keterampilan abad 21 yang sering disebut "4C" yaitu *Creativity*, *Communication*, *Collaboration*, dan *Critical Thinking*. Penjelasan mengenai keterampilan 4C abad 21 adalah sebagai berikut :



Gambar 20. *The 4Cs Super Skills*

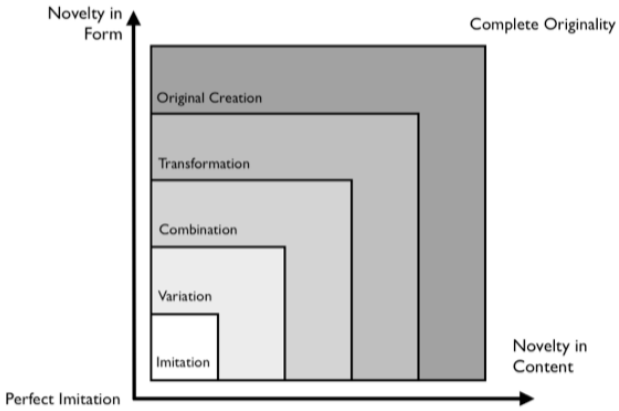
Sumber : Lippl, C. (2013: p.2) dan *Exploring the Pedagogical Meaning and Implications of the 4Cs "Super Skills" for the 21st Century through Bruner's 5E Lenses of Knowledge Construction to Improve Pedagogies of the New Learning Paradigm*

a. *Creativity*

Salah satu keterampilan dalam abad 21 yang harsu dimiliki oleh siswa adalah keterampilan kreativitas dan inovasi (*creativity and innovation*). Dalam jurnal "*Exploring the Pedagogical Meaning and Implications of the 4Cs "Super Skills" for the 21st Century through Bruner's 5E Lenses of Knowledge Construction to Improve Pedagogies of the New Learning Paradigm*", Charles Kivunja menyatakan bahwa "*The terms creativity and innovation are often used to refer to the conscious exploitation of "new ideas, or new uses of ideas, to add social or economic value* (IBSA, 2009:p.1)". Istilah kreativitas dan inovasi sering digunakan untuk membahas masalah kesadaran

mengeksploitasi ide-ide baru, atau penggunaan ide baru untuk nilai sosial atau ekomoni. Memiliki kreativitas dan inovasi yang tinggi dapat memudahkan seseorang dalam meraih kesuksesan. Seseorang akan sulit berkembang apabila memiliki tingkat kreativitas dan inovasi yang rendah. Siswa harus dipicu untuk berpikir di luar kebiasaan yang ada, melibatkan cara berpikir yang baru, memperoleh kesempatan untuk menyampaikan ide-ide dan solusi-solusi baru, mengajukan pertanyaan yang tidak lazim, dan mencoba mengajukan dugaan jawaban (Siti Zubaidah, 2016:4).

Dalam interview pembelajarn IBM 2010 terhadap 150 CEO dari 60 negara dan 33 industri menemukan bahwa kreativitas dinamakan sebagai kualitas leadership paling penting untuk menghadapi persaingan dari peningkatan kompleksitas dan ketidakpastian dunia (Maya Bialik, 2015:5).



Gambar 21. *Taxonomy for Crreativity*.

Sumber : *Skill for The 21st Century: What Should Students Learn?,* 2015:5)

Dilihat dari taksonomi tersebut, urutan aktivitas berdasarkan keterlibatan kreativitas dimulai dari imitasi yang baik. Kemudian dilanjutkan ke level berikutnya untuk memperoleh tingkat kreativitas yang sebenarnya.

Tabel 7. Kreativitas Pada Level Berbeda

Level of Creativity	Definition	Classroom Example
Imitation	Creation by identical replication. This is a foundational skill, and is often the starting point for more creative tasks.	Memorize an excerpt of a piece of literature and perform it aloud in class.
Variation	Creation by varying a particular aspect or aspects of the work, and imitating the rest exactly.	Rewrite a sentence from a piece of literature with the same grammatical structure, by changing the subject matter and vocabulary.
Combination	Mixture of two or more works into one, new work.	Create a Rube Goldberg machine out of the simple machines learned in class.
Transformation	Translation of an existing work into a different medium or representation.	Create a timeline of historical events based on class notes that separates political, social, and economic threads.
Original Creation	Creation of a new piece of work that is only very distantly, if at all, related to previous works.	Write a short story.

Sumber : *Skill for The 21st Century: What Should Students Learn?,* 2015:7)

b. *Communication*

Kemampuan komunikasi mencakup keterampilan dalam menyampaikan pemikiran dengan jelas dan persuasif secara lisan maupun tulisan, kemampuan menyampaikan opini dengan kalimat yang jelas, menyampaikan perintah dengan jelas, dan dapat memotivasi orang lain melalui kemampuan berbicara (Siti Zubaidah, 2016:4). Komunikasi yang baik merupakan keterampilan yang sangat berharga di dunia kerja dan dalam menjalani kehidupan sehari-hari. Komunikasi merupakan memahami dan *sharing* ide.

Penyampaian gagasan yang baik dan ide secara efektif menggunakan lisan, tulisan dan skill komunikasi nonverbal, mendengarkan dengan efektif untuk memahami arti, termasuk pengetahuan, nilai-nilai, sikap serta maksud, menggunakan komunikasi untuk menginformasikan, menginstruksi, memotivasi dan membujuk, menggunakan berbagai media dan teknologi, berkomunikasi secara efektif pada berbagai macam linguknga (Trilling & Fadel, 2009:p. 55). Dengan berbagai jenis komunikasi dan berbagai media, berkomunikasi yang baik dapat dilakukan dimana saja. Komunikasi dapat disesuaikan dengan berbagai macam lingkungan disekitar kita. Sehingga ketika sedang berkomunikasi, lawan bicara akan mudah memahami maksud pembicaraan yang disampaikan.

c. *Collaboration*

Definisi keterampilan kolaborasi adalah keterampilan dari kerja tim, bekerja dalam grup, bekerja secara kooperatif dengan pihak lain (Handsley, 2011: p. 1). Dalam bekerja dalam sebuah tim maka mempunyai komunikasi yang baik untuk memperoleh kolaborasi atau kerjasama yang baik pula. Kolaborasi selalu dilakukan oleh 2 orang atau lebih yang membentuk sebuah kelompok atau tim. Dalam berkolaborasi di sebuah tim, terdapat satu tujuan yang akan dicapai bersama-sama.

Dalam dunia pendidikan, bentuk kolaborasi dapat berupa kerja kelompok siswa di dalam kelas. Siswa dapat bekerjasama secara

kolaboratif pada tugas yang diberikan dan mengembangkan keterampilannya melalui pembelajaran tutor sebaya dalam kelompok. Dalam berkolaborasi harus dapat bertukar pikiran antar sesama angota kelompok demi mencapai sebuah mufakat.

d. *Critical Thinking*

Dalam *paper* yang berjudul "Keterampilan Abad Ke-21: Keterampilan Yang Diajarkan Melalui Pembelajaran", Siti Zubaidah menyatakan bahwa keterampilan berpikir kritis mencakup kemampuan mengakses, menganalisis, mensintesis informasi yang dapat dibelajarkan, dilatihkan dan dikuasai (P21, 2007a; Redecker et al 2011). Dengan pemikiran yang kritis, setiap pemikiran siswa akan lebih terbuka dalam mengahadapi setiap masalah. Akan muncul lebih banyak solusi yang dapat diterapkan melalui berpikir kritis.

Tabel 8. *Evolution of Taxonomies*

Taxonomies of Educational Objectives			
Bloom (1956)	**Anderson & Krathwohl (2001)**	**Marzano & Kendall (2006)**	**PISA (2000)**
Evaluation Synthesis Analysis Comprehension Knowledge	Create Evaluate Analyze Apply Understand Remember	Self-System Thinking Metacognition Knowledge Utilization Analysis Comprehension Retrieval	Communicate Construct Evaluate Integrate Manage Access

Sumber : *Skill for The 21st Century: What Should Students Learn?,* 2015:8)

Konsep terkenal berpikir kritis datang dari *Bloom* Taksonomi. Pada tabel diatas menggambarkan kemajuan tujuan pendidikan mulai dari akses pengetahuan level rendah ke level yang lebih tinggi dan luas, serta bermacam capaian dari berpikir kritis.

B. Kerangka Berpikir

Fokus penelitian ini adalah untuk mengetahui tingkat kontribusi biaya material dan biaya proses manufaktur *frame* kendaraan FG16 terhadap *cost report,* bagaimana peran pembuatan cost report dalam keterampilan abad 21 dan dalam pengembangan materi mata kuliah Manajemen Industri Otomotif.

Terdapat 3 tahap utama dalam penelitian ini yaitu: perhitungan biaya berdasarkan jenis, ukuran bahan dan proses pembuatan *frame* FG16, kedua adalah perhitungan prosentase kontribusi biaya *frame* FG16 terhadap *cost report* FG16, dan ketiga adalah analisa peran pembuatan *cost report* dalam kompetensi abad 21 serta dalam pengembangan mata kuliah Manajemen Industri Otomotif. Biaya material diperhitungkan dari jenis bahan dan ukuran bahan untuk pembuatan *frame* FG16. Kemudian biaya proses diperhitungkan dari jenis manufaktur yang digunakan untuk pembuatan *frame* FG16. Perhitungan biaya menggunakan *FCA input* yang sudah berisi rumus (formula) sesuai regulasi atau aturan panitia kompetisi *Student Formula Japan* 2016. Setelah itu dilakukan perhitungan prosentase tingkat kontribusi total biaya *frame* terhadap *cost report* FG16. Kemudian dilakukan analisa peran pembuatan *cost report* dalam kompetensi abad 21 serta dalam pengembangan mata kuliah Manajemen Industri Otomotif.

Material *frame* yang digunakan adalah material dengan tipe AISI 1020 dan *aluminum* 7075 sebagai material *main frame structure*. Sedangkan *bracket* pada *frame* menggunakan material *alloy steel*. Menurut tabel material, besaran biaya untuk material AISI 1020, *aluminum* dan *alloy steel*

memiliki harga yang berbeda. *Cost report* merupakan laporan biaya dari keseluruhan sistem kendaraan. Besar biaya total material *frame* yang dihitung akan digabung bersama dengan biaya total dari semua sistem. Sehingga total biaya material akan mempengaruhi total biaya *cost report*.

Desain *frame* untuk kendaraan FG15 lebih rumit dan FG16 lebih sederhana. Jumlah ukuran total material baik secara berat atau *volume* pada kedua kendaraan tersebut juga berbeda, yaitu lebih ringan *frame* kendaraan FG16.

Proses manufaktur utama yang digunakan untuk pembuatan *frame* kendaraan FG16 adalah pengelasan (*welding*). Dan ditambah dengan proses manufaktur tambahan seperti *setting* untuk *set up machine*, *machining* untuk *removing* material dan *grinding* untuk pembentukan profil material. Proses tersebut memiliki tingkat biaya yang berbeda. Total biaya proses manufaktur *frame* yang dihitung akan digabung bersama dengan biaya total dari semua sistem. Sehingga total biaya proses yang dilaksanakan untuk pembuatan *frame* kendaraan FG16 akan memiliki kondtribusi terhadap total biaya *cost report* kendaraan FG16.

Pembuatan dokumen cost report merupakan bentuk wujud keterampilan abad 21 yang sekarang ini harus dimiliki oleh setiap siswa. siswa harus lebih berfikir kritis, kreatif, mampu berkomunikasi dengan baik, dan dapat bekerjasama. Seperti yang sudah dicontohkan oleh tim mobil Garuda UNY dalam membuat kendaraan dan membuat setiap dokumen penting perlombaan melalui tahap-tahap yang sudah ditentukan. Dari prosedur atau

tahap pembuatan dokumen cost report yang sudah dilakukan dapat dijadikan menjadi tambahan materi untuk mata kuliah Manajemen Industri Otomotif. Penambahan materi sebagai bentuk pengembangan yang nantinya pembelajaran dapat dilakukan sampai pembuatan dokumen cost report untuk setiap sistem sebuah kendaraan.

C. Pertanyaan Penelitian

1. Berapa besar kontribusi biaya material *frame* kendaraan FG16 terhadap total *cost report FG16*?
    a. Berapa total biaya material *frame* kendaraan FG16?
    b. Berapa persen kontribusi biaya material *frame* kendaraan FG16 terhadap total *cost report FG16*?
2. Berapa besar kontribusi biaya proses manufaktur *frame* kendaraan FG16 terhadap total *cost report* FG16?
    a. Berapa total biaya proses manufaktur *frame* kendaraan FG16?
    b. Berapa persen kontribusi total biaya proses manufaktur *frame* kendaraan FG16 terhadap total *cost report FG16*?
3. Bagaimana peran pembuatan dokumen *cost report* dalam kompetensi abad 21 dan pengembangan materi mata kuliah Manajemen Industri Otomotif?
    a. Bagaimana peran pembuatan dokumen *cost report* dalam pengembangan materi mata kuliah Manajemen Industri Otomotif?
    b. Bagaimana peran pembuatan dokumen *cost report* di ajang *Student Formula Japan* sesuai kompetensi abad 21?

BAB III

METODE PENELITIAN

A. Desain Penelitian

Jenis penelitian yang digunakan adalah penelitian deskriptif. Menurut Suyanto dan Asep Jihad (2016:77), metode penelitian deskriptif adalah model penelitian yang menggambarkan masalah penelitian, yang masih berlangsung, yang berupa dampak suatu fenomena, hubungan antara dua variabel atau lebih, serta perbandingan dua variabel atau lebih. Penelitian deskriptif merupakan salah satu penelitian yang paling sederhana dan dipaparkan dalam bentuk laporan penelitian secara jelas. Pada penelitian deskriptif, peneliti tidak memberikan perlakuan khusus seperti mengubah, menambah ataupun melakukan manipulasi terhadap objek penelitian.

Penelitian ini sangat bermanfaat khususnya bagi tim untuk membuat *cost report* yang akan digunakan untuk kompetisi. Penelitian ini untuk mengetahui tingkat kontribusi bahan material dan proses pembuatan *frame* FG16 terhadap *cost report*. Analisa laporan biaya dari objek *frame* FG16 dapat digunakan sebagai dasar dan referensi pembuatan *cost report* pada kompetisi *Student Formula Japan* kedepannya. Diharapkan dari penelitian ini, pembuatan komponen kendaraan khususnya *frame* bisa dibuat lebih baik dengan biaya yang relatif rendah untuk mendapat poin yang tinggi. Penelitian yang dilakukan menggunakan data-data berupa angka (kuantitas) harga *frame* pada *cost report* kendaraan FG16. Sehingga pendekatan penelitian yang digunakan adalah penelitian kuantitatif.

B. Tempat dan Waktu Penelitian

Pelaksanaan observasi material dan manufaktur *frame* kendaraan FG16 berada di *Workshop Garuda UNY Team*. Perhitungan *cost report* dan pengolahan data *cost report frame* FG16 juga berada di *Basecamp Garuda UNY Team*, tepatnya di Gedung D13 Hall Aula FT, Fakultas Teknik Universitas Negeri Yogyakarta. Watu penelitian dimulai sejak 01 Desember 2017 sampai 01 Maret 2018.

C. Objek Penelitian

Objek penelitian adalah apa yang menjadi titik perhatian suatu penelitian (Suharsimi Arikunto, 2013:161). Penelitian yang akan dilakukan selalu dan wajib memiliki titik perhatian untuk objek yang akan diteliti. Objek penelitian yang digunakan pada penelitian ini adalah rangka FG16 dan rangka FG15.

D. Variabel Penelitian

Variabel penelitian adalah segala sesuatu yang berbentuk apa saja yang ditetapkan oleh peneliti untuk dipelajari sehingga diperoleh informasi tentang hal tersebut, kemudian ditarik kesimpulannya (Sugiyono, 2012:38). Penentuan variabel yang akan diteliti ditentukan berdasarkan tema penelitian yang akan diteliti. Terdapat variabel bebas dan variabel terikat yang wajib ada dalam sebuah penelitian ilmiah tugas akhir. Variabel bebas adalah variabel yang mempengaruhi variabel terikat. Variabel terikat adalah variabel yang dipengaruhi oleh variabel bebas dalam sebuah penelitian.

Variabel terikat pada penelitian ini adalah nilai dari laporan pembiayaan (*cost report*). Variabel bebas pada penelitian ini adalah material dan manufaktur (proses pembuatan) *frame*. Kedua variabel tersebut yang akan menjadi bahan untuk dilakukan penelitian.

E. Teknik Pengambilan Data

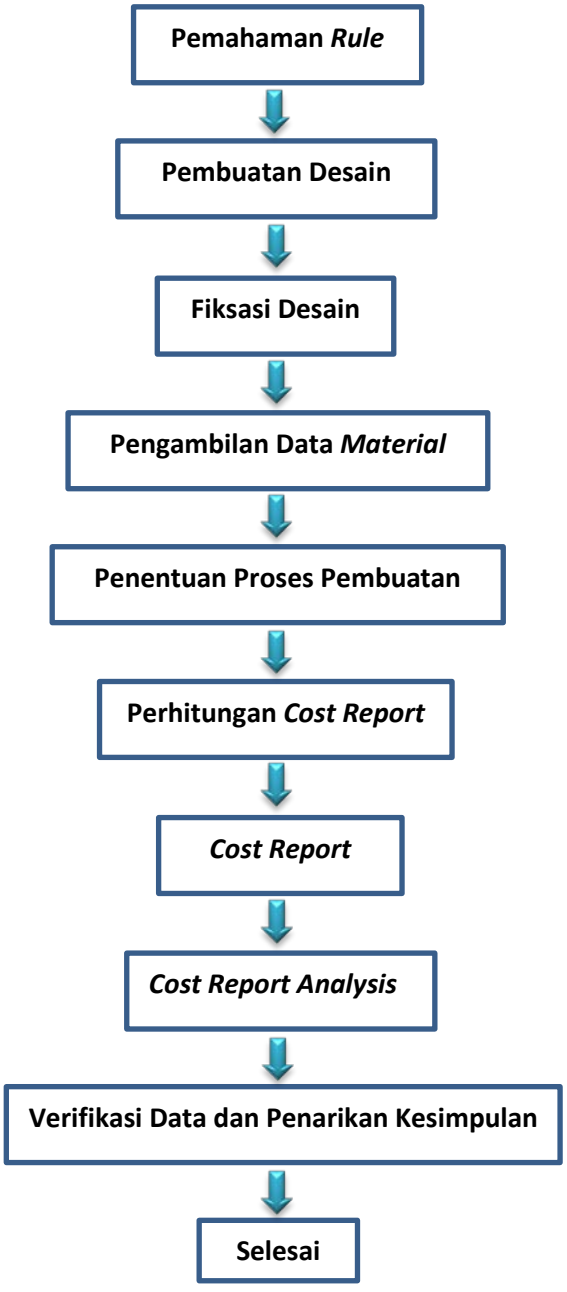
Teknik pengambilan data pada penelitian ini adalah mengamati dan mencatat data meliputi data jenis material, ukuran material, proses pembuatan yang digunakan. Keseluruhan data tesebut juga didukung menggunakan data dari 5 tabel yang digunakan sebagai basis data perhitungan biaya untuk *cost report* yaitu *materials table*, *processes table*, *multipliers process table, fasteners table*, dan *toolings table*. Proses pengukuran dimensi bahan pada *frame* FG16 menggunakan *software Solid Work* 2016 dan penentuan proses manufaktur *frame* sudah disesuaikan dengan regulasi dan dilakukan sebelum manufaktur.

F. Teknik Analisis Data

Setelah melakukan pengambilan data, maka dilakukan perhitungan biaya untuk *cost report* dari setiap variabel yang sudah didapatkan berdasarkan tabel. Data tersebut dimasukkan kedalam *formula* (rumus) yang sudah ada di *FCA Input* sesuai jenis data dari setiap variabel yang ada pada semua sistem kendaraan FG16. *Formula* (rumus) yang ada didalam *file FCA Input* merupakan file resmi yang digunakan untuk perhitungan *cost report* di kompetisi *Student Formula Japan* 2016. Setelah didapatkan data keseluruhan, maka dapat dilakukan perhitungan dan analisa prosentase

tingkat kontribusi total biaya material & manufaktur *frame* terhadap *cost report* FG16. Kemudian dilakukan analisa peran pembuatan dokumen *cost report* dalam kompetensi abad 21 dan pengembangan materi mata kuliah Manajemen Industri Otomotif.

G. Skema Penelitian



BAB IV

HASIL PENELITIAN DAN PEMBAHASAN

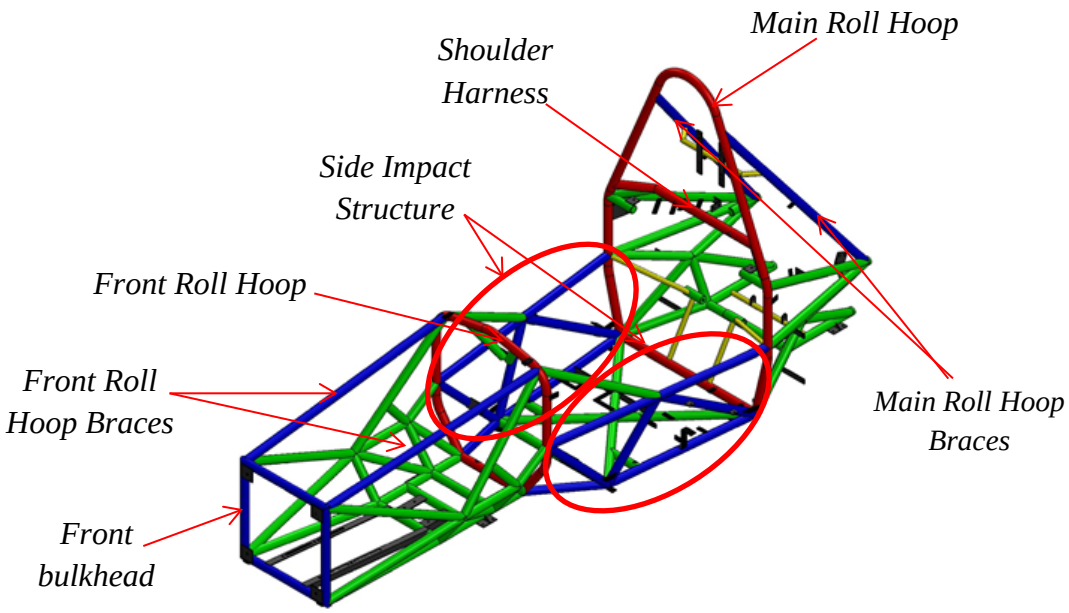
A. Hasil Penelitian

1. Pembuatan Desain *Frame* FG16

Pembuatan desain *frame* kendaraan FG16 didasarkan pada regulasi kompetisi *Student Formula Japan*. Regulasi kompetisi *Student Formula* berlaku selama 2 tahun periode dengan diadakan revisi setiap tahun pada regulasi jika ada hal yang perlu dirubah. Pada saat kompetisi tahun 2016, regulasi bagian *cost and manufacturing event* sama dengan regulasi kompetisi tahun 2015. Proses desain rangka kendaraan FG16 menggunakan *software SolidWork*. Menggunakan *software SolidWork* ini, *designer* dapat mengaplikasikan berbagai jenis bahan yang akan digunakan untuk di analisa baik dari segi berat, kekuatan maupun *rigidity*.

Rangka dengan kelengkapan *bracket* atau *mounting* yang telah di desain memiliki jenis materialnya masing-masing dengan ukuran dan kuantitas yang berbeda-beda. Untuk desain *frame* kendaraan FG16 adalah bentuk pengembangan desain dari tahun 2015. Desain rangka FG16 juga sudah sesuai dengan regulasi dan lolos dokumen *Structural Equivalency Spreadsheet* (SES) serta lolos *technical inspection* kompetisi *Student Formula Japan*. Bentuk desain *frame* kendaraan FG16 yang lebih sederhana membuatnya lebih ringan tanpa mengesampingkan aspek kekuatan. Desain *frame* yang dibuat tahun 2016 memiliki tipe yang sama dari tahun 2015 yaitu rangka konvensional tipe *tubular section* karena

menggunakan *tube* (pipa). Bahan yang digunakan adalah *steel tube* AISI 1020 untuk struktur utama, *alloy steel* untuk *bracket* dan *aluminium* untuk *rear frame*. Berikut adalah bentuk desain *frame* kendaraan FG16 beserta nama bagian struktur utamanya :



Gambar 22. *Frame* FG16

Sub *part* rangka kendaraan FG16 :

- *Main roll hoop* : *roll bar* rangka yang berlokasi di belakang *driver.*
- *Front roll hoop* : *roll bar* rangka yang berlokasi di depan *driver* dan dekat dengan *steering wheel*.
- *Main roll hoop braces* : bagian rangka yang berada diantara *main hoop* dan *front hoop* serta berfungsi juga sebagai penghubung dan *support* untuk bagian *main hoop* dengan *front hoop*.

- *Side impact structure* : struktur rangka di bagian samping *driver* terhitung dari 350 mm diatas tanah.
- *Front roll hoop braces* : bagian rangka yang berada diantara *front roll hoop* dan *front bulkhead* serta berfungsi sebagai *support* untuk bagian *front roll hoop* dengan *front bulkhead*.
- *Front bulkhead* : struktur rangka yang ada di bagian paling depan dan sebagai dudukan untuk *mounting* dari *impact attenuator*.
- *Rear bulkhead* : struktur rangka yang ada di bagian paling belakang dan disebut juga rangka belakang.
- *Shoulder harness* : struktur rangka berada di belakang pundak driver dan sebagai dudukan *seat belt*.
- *All frame member, mountings/brackets,* dan *supports.*

2. Biaya Material *Frame* Kendaraan FG16

Pembiayaan atau pengeluaran biaya penggunaan material untuk pembuatan *part* dibuat sebagai salah satu poin di dalam laporan pembiayaan (*cost report*) pembuatan kendaraan untuk kompetisi *Student Formula Japan*. Perhitungan biaya material dihitung berdasarkan ukuran (*size*) beserta satuan (*unit*), nama area yang digunakan untuk acuan perhitungan (*Area Name*), luas area, panjang material yang dihitung dari area yang sebagai acuan perhitungan (*length*), berat jenis (*density*), dan jumlah (*quantity*). Variabel tersebut diisi sesuai dengan material *part* yang

akan dihitung biayanya menggunakan *formula* logika IF (logical_test, [value_if_true], [value_if_false]) sebagai berikut :

```
=IF(Area="",UnitCost*Quantity,UnitCost*Area*Length*Density*Quantity)
```

Deskripsi formula :

"*Jika kolom area tidak diisi atau benar (value is true) maka unitcost dikali quantity. Jika kolom area diisi atau salah (value is false) maka unitcost dikali area dikali length dikali density dikali quantity*"

Dari rumus tersebut maka data material yang ada pada desain dapat dimasukkan dan dihitung biayanya sesuai masing-masing sub *part* rangka. Dalam kompetisi *Student Formula Japan*, data perhitungan yang semakin lengkap akan menambah poin akurasi. Sehingga data yang dimasukkan ke masing-masing kolom variabel perhitungan menggunakan variabel yang selengkap mungkin yaitu *area name*, *area*, *length*, *density*, dan *quantity*. Semakin lengkap data maka hasil yang didapatkan akan semakin akurat dan lebih detail. Berikut adalah hasil perhitungan total biaya material *frame* kendaraan FG16.

Tabel 9. Total Biaya Material *Frame* FG16

No	Nama Kendaraan	Cost Material Frame
1.	Formula Garuda 16	$157.51

Biaya material *frame* kendaraan FG16 sebesar $157.51. Total biaya material merupakan gabungan dari setiap biaya material untuk sub-sub *part* pada *frame* yang dijumlahkan. Penggunaan material untuk setiap sub

part *frame* berbeda-beda. dari segi kuantitas penggunaan material dapat diambil data sebagai berikut.

Tabel 10. Rekapan Kuantitas Penggunaan Material *Frame FG16*

No.	Jenis Material	Kuantitas
1.	Tubing, Steel	33.31 kg
2.	Steel, Alloy	2.63 kg
3.	Steel Mild	0.33 kg
4.	Aluminum, Premium	10.54 kg
5.	Aluminum, Normal	-
6.	Paint	0.02 m^2

Tabel data material struktur *frame* FG16 berada pada lampiran yang berisi data material yang digunakan.

3. Biaya Proses Manufaktur *Frame* Kendaraan FG16

Pembiayaan yang dibuat untuk dokumen *cost report* di kompetisi *Student Formula Japan* mencakup biaya proses (*Process Cost*). Semua proses yang dilakukan untuk membuat *part* dari proses awal bahan mentah menjadi *part* yang utuh dihitung biayanya. Perhitungan biaya untuk proses manufaktur dilakukan untuk mengetahui seberapa besar biaya proses yang dibutuhkan untuk membuat sebuah *part* hingga menjdai sebuah kendaraan siap jalan. Perhitungan biaya proses manufaktur menggunakan rumus formula yang ada didalam file *FCA input* yaitu sebagai berikut :

a. Formula Assembly Sheet

Cost process = UnitCost x Quantity x Multiplier Value

b. *Formula Part Sheet* IF (logical_test, [value_if_true], [value_if_false])

=IF(MultiplierValue<>"",UnitCost*Quantity*MultiplierValue, UnitCost*Quantity)

Deskripsi Formula :

"Jika nilai Multiplier Value lebih kecil atau lebih besar dari kosong, maka UnitCost kali Quantity kali Multiplier Value. Apabila nilai Multiplier Value sama dengan kosong (tidak terisi), maka UnitCost kali Quantity"

Formula *assembly sheet* digunakan pada *sheet* bagian *assembly* dan *formula part sheet* digunakan pada *sheet* bagian *part*. *Formula* tersebut digunakan untuk menghitung biaya proses yang dilakukan sesuai jenis proses dan besar biayanya yang tertera di tabel proses. Berikut ini adalah total biaya proses manufaktur *frame* kendaraan FG16.

Tabel 11. Total Biaya Proses Manufaktur *Frame* FG16

No	Nama Kendaraan	Cost Process Frame
1.	Formula Garuda 16	$1,001.01

Besar biaya proses manufaktur *frame* FG16 sebesar $1,001.01. Setiap sub part memiliki proses manufaktur yang berbeda walaupun terkadang ada beberapa langkah proses yang sama. Kuantitas dari jumlah proses manufakturnya juga berbeda. Kuantitas jenis proses manufaktur rangka FG16 adalah sebagai berikut.

Tabel 12. Rekapan Kuantitas Langkah Proses Manufaktur *Frame* FG16

No	Nama Kendaraan	Step Process Quantity
1.	Formula Garuda 16	426

Kuantitas proses manufaktur FG16 yaitu sebanyak 426 proses. Untuk data lengkap kuantitas proses setiap sub part dan biaya proses yang digunakan berada pada lampiran.

4. *Cost Report* Kendaraan FG16

Cost Report yang dibuat berisi biaya-biaya *part* dari yang dibuat atau dibeli hingga menjadi kendaraan FG16 yang siap jalan. Perhitungan *cost report* yang dilakukan menggunakan *file FCA Input* beserta *formula* didalamnya akan menghasilkan perhitungan biaya yang nantinya dimasukkan ke dalam BOM. Biaya dari keseluruhan *part* ini dirangkum di dalam BOM (*Bill of Material*) yang berisi keseluruhan *list part* beserta biayanya. Hasil BOM akan dilampirkan pada lampiran 1 sebagai salah satu data yang mewakili *cost report* total kendaraan FG16. Total *cost report* kendaraan FG16 dalam BOM sebesar $16,971.81. Data *cost report* secara detail dari keseluruhan pembiayaan kendaraan FG16 terdapat pada lampiran.

Setelah diketahui data total biaya material *frame* kendaraan FG16, total biaya material *frame* kendaraan FG16, dan total *cost report* kendaraan FG16, dapat dianalisa (a) tingkat kontribusi biaya material *frame* FG16 terhadap total *cost report* FG16, (b) tingkat kontribusi biaya proses manufaktur *frame* FG16 terhadap total *cost report* FG16, dam (c) peran pembuatan dokumen *cost report* dalam kompetensi abad 21 dan pengembangan materi mata kuliah Manajemen Industri Otomotif.

5. Tingkat Kontribusi Total Biaya Material *Frame* FG16 Terhadap Total *Cost Report* FG16

Tingkat kontribusi total biaya material *frame* terhadap total *cost report* menggunakan rumus sebagai berikut.

$$\text{Kontribusi Biaya Material } \textit{Frame} \text{ Terhadap } \textit{Cost Report} = \frac{\text{Total Biaya Material } \textit{Frame}}{\text{Total } \textit{Cost Report}} \times 100\%$$

Rumus tersebut akan menunjukan seberapa besar kontribusi atau sumbangsih total biaya material *frame* kendaraan FG16 yang ditunjukkan dalam satuan prosentase. Berikut ini adalah perhitungan tingkat kontribusi biaya material *frame* terhadap total *cost report*:

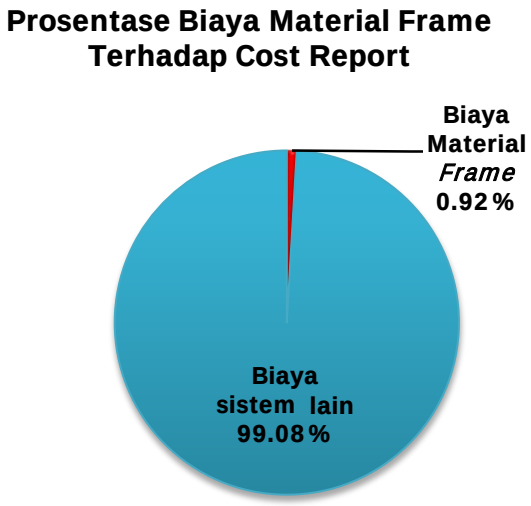
Kontribusi Biaya Material *Frame* FG16 Terhadap *Cost Report* FG16

$$= \frac{\text{Total Biaya Material } \textit{Frame}}{\text{Total } \textit{Cost Report}} \times 100\%$$

$$= \frac{\$\ 157.51}{\$\ 16{,}971.81} \times 100\%$$

$$= 0.0092 \times 100\%$$

$$= 0.92\%$$



Gambar 23. *Chart* Prosentase Kontribusi Biaya Material *Frame* FG16

6. Tingkat Kontribusi Total Biaya Proses Manufaktur *Frame* FG16 Terhadap Total *Cost Report* FG16

Tingkat kontribusi biaya proses manufaktur rangka terhadap *cost report* adalah sebagai berikut.

$$\text{Kontribusi biaya proses manufaktur } \textit{frame} \text{ terhadap } \textit{cost report} = \frac{\text{Total Biaya Proses Manufaktur } \textit{Frame}}{\text{Total } \textit{Cost Report}} \times 100\%$$

Dari rumus yang sudah tertera, dapat dihitung prosentase kontribusi nilai biaya proses manufaktur rangka terhadap *cost report*. Tingkat kontribusi yang didapatkan dalam bentuk nilai prosentase yang akan membuktikan besar kontribusi biaya proses manufaktur terhadap *cost report*. Perhitungannya adalah sebagai berikut:

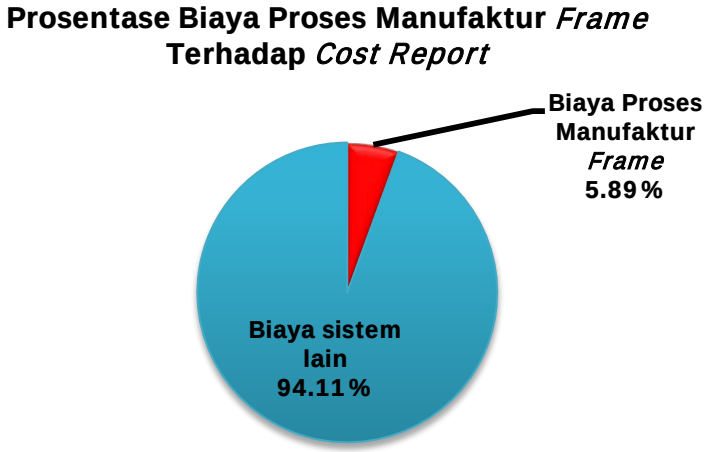
Kontribusi Biaya Proses Manufaktur *Frame* Terhadap *Cost Report*

$$= \frac{\text{Total Biaya Proses Manufaktur } \textit{Frame}}{\text{Total } \textit{Cost Report}} \times 100\%$$

$$= \frac{\$\ 1{,}001.01}{\$\ 16{,}971.81} \times 100\%$$

$$= 0.0589 \times 100\%$$

$$= 5.89\%$$



Gambar 24. *Chart* Prosentase Kontribusi Biaya Proses *Frame* FG16

B. Pembahasan

1. Kontribusi Total Biaya Material *Frame* Kendaraan FG16 Terhadap Total *Cost Report* FG16

Berdasarka data biaya material yang dibutuhkan untuk membuat rangka kendaraan FG16, terdapat kontribusi biaya material *frame* terhadap total biaya *cost report*. Besar kontribusi biaya material *frame* terhadap total biaya *cost report* sebesar 0.92%. Variabel material dalam pembiayaan yang dilaporkan dalam bentuk *cost report* khususnya untuk rangka (*frame*) kendaraan FG16 yang sebesar 0.92% merupakan salah

satu variabel penting yang menjadi dasar pembuatan nilai biaya *cost report* dan dibuat oleh anggota *Garuda UNY Racing Team*. Sehingga dalam pembuatan dokumen *cost report* yang dilaksanakan di *basecamp* dari *Garuda UNY Racing Team* untuk berkas penilaian *Cost and Manufacturing Event* di kompetisi *Student Formula Japan* 2016, biaya material harus dihitung dan dimasukkan ke dalam dokumen *cost report*.

Dapat diketahui total biaya material *frame* kendaraan FG16 sebesar $157.51. Biaya material tersebut terbagi untuk 52 *sub part* dari rangka kendaraan FG16 dan 5 jenis material yang digunakan. Perhitungan total biaya material yang digunakan untuk membuat rangka kendaraan FG16 akan dimasukkan ke dalam *cost report* sebagai dokumen laporan biaya pembuatan kendaraan FG16.

Rangka (*frame*) merupakan komponen yang sangat fital dalam sebuah kendaraan. *Frame* menjadi titip tumpu atau sebagai dudukan dari mekanisme *chassis* kendaraan dan sistem penting yang lain dalam kendaraan. Dalam membuat sebuah kendaraan juga memerlukan biaya. Tingkat biaya yang semakin rendah yang diimbangi dengan performa kendaraan yang baik, akan memberikan poin tinggi dalam penilaian dokumen *cost report*. Akurasi (ketepatan) dan ketelitian akan sangat dibutuhkan dalam pembuatan dokumen *cost report*.

Total biaya *cost report* kendaraan FG16 sebesar $16,971.81. Dari total biaya *cost report* $16,971.81, didalamnya sudah termasuk biaya material *frame*. Total biaya dalam *cost report* sudah termasuk 5 variabel

biaya yaitu *materials*, *process*, *multiplier process*, *fasteners*, dan *toolings*. Material menjadi salah satu variabel penting didalam *cost report*, khususnya material *frame*. Kemudian berapa persen kontribusi total biaya material *frame* kendaraan FG16 terhadap total keseluruhan *cost report*.

Total biaya material sebesar $157.51 menjadi bagian dari total keseluruhan biaya dalam dokumen *cost report*. Walaupun terlihat sedikit, nilai biaya material *frame* sangat berpengaruh dalam penilaian *cost and manufacturing event*. Dari pembahasan yang telah dijabarkan, terdapat kontribusi biaya material *frame* terhadap total biaya *cost report* sebesar 0.92%.

2. Kontribusi Total Biaya Proses Manufaktur *Frame* Kendaraan FG16 Terhadap Total *Cost Report* FG16

Berdasarkan data yang telah didapatkan berupa total biaya proses menufaktur *frame* dan total *cost report*, terdapat kontribusi biaya proses manufaktur *frame* kendaraan FG16 terhadap *cost report.* Tingkat prosentase kontribusi biaya proses manufaktur *frame* kendaraan FG16 terhadap *cost report* sebesar 5.89%. Nilai biaya proses manufaktur rangka sebesar $1,001.01 memberikan kontribusi 5.89% dari total *cost report* sebesar $16,971.81.

Diketahui total biaya proses manufaktur sebesar $1,001.01 dan total *cost report* sebesar $16,971.81. Proses manufaktur dari setiap *part* di dalam kendaraan memiliki nilai biaya. Biaya yang diberikan sudah dibedakan sesuai jenisnya yang tertera dalam *cost table* yaitu *process*

table. Dari hasil biaya proses manufaktur rangka kendaraan FG26 yang telah diketahui, dapat diperoleh nilai kontribusi biaya proses manfaktur rangka kendaraan FG16 terhadap total biaya pada *cost report*.

Nilai tersebut berpengaruh juga dalam bentuk poin yang didapatkan. Apabila biaya proses manufaktur rangka kendaraan FG16 tidak dihitung dan tidak dimasukkan ke dalam *cost report* akan berdampak pada poin penalti berupa pengurangan poin *cost and manufacturing event* atau penambahan biaya total *cost report* dari yang seharusnya. Namun dari hasil tersebut dapat diketahui bahwa biaya proses manufaktur rangka kendaraan FG16 memiliki kontribusi terhadap *cost report*. Variabel proses manufaktur juga merupakan salah satu variabel penting yang menjadi dasar pembuatan nilai biaya *cost report* dan dibuat oleh anggota *Garuda UNY Racing Team*. Sehingga dalam pembuatan dokumen *cost report* yang dilaksanakan di *basecamp* dari *Garuda UNY Racing Team* untuk berkas penilaian *Cost and Manufacturing Event* di kompetisi *Student Formula Japan* 2016, biaya material harus dihitung dan dimasukkan ke dalam dokumen *cost report*.

3. Peran Pembuatan Dokumen *Cost Report*

a. Dalam Kompetensi/Keterampilan Abad 21

Berdasarkan hasil data yang sudah didapatkan. Data yang meliputi tahap-tahap pembuatan *cost report*, analisa tingkat kontribusi biaya material dan biaya proses manufaktur *frame* kendaraan FG16 terhadap *cost report* dapat dikategorikan sebagai wujud hasil dari

keterampilan abad 21. Pembuatan dokumen *cost report* di mulai dari pembuatan desain kendaraan hingga kendaraan itu jadi.

Wujud keterampilan pertama yaitu "*communication*" dan kedua adalah "*collaboration*". Dalam sebuah tim yang baik agar dapat menghasilkan produk yang berkualitas termasuk di *Garuda UNY Racing Team* harus memiliki komunikasi yang baik antar anggota tim dan mampu bekerjasama. Kedua keterampilan ini sangat berkaitan erat dalam perannya di sebuah tim. Dimulai dari diskusi awal pembuatan desain dengan berbagai pemikiran setiap divisi yang berbeda-beda, harus didapatkan kesepakatan demi tercipta kolaborasi yang baik dan hasil produk yang berkualitas.

Wujud keterampilan yang ketiga yaitu "*critical thinking*" dan keempat adalah "*creativity*". Dalam diskusi di *Garuda UNY Racing Team*, setiap anggota dituntut untuk dapat berpikir kreatif dan berpikir kritis atas segala permasalahan dan pendapat yang muncul. Bentuk kreativitas yang sudah nyata terbukti adalah setiap kendaraan hasil buatan mahasiswa di *Garuda UNY Racing Team*, salah satunya yaitu kendaraan *Formula Garuda*. Serta segala kelengkapan dalam mengikuti setiap kompetisi termasuk dokumen-dokumen penting seperti *cost report*. Setelah desain kendaraan jadi dan proses manufaktur sudah ditentukan, tim wajib mencatat data seluruh komponen termasuk jenis material beserta kuantitasnya, jenis proses manufaktur yang digunakan, pengikatan yang digunakan, dan

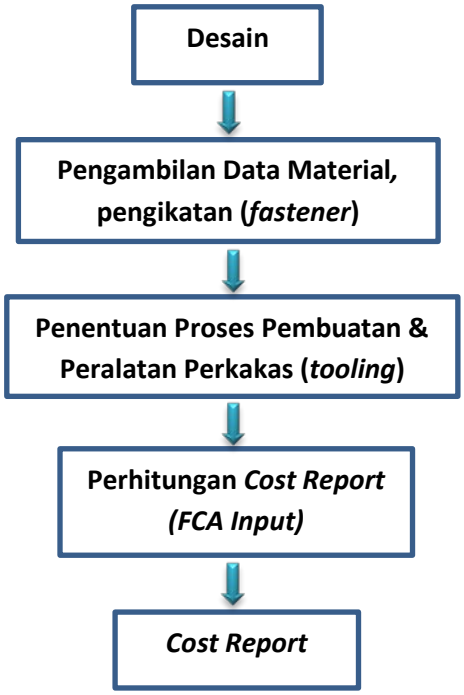
perkakas yang digunakan. Data tersebut akan digunakan untuk menghitung biaya setiap komponen dan digunakan sebagai bahan membuat dokumen *cost report*. Sehingga mahasiswa wajib dituntut berpikir kritis dalam menghadapi setiap masalah termasuk teliti dalam mencari solusi, dapat bekerjasama dengan tim yang memiliki komunikasi baik, dan kreatif menentukan setiap keputusan atau pekerjaan yang efektif serta efisien. Oleh karena itu, pembuatan dokumen *cost report* merupakan wujud keterampilan 4C dari abad 21 yang harus dimiliki oleh setiap mahasiswa yaitu *communication*, *collaboration*, *critical thinking* dan *creativity*.

b. Dalam Pengembangan Materi Mata Kuliah Manajemen Industri Otomotif

Berdasarkan hasil data pembuatan dan analisa dokumen *Cost Report*, prosedur pembuatan dokumen cost report dimulai dari prosedur pengambilan data berdasarkan desain kendaraan, pengisian data pada *FCA Input*, perhitungan dan analisa. Dari rangkaian tahap yang sudah tersusun, dapat dijadikan sebagai pengembangan materi mata kuliah Manajemen Industri Otomotif (MIO) yang tertera dalam kurikulum S1 Pendidikan Teknik Otomotif. Mata kuliah MIO berada pada fase semester 5 sesuai kurikulum dengan kode OTO6229.

Bentuk pengembangan yang dilakukan berupa penambahan materi pembuatan dokumen *cost report* ke dalam mata kuliah MIO. Sehingga pada pelaksanaannya, proses pembelajaran mata kuliah MIO sampai

pada materi pembuatan dokumen *cost report.* Materi *cost report* merupakan dokumen yang bertaraf internasional digunakan pada kompetisi *Formula SAE* yang memiliki 10 seri di dunia dan secara resmi diselenggarakan oleh *SAE Internasional*.



Gambar 25. Tahap Pembuatan *Cost Report*

Tahap pertama adalah tahap pembuatan desain atau dapat langsung melakukan pengamatan terhadap desain atau kendaraan yang sudah ada. *Cost report* merupakan laporan pembiayaan khususnya untuk bidang otomotif berupa kendaraan bermotor. Objek tersebut dapat diamati untuk kemudian dilanjutkan ke tahap kedua. Tahap kedua yaitu pengambilan data berupa material dan pengikatan yang digunakan. Data material yang diambil adalah data material mentah (*raw material*) dan pengikatan seperti baut, mur, *clam*, dan

jenis pengikatan lain yang digunakan. Dan tahap ketiga adalah penentuan proses yang akan digunakan untuk membuat setiap part yang akan dibuat dan peralatan perkakas (*tooling*) yang akan digunakan pada proses yang dipilih. Setiap jenis material, pengikatan, proses pembuatan dan perkakas memiliki tingkat biaya yang berbeda-beda. sehingga harus dapat memilih dengan cermat agar biaya tidak terlalu tinggi namun tetap memiliki performa atau hasil yang baik. Kemudian tahap terakhir adalah penginputan data & perhitungan pada tabel pada *file FCA Input* sesuai jenis data yang sudah didapatkan. Ketika data sudah diinput, maka proses perhitungan juga sudah langsung secara otomatis yang dilakukan oleh sistem sesuai *formula* (rumus) dalam *FCA Input*. Penginputan setiap jenis data dimensi dan biaya disesuaikan dengan jenis part yang dibeli atau dibuat. Tingkat biaya diketahui melalui tabel biaya (*Cost Table*) yang memiliki 5 jenis tabel yaitu *materials table* (tabel proses), *processes table* (tabel proses), *multiplier processes table* (tabel pengalian proses), *fasteners table* (tabel pengikatan), dan *toolings table* (tabel perkakas). Setelah data dimasukan dengan benar, akan muncul hasil biaya yang digunakan. Setelah semua biaya part yang ada pada kendaraan telah terhitung maka akan menjadi dokumen *cost report* (laporan pembiayaan).

BAB V

SIMPULAN DAN SARAN

A. Simpulan

Berdasarkan dari penelitian dan pembahasan yang telah dilakukan, dapat diambil simpulan sebagai berikut :

1. Biaya material *frame* kendaraan FG16 sebesar $157.51 memiliki kontribusi 0.92% terhadap total biaya pada *cost report*. Yang menjadi poin penting tingkat kontribusi nilai biaya material pada *cost report* adalah jenis material dan kuantitas material untuk membuat *frame* kendaraan FG16. Terdapat 5 jenis material yang digunakan yaitu terdiri dari *steel tube*, *alloy steel*, *mild steel*, *aluminum premium*, dan *paint*. Dan kuantitas berat material yang digunakan untuk *frame* kendaraan FG16 adalah 46.81kg dengan luas pengecatan 0.02m^2. Berdasarkan hasil yang sudah didapatkan, dapat disimpulkan biaya material *frame* kendaraan FG16 memiliki kontribusi terhadap total biaya pada *cost report*.
2. Biaya proses *frame* kendaraan FG16 sebesar $1,001.01 memiliki kontribusi 5.89% terhadap total biaya pada *cost report*. Poin penting yang mempengaaruhi nilai biaya proses pada *cost report* adalah jenis proses dan kuantitas langkah proses beserta nilai pengalinya. Terdapat 426 langkah proses yang digunakan untuk untuk membuat *frame* kendaraan FG16. Berdasarkan hasil penelitian yang sudah dilakukan, dapat disimpulkan biaya proses manufaktur *frame* kendaraan FG16 memiliki kontribusi terhadap total biaya pada *cost report*.

3. Pembuatan dokumen *cost report* merupakan salah satu bentuk atau wujud keterampilan abad 21 yang harus dimiliki oleh setiap mahasiswa yaitu *communication*, *collaboration*, *critical thinking* dan *creativity* yang dapat digunakan sebagai bentuk pengembangan materi mata kuliah Manajemen Industri Otomotif. *Communication* yang berarti mampu berkomunikasi dengan baik antar setiap anggota tim dalam melaksanakan pekerjaannya khususnya membuat dokumen *cost report*. *Collaboration* yang berarti mampu bekerjasama dalam sebuah tim agar lebih efektif dan efisien dalam membuat dokumen *cost report*. *Critical thinking* yang berarti mampu berpikir kritis termasuk teliti agar tidak terjadi kesalahan (*miss*) dalam perhitungan biaya setiap komponen yang jumlahnya sangat banyak. *Creativity* yang berarti memiliki kreativitas dalam membuat sebuah kendaraan agar memiliki performa yang baik dan dapat menentukan alur kerja pembuatan *cost report* yang lebih efektif dan efisien.

B. Saran

Berdasarkan penelitian yang telah dilakukan, dapat diajukan saran sebagai berikut:

1. Dalam pembuatan dokumen *cost report* harus secara detail memahami regulasi, baik untuk regulasi *static event*, *dynamic event*, dan regulasi keseluruhan terkait kompetisi *Student Formula*.
2. Pembuatan kendaraan untuk kompetisi *Student Formula* maupun kendaraan komersial harus memperhatikan biaya dalam pembuatannya.

Semakin murah atau semakin efisien nilai harga kendaraan yang dibuat dengan performa yang baik akan medapatkan nilai poin yang tinggi.

3. Pembuatan *cost report* harus lebih detail dan akurat agar tidak ada kesalahan perhitungan biaya dalam pembuatan dokumen *cost report*.
4. Hasil penelitian ini dapat menjadi referensi dalam pembuatan dokumen *cost report* khususnya untuk *Garuda UNY Racing Team* maupun tim mobil yang lain pada kompetisi *Student Formula* yang memiliki 10 seri di dunia.

DAFTAR PUSTAKA

Arikunto, Suharsimi. 2013. *Prosedur Penelitian Suatu Pendekatan Praktik*. Jakarta: PT Rineka Cipta.

Bialik, Maya. 2015. *Skills for the 21st Century: What Should Student Learn?*. Boston: Diakses dari https://www.researchgate.net/publication/318681750 pada tanggal 19 Maret 2018

Chung, Deborah D.L. 1994. *Carbon Fiber Composites*. Oxford: Butterworth-Heinemann.

Fauzi, Naufal Annas. 2016. *Kesesuaian Perancangan, Pengembangan dan Hasil Pengujian Impact Attenuator pada Kendaraan Formula Sae FG16 Garuda UNY Team Terhadap 2016 Formula SAE Rules*. Yogyakarta: Universitas Negeri Yogyakarta.

Haryana, Kir. 2007. *Modul Manajemen Industri*. Diakses pada tanggal 14 Februari 2018.

JSAE. 2016. *Student Formula Japan 2016*. Diakses dari https://www.jsae.or.jp/formula/en/web. pada tanggal 29 April 2016

Jurusan Pendidikan Teknik Otomotif. 2014. *Kurikulum 2014 Program Studi Pendidikan Teknik Otomotif (S1) Teknik Otomotif (D3)*. Yogyakarta: FT UNY.

Kivunja, Charles. 2015. *Exploring the Pedagogical Meaning and Implications of the 4Cs "Super Skills" for the 21st Century through Bruner's 5E Lenses of Knowledge Construction to Improve Pedagogies of the New Learning Paradigm*. Armidale: Diakses dari https://www.researchgate.net/ pada tanggal 19 Maret 2018.

Kusumam, Aliangga, Mukhidin, dan Bachtiar Hasan. 2016. *Pengembangan Bahan Ajar Mata Pelajaran Dasar dan Pengukuran Listrik Untuk Sekolah Menengah Kejuruan*. Bandung: Jurnal Pendidikan Teknologi dan Kejuruan. Vol. 23, No. 1:29-30.

Prakoso, Bondan. 2016. *Tugas Akhir Skripsi.Business Logic Plan Pengembangan Produksi Formula Garuda 16 Dalam Ajang Kompetisi Student Formula Japan Tahun 2016*. Yogyakarta: Universitas Negeri Yogyakarta.

Rajput, R.K. 2007. *A Textbook of Automobile Engineering*. New Delhi: Laxmi Publications (P) LTD.

Ramakhrisna, Kamaraju. 2012. *Automobile Engineering.* New Delhi: PHI Learning Private Limited.

Reid, Konrad. 2014. *Automotive Handbook*. Stuttgart: Robert Bosch GmbH.

SAE International. 2015. *2016 Formula SAE Rules*. SAE. Diakses dari https://www.fsaeonline.com/ pada tanggal 1 Desember 2016.

SAE International. 2016. *Cost tables*. Diakses dari https://www.fsaeonline.com/ pada tanggal 1 April 2016.

SAE International. 2016. *FCA Input*. Diakses dari https://www.fsaeonline.com/ pada tanggal 1 April 2016.

Shimada, Yukio. 2007. *Motor Car Development/Fabrication Guide (For Students and Junior Engineers).* Tokyo: JSAE.

Suyanto, dan Asep Jihad. 2016. *Betapa Mudah Menyusun Tulisan Ilmiah*. Yogyakarta: Esensi Erlangga Group.

Sugiyono. 2013. *Metode Penelitian Kuantitatif, Kualitatif dan R&D.* Bandung: Alfabeta.

Vlack, Lawrence H. Van. 2004. *Elemen-elemen Ilmu dan Rekayasa Material*. Jakarta: Penerbit Erlangga.

Zubaidah, Siti. 2016. *Keterampilan Abad Ke-21: Keterampilan yang Diajarkan Melalui Pembelajaran*. Malang: Diakses dari https://www.researchgate.net/publication/318013627 pada tanggal 19 Maret 2018

LAMPIRAN

Lampiran 1

Struktur Kurikulum S1 Pendidikan Teknik Otomotif

No.	Kode	Mata Kuliah	SKS				Sem		PRA SYARAT
			T	P	L	J	Gsl	Gnp	
1.	MKU6301	Pendidikan Agama Islam*	3			3	1		Minimal B
	MKU6302	Pendidikan Agama Katolik*							
	MKU6303	Pendidikan Agama Kristen*							
	MKU6304	Pendidikan Agama Budha*							
	MKU6305	Pendidikan Agama Hindu*							
	MKU6306	Pendidikan Agama Konghuchu*							
2.	KTF6205	Matematika	2			2	1		
3.	KTF6206	Fisika	2			2	1		
4.	MDK6201	Ilmu Pendidikan	2			2	1		Minimal C
5.	OTO6201	Gambar Teknik	1	1		2	1		Minimal C
6.	OTO6302	Alat dan Pengukuran Teknik	2	1		3	1		Minimal C
7.	OTO6303	Teknologi Pembentukan Dasar	1	2		3	1		
8.	OTO6204	Teknologi Otomotif Dasar	2			2	1		
9.	OTO6305	Listrik dan Elektronika Dasar	1	1		2	1		Minimal C
		Jumlah SKS Semester	16	5	0	21			
No	Kode	Mata Kuliah	SKS				Sem		PRA SYARAT
			T	P	L	J	Gsl	Gnp	
Semester 2									
10	KTF6207	Keselamatan dan Kesehatan Kerja	2			2		2	
11	OTO6206	Aplikasi Komputer		2		2		2	
12	OTO6207	Matematika Lanjut	2			2		2	
13	OTO6208	Mekanika Fluida	2			2		2	
14	OTO6209	Statika dan Kekuatan Material	2			2		2	
15	OTO6310	Material Teknik	2	1		3		2	
16	OTO6211	Termodinamika	2			2		2	
17	OTO6312	Elektronika Analog dan Digital	2	1		3		2	
18	OTO6213	Bahan Bakar dan Pelumas Otomotif	2			2		2	
19	OTO6314	Teknologi Sepeda Motor	1	2		3		2	Minimal C
		Jumlah SKS Semester	17	6	0	23			
No	Kode	Mata Kuliah	SKS				Sem		PRA SYARAT
			T	P	L	J	Gsl	Gnp	
Semester 3									
20	MKU6207	Pendidikan Kewarganegaraan	2			2	3		Minimal C
21	MDK6202	Psikologi Pendidikan	2			2	3		Minimal C

22	OTO6215	Elemen Mekanik Otomotif	2			2	3		
23	OTO6316	Pneumatik dan Hidrolik	2	1		3	3		
24	OTO6217	Mekanika Gerak Kendaraan	2			2	3		
25	OTO6218	Desain Otomotif		2		2	3		
26	OTO6419	Teknologi Motor Bensin	2	2		4	3		Minimal C
27	OTO6320	Listrik dan Elektronika Otomotif	2	1		3	3		Minimal C
28	OTO6321	Sistem Pemindah Tenaga	2	1		3	3		Minimal C
		Jumlah SKS Semester	16	7	0	23			
No	Kode	Mata Kuliah	SKS				Sem		PRA SYARAT
			T	P	L	J	Gsl	Gnp	
Semester 4									
29	MKU6211	Bahasa Inggris	2			2		4	Minimal C
30	MKU6214	Pendidikan Sosial Budaya	2			2		4	Minimal C
31	MDK6303	Manajemen Pendidikan	2		1	3		4	Minimal C
32	OTO6322	Kemudi, Rem dan Suspensi	1	2		3		4	Minimal C
33	OTO6423	Teknologi Motor Diesel	2	2		4		4	Minimal C
34	OTO6324	Teknologi Bodi Kendaraan	1	2		3		4	Minimal C
35	OTO6325	Sistem AC	2	1		3		4	Minimal C
36	OTO6227	Regulasi dan Manajemen Transportasi	2			2		4	
		Jumlah SKS Semester	14	7	1	22			
No	Kode	Mata Kuliah	SKS				Sem		PRA SYARAT
			T	P	L	J	Gsl	Gnp	
Semester 5									
37	MKU6209	Bahasa Indonesia	2			2	5		Minimal C
38	MKU6210	Statistika	2			2	5		Minimal C
39	KTF6201	Kurikulum dan Pembelajaran Kejuruan	2			2	5		Minimal C
40	KTF6203	Media Pembelajaran dan Teknologi Informasi	2			2	5		Minimal C
41	KTF6208	Pendidikan Teknologi dan Kejuruan	2			2	5		Minimal C
42	KTF6309	Praktek Industri			3	3	5		Minimal C
43	OTO6228	Teknologi Alat Berat	1	1		2	5		
44	OTO6229	Manajemen Industri Otomotif	2			2	5		
45	OTO6331	Diagnosis	1	1		2			
46	OTO6430	Teknologi Pengecatan	1	2		3	5		Minimal C
		Jumlah SKS Semester	15	4	3	22			
No	Kode	Mata Kuliah	SKS				Sem		PRA SYARAT
			T	P	L	J	Gsl	Gnp	
Semester 6									
47	MKU6208	Pancasila	2			2		6	Minimal C
48	MKU6212	Kewirausahaan	2			2		6	Minimal C
49	MDK6204	Sosio Antropologi Pendidikan	2			2		6	Minimal C
50	MKP6301	Metodologi Penelitian	3			3		6	Minimal C

		Pendidikan							
51	KTF6202	Strategi Pembelajaran Kejuruan	2			2		6	Minimal C
52	KTF6204	Penilaian Pembelajaran Kejuruan	2			2		6	Minimal C
53	OTO6346	Diagnosis Kendaraan**	1	2		3		6	
	OTO 6341	Diagnosis Sepeda Motor**							
	OTO 6342	Diagnosis Bodi Kendaraan**							
	OTO 6343	Diagnosis Alat Berat**							
	OTO 6344	Diagnosis Kelistrikan Kendaraan**							
54	OTO6332	Pembelajaran Mikro		2	1	3		6	
55	OTO6326	Engine Management System**	2	1		3		6	
	OTO6339	Engine Management System Sepeda Motor**							
	OTO 6340	Engine Management System Alat Berat**							
	OTO6337	Sistem Kontrol Elektronik Otomotif **							
	OTO6333	Disain Bodi Otomotif **							
		Jumlah SKS Semester	16	5	1	22			
No	Kode	Mata Kuliah	SKS				Sem		PRA SYARAT
			T	P	L	J	Gsl	Gnp	
Semester 7									
56	PPL6301	Magang Kependidikan			3	3	7		Minimal C
57	MKU6313	Kuliah Kerja Nyata			3	3	7		Minimal C
58	OTO6334	Teknologi Kendaraan Hybrid **	2	1		3	7		
	OTO6335	Teknologi Otomotif Lanjut **							
	OTO6336	Modifikasi Sepeda Motor **							
	OTO6338	Sistem Kelistrikan dan Kontrol Alat Berat**							
	OTO 6345	Teknologi Pengecatan Lanjut**							
		Jumlah SKS Semester	2	1	6	9			
No	Kode	Mata Kuliah	SKS				Sem		PRA SYARAT
			T	P	L	J	Gsl	Gnp	
Semester 8									
59	MKP6602	Tugas Akhir Skripsi			6	6		8	Minimal C
		Jumlah SKS Semester	0	0	6	6			
		Jumlah Total SKS	96	35	17	148			

Lampiran 2

Tabel Data Material *Frame* FG16

No	Nama Struktur Rangka	Size1 (Unit1)	Size2 (Unit2)	Material	Area (cm^2)	Length (cm)	Density (kg/cm^3)	Qty
1	Tube Frame	7.54kg	-	Tubing, Steel	1.4	517.84	0.00770	1
		10.71 kg	-	Tubing, Steel	1.33	1,000.83	0.00770	1
		14.13 kg	-	Tubing, Steel	0.98	1,783.42	0.00770	1
		0.66 kg	-	Tubing, Steel	0.61	168.33	0.00770	1
2	Front A-Arm Upper Bracket	0.12kg	-	Steel, Alloy	2.44	6.5	0.00785	4
3	Front A-Arm Lower Bracket	0.14kg	-	Steel, Alloy	2.44	7.51	0.00785	4
4	Rear A-Arm Steel Upper Bracket	0.11kg	-	Steel, Alloy	2.44	5.74	0.00785	2
5	Rear A-Arm Aluminum Upper Bracket	0.2kg	-	Aluminum, Premium	18.49	3.9	0.00281	2
6	Rear A-Arm Steel Lower Bracket	0.12kg	-	Steel, Alloy	2.44	60.50	0.00785	2
7	Rear A-Arm Aluminum Lower Bracket	0.2kg	-	Aluminum, Premium	18.49	3.9	0.00281	2
8	Front Bellcrank Bracket	0.03kg	-	Steel, Alloy	20.00	0.20	0.00785	4
9	Front Suspension Mounting	0.04kg	-	Steel, Alloy	24.00	0.20	0.00785	4
10	Rear Suspension Mounting	0.03kg	-	Aluminum, Premium	35.50	0.32	0.00281	2
11	Pedal Box Hole Adjuster	0.3kg	-	Steel, Alloy	0.76	50.55	0.00785	2
12	Gear Box Mounting	0.11kg	-	Steel, Alloy	1.16	12.30	0.00785	2
13	Steering Shaft Bearing Housing	0.31kg	-	Steel, Alloy	11.95	3.30	0.00785	1
14	Front Seat Belt Mounting	-	-	-	-	-	-	2
15	Middle Seat	-	-	-	-	-	-	2

	Belt Mounting							
16	Rear Seat Belt Mounting	-	-	-	-	-	-	2
17	Battery Seat	-	-	Steel, Alloy	-	-	0.00785	1
18	Radiator Mounting	0.02kg	-	Steel, Alloy	9.90	0.20	0.00785	4
19	Muffler Mounting	0.09kg	-	Steel, Alloy	79.93	0.15	0.00785	2
20	Head Rest Mounting	0.05kg	-	Steel, Alloy	30.60	0.20	0.00785	2
21	Pressure Regulator Mounting	0.03kg	-	Steel, Alloy (per kg)	1.56	2.30	0.00785	1
22	Shifter Solenoid Mounting	0.05kg	-	Steel, Alloy (per kg)	1.56	4.30	0.00785	1
23	Fuel Tank Mounting	0.07kg	-	Steel, Alloy	45.20	0.20	0.00785	4
24	Impact Attenuator Mounting	0.04kg	-	Steel, Alloy	17.20	0.30	0.00785	4
25	Rear Bulkhead	9.76kg	-	Aluminum, Premium	1,827.87	1.80	0.00281	1
26	Jacking Point	0.27kg	-	Tubing, Steel	0.98	34.30	0.00785	1
27	Jack Member	0.22kg	-	Aluminum, Premium	131.86	0.60	0.00281	2
28	Jacking Member Bracket	0.13kg	-	Aluminum, Premium	11.73	3.80	0.00281	4
29	Firewall Bracket	0.03kg	-	Steel, Alloy	66.00	0.20	0.00785	1
30	Manual Shifter Mounting	0.07kg	-	Steel, Mild	2.01	4.30	0.00790	1
		0.19kg	-	Steel, Mild	60.00	0.4	0.00790	1
		0.07kg	-	Steel, Mild	31.50	0.3	0.00790	1
		$0.02m^2$	-	Paint	-	-	-	1
31	Main switch mounting	0.17kg	-	Steel, Alloy (per kg)	1.56	2.30	0.00785	1
32	Anti Roll Bar Mounting	0.03kg	-	Steel, Alloy	23.08	0.20	0.00785	4
33	Rear Bellcrank Bearing	22mm	7mm	Bearing, Ball, Radial	-	-	-	4
34	Upper Seat Mounting	0.02kg	-	Steel, Alloy	15.90	0.20	0.0785	2
35	Lower Seat Mounting	0.02kg	-	Steel, Alloy	11.40	0.20	0.00785	2
36	Front Mounting Engine Adapter	0.06kg	-	Steel, Alloy	5.07	1.40	0.00785	2
37	Bottom Engine Mounting	0.01kg	-	Steel, Alloy	6.66	0.20	0.00785	2
38	Oil Catchtank	0.03kg	-	Steel, Alloy	17.42	0.20	0.00785	2

	Mounting							
39	Cooling Additional Bottle Mounting	0.02kg	-	Steel, Alloy	12.75	0.20	0.00785	1
40	Overflow Bottle Mounting	0.03kg	-	Steel, Alloy	17.90	0.20	0.00785	1
41	Dashboard Mounting	0.02kg	-	Steel, Alloy	10.24	0.20	0.00785	1
42	Resonator Mounting	0.01kg	-	Steel, Alloy	5.12	0.20	0.00785	1
43	Diffuser Mounting	0.03kg	-	Steel, Alloy	39.80	0.20	0.00785	1
44	Front Side Body Mounting	0.01kg	-	Steel, Alloy	12.10	0.20	0.00785	1
45	Inner Side Body Mounting	0.1kg	-	Steel, Alloy	60.80	0.20	0.00785	1
46	Battery Seat Bracket	0.03kg	-	Steel, Alloy	21.60	0.20	0.00785	1
47	Fuel Tank Mounting Support	0.11kg	-	Steel, Alloy	67.40	0.20	0.00785	1
48	Regulator Mounting	0.03kg	-	Steel, Alloy	10.68	0.20	0.00785	1
49	Ignition Coil Mounting	0.03kg	-	Steel, Alloy	14.43	0.20	0.00785	1
50	Rear Bulkhead Adapter	0.15kg	-	Steel, Alloy	6.33	2.95	0.00785	4
51	Plenum Holder Mounting	0.03kg	-	Steel, Alloy	19.12	0.20	0.00785	1
52	Capacitor Bank Bracket	0.03kg	-	Steel, Alloy	14.74	0.20	0.00785	1

Lampiran 3

Tabel *Cost Material* kendaraan FG16

No.	Nama Assembly/Part Rangka	Material	Cost/Part	Part Qty	Total Cost
1	Tube Frame	Tubing, Steel	$ 67.88	1	$ 67.88
2	Front A-Arm Upper Bracket	Steel, Alloy	$ 0.28	4	$ 1.12
3	Front A-Arm Lower Bracket	Steel, Alloy	$ 0.32	4	$ 1.29
4	Rear A-Arm Steel Upper Bracket	Steel, Alloy	$ 0.25	2	$ 0.50
5	Rear A-Arm Aluminum Upper Bracket	Aluminum, Premium	$ 0.85	2	$ 1.70
6	Rear A-Arm Steel Lower Bracket	Steel, Alloy	$ 2.61	2	$ 5.22
7	Rear A-Arm Aluminum Lower Bracket	Aluminum, Premium	$ 0.85	2	$ 1.70
8	Front Bellcrank Bracket	Steel, Alloy	$ 0.07	4	$ 0.28
9	Front Suspension Mounting	Steel, Alloy	$ 0.09	4	$ 0.36
10	Rear Suspension Mounting	Aluminum, Premium	$ 0.13	2	$ 0.26
11	Pedal Box Hole Adjuster	Steel, Alloy	$ 0.68	2	$ 1.36
12	Gear Box Mounting	Steel, Alloy	$ 0.25	2	$ 0.50
13	Steering Shaft Bearing Housing	Steel, Alloy	$ 0.70	1	$ 0.70
14	Front Seat Belt Mounting	-	-	2	-
15	Middle Seat Belt Mounting	-	-	2	-
16	Rear Seat Belt Mounting	-	-	2	-
17	Battery Seat	Steel, Alloy	$ 1.10	1	$ 1.10
18	Radiator Mounting	Steel, Alloy	$ 0.14	4	$ 0.56
19	Muffler Mounting	Steel, Alloy	$ 0.02	2	$ 0.04
20	Head Rest Mounting	Steel, Alloy	$ 0.11	2	$ 0.22
21	Pressure Regulator Mounting	Steel, Alloy (per kg)	$ 0.06	1	$ 0.06
22	Shifter Solenoid Mounting	Steel, Alloy (per kg)	$ 0.12	1	$ 0.12
23	Fuel Tank Mounting	Steel, Alloy	$ 0.16	4	$ 0.64
24	Impact Attenuator Mounting	Steel, Alloy	$ 0.09	4	$ 0.36
25	Rear Bulkhead	Aluminum,	$ 38.83	1	$ 38.83

		Premium			
26	Jacking Point	Tubing, Steel	$ 0.59	1	$ 0.59
27	Jack Member	Aluminum, Premium	$ 0.93	2	$ 1.86
28	Jacking Member Bracket	Aluminum, Premium	$ 0.53	4	$ 2.12
29	Firewall Bracket	Steel, Alloy	$ 0.23	1	$ 0.23
30	Manual Shifter Mounting	Steel, Mild	$ 0.27	1	$ 0.27
31	Main switch mounting	Steel, Alloy (per kg)	$ 0.06	1	$ 0.06
32	Anti Roll Bar Mounting	Steel, Alloy	$ 0.08	4	$ 0.32
33	Rear Bellcrank Bearing	Bearing, Ball, Radial	$ 5.82	4	$ 23.28
34	Upper Seat Mounting	Steel, Alloy	$ 0.06	2	$ 0.12
35	Lower Seat Mounting	Steel, Alloy	$ 0.11	2	$ 0.22
36	Front Mounting Engine Adapter	Steel, Alloy	$ 0.50	2	$ 1
37	Bottom Engine Mounting	Steel, Alloy	$ 0.02	2	$ 0.04
38	Oil Catchtank Mounting	Steel, Alloy	$ 0.06	2	$ 0.12
39	Cooling Additional Bottle Mounting	Steel, Alloy	$ 0.05	1	$ 0.05
40	Overflow Bottle Mounting	Steel, Alloy	$ 0.06	1	$ 0.06
41	Dashboard Mounting	Steel, Alloy	$ 0.13	1	$ 0.13
42	Resonator Mounting	Steel, Alloy	$ 0.02	1	$ 0.02
43	Diffuser Mounting	Steel, Alloy	$ 0.14	1	$ 0.14
44	Front Side Body Mounting	Steel, Alloy	$ 0.04	1	$ 0.04
45	Inner Side Body Mounting	Steel, Alloy	$ 0.22	1	$ 0.22
46	Battery Seat Bracket	Steel, Alloy	$ 0.08	1	$ 0.08
47	Fuel Tank Mounting Support	Steel, Alloy	$ 0.12	1	$ 0.12
48	Regulator Mounting	Steel, Alloy	$ 0.04	1	$ 0.04
49	Ignition Coil Mounting	Steel, Alloy	$ 0.05	1	$ 0.05
50	Rear Bulkhead Adapter	Steel, Alloy	$ 0.33	4	$ 1.32
51	Plenum Holder Mounting	Steel, Alloy	$ 0.17	1	$ 0.17
52	Capacitor Bank Bracket	Steel, Alloy	$ 0.05	1	$ 0.05
Total					$ 157.51

Lampiran 4

Tabel *Cost Process* kendaraan FG16

No	Nama Assembly/Part	Process Qty/Part	Cost Process /Part	Part Qty	Total Cost
1	Frame	36	$ 124.54	1	$ 124.54
2	Tube Frame	16	$ 385.49	1	$ 385.49
3	Front A-Arm Upper Bracket	5	$ 3.44	4	$ 13.76
4	Front A-Arm Lower Bracket	5	$ 3.56	4	$ 14.24
5	Rear A-Arm Steel Upper Bracket	5	$ 4.5	2	$ 9
6	Rear A-Arm Aluminum Upper Bracket	6	$ 6.27	2	$ 12.54
7	Rear A-Arm Steel Lower Bracket	5	$ 4.53	2	$ 9.06
8	Rear A-Arm Aluminum Lower Bracket	6	$ 6.27	2	$ 12.54
9	Front Bellcrank Bracket	3	$ 2.21	4	$ 8.84
10	Front Suspension Mounting	3	$ 3.51	4	$ 14.04
11	Rear Suspension Mounting	4	$ 4.21	2	$ 8.42
12	Pedal Box Hole Adjuster	3	$ 12.4	2	$ 24.8
13	Gear Box Mounting	3	$ 2.44	2	$ 4.88
14	Steering Shaft Bearing Housing	5	$ 5.42	1	$ 5.42
15	Front Seat Belt Mounting	3	$ 1.23	2	$ 2.46
16	Middle Seat Belt Mounting	3	$ 1.23	2	$ 2.46
17	Rear Seat Belt Mounting	3	$ 1.23	2	$ 2.46
18	Battery Seat	2	$ 12.30	1	$ 12.3
19	Radiator Mounting	2	$ 7.96	4	$ 31.84
20	Muffler Mounting	3	$ 1.45	2	$ 2.9
21	Head Rest Mounting	2	$ 1.65	2	$ 3.3
22	Pressure Regulator Mounting	3	$ 2.01	1	$ 2.01
23	Shifter Solenoid Mounting	3	$ 2.31	1	$ 2.31
24	Fuel Tank Mounting	4	$ 4.01	4	$ 16.04
25	Impact Attenuator Mounting	2	$ 1.15	4	$ 4.6
26	Rear Bulkhead	7	$ 120.25	1	$ 120.25
27	Jacking Point	2	$ 0.38	1	$ 0.38
28	Jack Member	3	$ 4.81	2	$ 9.62
29	Jacking Member Bracket	7	$ 4.4	4	$ 17.6
30	Firewall Bracket	3	$ 10.70	1	$ 10.70
31	Manual Shifter Mounting	10	$ 2.79	1	$ 2.79
32	Main switch mounting	3	$ 8.51	1	$ 8.51
33	Anti Roll Bar Mounting	4	$ 2.77	4	$ 11.08
34	Rear Bellcrank Bearing	-	$ -	4	$ -
35	Upper Seat Mounting	2	$ 0.95	2	$ 1.9
36	Lower Seat Mounting	3	$ 0.86	2	$ 1.72

37	Front Mounting Engine Adapter	5	$ 4.58	2	$ 9.16
38	Bottom Engine Mounting	4	$ 6.19	2	$ 12.38
39	Oil Catchtank Mounting	3	$ 2.36	2	$ 4.72
40	Cooling Additional Bottle Mounting	3	$ 1.71	1	$ 1.71
41	Overflow Bottle Mounting	3	$ 2.36	1	$ 2.36
42	Dashboard Mounting	4	$ 2.39	1	$ 2.39
43	Resonator Mounting	3	$ 0.78	1	$ 0.78
44	Diffuser Mounting	5	$ 17.32	1	$ 17.32
45	Front Side Body Mounting	2	$ 1.50	1	$ 1.50
46	Inner Side Body Mounting	5	$ 8.20	1	$ 8.20
47	Battery Seat Bracket	2	$ 1.98	1	$ 1.98
48	Fuel Tank Mounting Support	2	$ 1.27	1	$ 1.27
49	Regulator Mounting	3	$ 2.36	1	$ 2.36
50	Ignition Coil Mounting	3	$ 2.36	1	$ 2.36
51	Rear Bulkhead Adapter	5	$ 3.65	4	$ 14.6
52	Plenum Holder Mounting	2	$ 0.8	1	$ 0.8
53	Capacitor Bank Bracket	3	$ 2.32	1	$ 2.32
Total					$ 1,001.01

Lampiran 5

University	Universitas Negeri Yogyakarta
System	Frame and Body
Assembly	Frame
P/N Base	A0008
Suffix	BA
Details	Tube Frame Assy

Car #	29	**Asm Cost**	$ 1,229.94
		Qty	1
FileLink1			
FileLink2		**Extended C**	$ 1,229.94
FileLink3			

ItemOrder	Part	Part Cost	Quantity	Sub Total
10	Tube Frame	$ 483.04	1	$ 483.04
20	Front A-Arm Upper Bracket	$ 3.72	4	$ 14.87
30	Front A-Arm Lower Bracket	$ 3.89	4	$ 15.54
40	Rear A-Arm Steel Upper Bracket	$ 4.75	2	$ 9.49
50	Rear A-Arm Aluminum Upper Bracket	$ 7.12	2	$ 14.25
60	Rear A-Arm Steel Lower Bracket	$ 7.14	2	$ 14.28
70	Rear A-Arm Aluminum Lower Bracket	$ 7.12	2	$ 14.25
80	Front Bellcrank Bracket	$ 2.92	2	$ 5.84
90	Front Suspension Mounting	$ 3.60	4	$ 14.40
100	Rear Suspension Mounting	$ 4.34	2	$ 8.68
110	Pedal Box Hole Adjuster	$ 13.08	2	$ 26.15
120	Gear Box Mounting	$ 2.69	2	$ 5.38
130	Steering Shaft Bearing Housing	$ 6.12	1	$ 6.12
140	Front Seat Belt Mounting	$ 3.77	2	$ 7.54
150	Middle Seat Belt Mounting	$ 3.77	2	$ 7.54
160	Rear Seat Belt Mounting	$ 3.77	2	$ 7.54
170	Battery Seat	$ 14.12	1	$ 14.12
180	Radiator Mounting	$ 8.10	4	$ 32.40
190	Muffler Mounting	$ 1.47	2	$ 2.94
200	Head Rest Mounting	$ 1.76	2	$ 3.52
210	Pressure Regulator Mounting	$ 2.07	1	$ 2.07
220	Shifter Solenoid Mounting	$ 2.43	1	$ 2.43
230	Fuel Tank Mounting	$ 4.84	4	$ 19.36
240	Impact Attenuator Mounting	$ 1.24	4	$ 4.96
250	Rear Bulkhead	$ 159.08	1	$ 159.08
260	Jacking Point	$ 0.97	1	$ 0.97
270	Jack Member	$ 5.74	2	$ 11.48
280	Jacking Member Bracket	$ 4.92	4	$ 19.70
290	Firewall Bracket	$ 10.94	1	$ 10.94
300	Manual Shifter Mounting	$ 3.73	1	$ 3.73
310	Main Switch mounting	$ 8.58	1	$ 8.58
320	Anti Roll Bar Mounting	$ 3.02	4	$ 12.08
330	Rear Bellcrank Bearing	$ 5.82	4	$ 23.28
340	Upper Seat Mounting	$ 1.01	2	$ 2.01
350	Lower Seat Mounting	$ 0.97	2	$ 1.94
360	Front Mounting Engine Adapter	$ 5.08	2	$ 10.16
370	Bottom Engine Mounting	$ 6.54	2	$ 13.08
380	Oil Catchtank Mounting	$ 2.42	2	$ 4.84
390	Cooling Additional Bottle Mounting	$ 1.75	1	$ 1.75
400	Overflow Bottle Mounting	$ 2.42	1	$ 2.42
410	Dashboard Mounting	$ 2.52	1	$ 2.52
420	Resonator Mounting	$ 0.80	1	$ 0.80
430	Diffuser Mounting	$ 17.46	1	$ 17.46
440	Front Side Body Mounting	$ 1.54	1	$ 1.54
450	Inner Side Body Mounting	$ 8.41	1	$ 8.41
460	Baterry Seat Bracket	$ 2.06	1	$ 2.06
470	Fuel Tank Mounting Support	$ 1.39	1	$ 1.39
480	Regulator Mounting	$ 2.39	1	$ 2.39
490	Ignition Coil Mounting	$ 2.41	1	$ 2.41

500	Rear Bulkhead Adapter	$	3.98	4	$ 15.93
510	Plenum Holder Mounting	$	0.97	1	$ 0.97
520	Capacitor Bank Bracket	$	2.37	1	$ 2.37
				Sub Total	**$ 1,081.02**

ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
												Sub Total	**$ -**

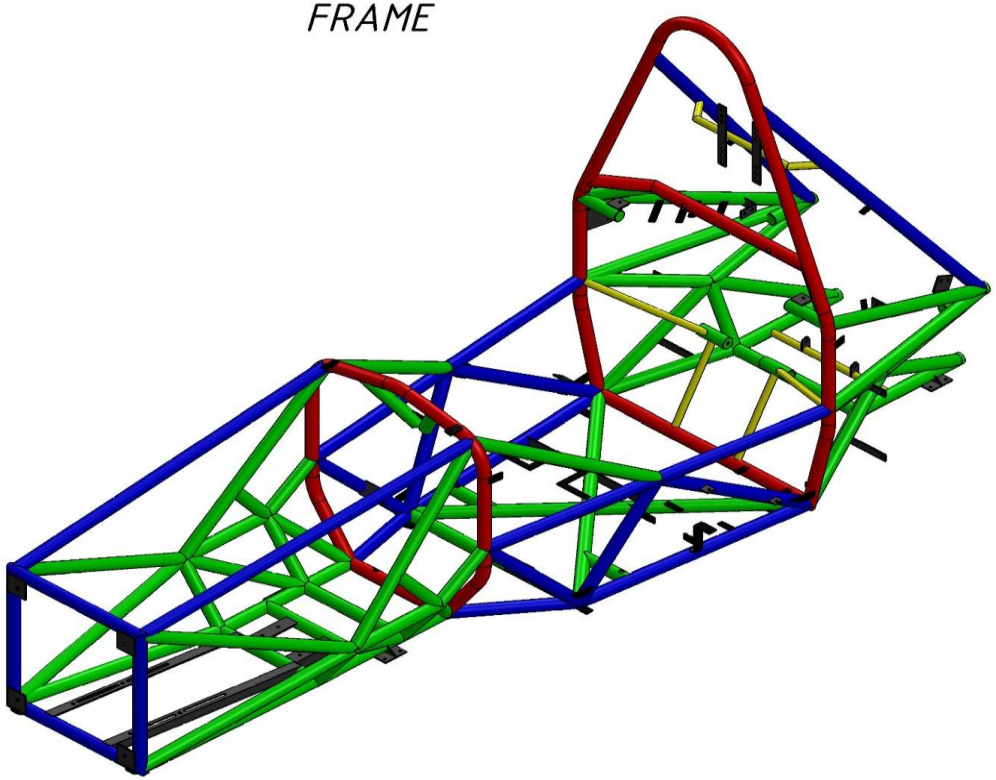
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Weld	Weld rear bulkhead adapter	$ 0.15	cm	31.92		1	$ 4.79
20	Weld	Weld all steel a-arm bracket	$ 0.15	cm	241.03		1	$ 36.15
30	Weld	Weld front bellcrank and front suspension mounting	$ 0.15	cm	91.60		1	$ 13.74
40	Weld	Weld pedal box pedal box adjuster and gear box mounting	$ 0.15	cm	34.18		1	$ 5.13
50	Weld	Weld steering shaft bearing housing	$ 0.15	cm	15.36		1	$ 2.30
60	Weld	Weld front, middle, rear eye bolt of seat belt mounting	$ 0.15	cm	30.16		1	$ 4.52
70	Weld	Weld radiator mounting, muffler mounting, and resonator mounting	$ 0.15	cm	36.10		1	$ 5.42
80	Weld	Weld head rest mounting and main switch mounting	$ 0.15	cm	29.12		1	$ 4.37
90	Weld	Weld pressure regulator mounting and shifter solenoid mounting	$ 0.15	cm	12.00		1	$ 1.80
100	Weld	Weld fuel tank mounting and fuel tank mounting support	$ 0.15	cm	32.00		1	$ 4.80
110	Weld	Weld impact attenuator mounting	$ 0.15	cm	36.00		1	$ 5.40
120	Weld	Weld anti roll bar mounting	$ 0.15	cm	60.80		1	$ 9.12
130	Weld	Weld upper and lower seat mounting	$ 0.15	cm	24.00		1	$ 3.60
140	Weld	Weld oil catchtank, cooling additional bottle, and overflow bottle mounting	$ 0.15	cm	17.80		1	$ 2.67
150	Weld	Weld front and bottom engine mounting	$ 0.15	cm	23.96		1	$ 3.59
160	Weld	Weld battery seat bracket, regulator and ignition mounting	$ 0.15	cm	20.00		1	$ 3.00
170	Weld	Weld dashboard, diffuser, and body mounting	$ 0.15	cm	41.70		1	$ 6.26
180	Weld	Weld fire wall bracket	$ 0.15	cm	27.5		1	$ 4.13
190	Weld	Weld manual shifter mounting and plenum holder mounting	$ 0.15	cm	30.00		1	$ 4.50
200	Assemble, 3 kg, Line-on-Line	Assembly rear bulkhead to space frame	$ 0.38	unit	1		1	$ 0.38
210	Assemble, 1 kg, Line-on-Line	Fasten rear bulkhead bolt and washer	$ 0.13	unit	4		1	$ 0.50
220	Wrench <= 25.4 mm	Tighten rear bulkhead bolt and nut	$ 1.50	unit	4	Fastener Engagement Length > 4D	1.5	$ 9.00
230	Assemble, 1 kg, Line-on-Line	Assembly rear a-arm aluminum bracket and suspension mounting to rear bulkhead	$ 0.13	unit	5		1	$ 0.63
240	Assemble, 1 kg, Line-on-Line	Fasten rear a-arm bracket and suspension mounting bolt, nut, and washer	$ 0.13	unit	18		1	$ 2.25
250	Wrench <= 6.35 mm	Tighten rear a-arm aluminum bracket and suspension mounting bolt and nut	$ 1.00	unit	18	Fastener Engagement Length > 4D	1.5	$ 27.00
260	Assemble, 1 kg, Interference	Assembly rear bellcrank bearing to rear bulkhead	$ 0.19	unit	4		1	$ 0.75
270	Assemble, 1 kg, Line-on-Line	Assembly jacking member bracket to rear bulkhead	$ 0.13	unit	4		1	$ 0.50
280	Assemble, 1 kg, Line-on-Line	Fasten jacking member bracket bolt, nut, and washer	$ 0.13	unit	4		1	$ 0.50
290	Wrench <= 6.35 mm	Tighten jacking member bracket bolt and nut	$ 1.00	unit	4	Fastener Engagement Length > 4D	1.5	$ 6.00
300	Assemble, 1 kg, Line-on-Line	Assembly jack member to rear bulkhead	$ 0.13	unit	2		1	$ 0.25
310	Assemble, 1 kg, Line-on-Line	Fasten jack member bolt, washer and nut	$ 0.13	unit	4		1	$ 0.50
320	Wrench <= 6.35 mm	Tighten jack member bolt and nut	$ 1.00	unit	4	Fastener Engagement Length > 2D	1.25	$ 5.00
330	Assemble, 1 kg, Interference	Assembly jacking point to jack member	$ 0.19	unit	1		1	$ 0.19
340	Assemble, 1 kg, Line-on-Line	Assembly battery seat to space frame	$ 0.13	unit	1		1	$ 0.13
350	Assemble, 1 kg, Line-on-Line	Fasten battery seat bolt, washer and nut	$ 0.13	unit	4		1	$ 0.50
360	Wrench <= 6.35 mm	Tighten battery seat bolt and nut	$ 1.00	unit	4	Fastener Engagement Length > 2D	1.25	$ 5.00
							Sub Total	**$ 124.54**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2	Unit2	Quantity	Sub Total
10	Bolt, Grade 12.9	Bolt for rear bulkhead	0.257	8		40		4	$ 1.03
20	Bolt, Grade 12.9	Bolt for rear aluminum a-arm bracket and jack member bracket	0.086	5		35		20	$ 1.72
30	Bolt, Grade 12.9	Bolt for rear suspension bracket and battery seat bracket	0.142	6		40		2	$ 0.28
40	Nut, Grade 12.9	Nut for rear bulkhead	0.074	8				4	$ 0.30
50	Nut, Grade 12.9	Nut for rear aluminum a-arm bracket and jack member bracket	0.041	5				20	$ 0.82
60	Nut, Grade 12.10	Nut for rear suspension bracket and battery seat bracket	0.050	6				2	$ 0.10
70	Washer, Grade 12.9	Washer for rear bulkhead	0.020	8				4	$ 0.08
80	Washer, Grade 12.10	Washer for rear aluminum a-arm bracket and jack member bracket	0.020	5				40	$ 0.80
90	Washer, Grade 12.11	Washer for rear suspension bracket and battery seat bracket	0.020	6				4	$ 0.08

Sub Total	**$ 5.21**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FractionIncluded	Sub Total
10	Weld	Welding steel plate	$ 500.00	point	115	3000	1	$ 19.17
							Sub Total	**$ 19.17**

FRAME



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	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : RW	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GUT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 483.04
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Tube Frame	**FileLink3**		**FileLink2**		**Extended Cost**	$ 483.04
P/N Base	00032			**FileLink3**			
Suffix	AA						
Details	Student Made Tube steel Frame						

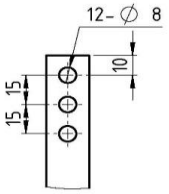
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Tubing, Steel	Frame Tube material Ø25,4 x 2,60 mm thickness	$ 2.25	7.54	kg			Circular Tube	1.40	517.84	0.0077	1	$ 12.56
20	Tubing, Steel	Frame Tube material Ø25,4 x 1,80 mm thickness	$ 2.25	10.71	kg			Circular Tube	1.33	1,009.83	0.0077	1	$ 23.27
30	Tubing, Steel	Frame Tube material Ø25,4 x 1,30 mm thickness	$ 2.25	14.13	kg			Circular Tube	0.98	1,783.42	0.0077	1	$ 30.28
40	Tubing, Steel	Frame Tube material Ø13,8 x 1,60 mm thickness	$ 2.25	0.66	kg			Circular Tube	0.6100	168.33	0.0077	1	$ 1.78
												Sub Total	**$ 67.888**

ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Tube cut	Cutting Ø25,4 mm steel tube material	$ 0.15	cm	2.54	Repeat 89	89	$ 33.91
20	Tube cut	Cutting Ø13,8 mm steel tube material	$ 0.15	cm	1.38	Repeat 8	8	$ 1.66
30	Tube bends	Bending main hoop	$ 0.75	bend	5			$ 3.75
40	Tube bends	Bending front hoop	$ 0.75	bend	5			$ 3.75
50	Tube end preperation for welding	Preparing for main hoop welding	$ 0.75	end	4			$ 3.00
60	Weld - Round Tubing	Welding main hoop	$ 0.38	cm	9.11	Repeat 2	2	$ 6.92
70	Tube end preperation for welding	Preparing for front welding	$ 0.75	end	4			$ 3.00
80	Weld - Round Tubing	Welding front hoop	$ 0.38	cm	8.48	Repeat 2	2	$ 6.44
90	Tube end preperation for welding	Preparing for front bulkhead welding	$ 0.75	end	8			$ 6.00
100	Weld - Round Tubing	Welding front bulkhead	$ 0.38	cm	9.7	Repeat 4	4	$ 14.74
110	Tube end preperation for welding	Preparing for welding frame structures between front hoop and front bulkhead	$ 0.75	end	64			$ 48.00
120	Weld - Round Tubing	Welding frame structures between front hoop and front bulkhead	$ 0.38	cm	162.56			$ 61.77
130	Tube end preperation for welding	Preparing for welding frame structures between front hoop and main hoop	$ 0.75	end	42			$ 31.50
140	Weld - Round Tubing	Welding frame structures between front hoop and main hoop	$ 0.38	cm	106.68			$ 40.54
150	Tube end preperation for welding	Preparing for welding frame structures behind of main hoop	$ 0.75	end	72			$ 54.00
160	Weld - Round Tubing	Welding frame structures behind of main hoop	$ 0.38	cm	175			$ 66.50
							Sub Total	**$ 385.49**

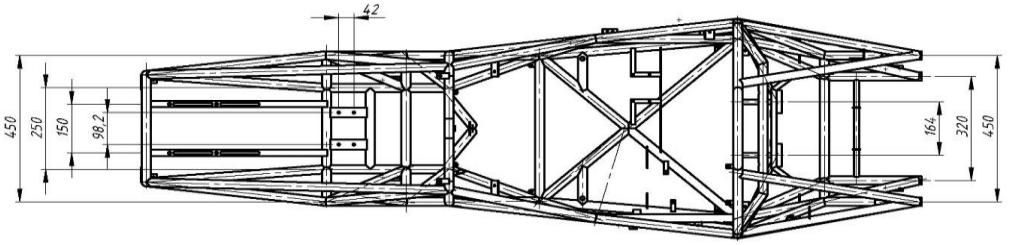
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

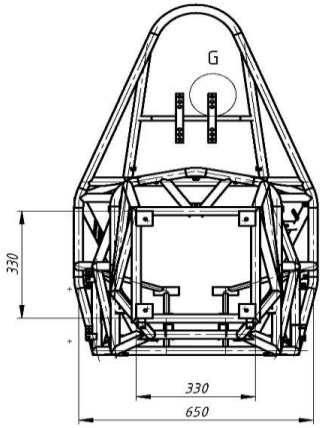
ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
10	Weld	Welding fixture	$ 500.00	point	178	3000	1	$ 29.67
							Sub Total	**$ 29.67**

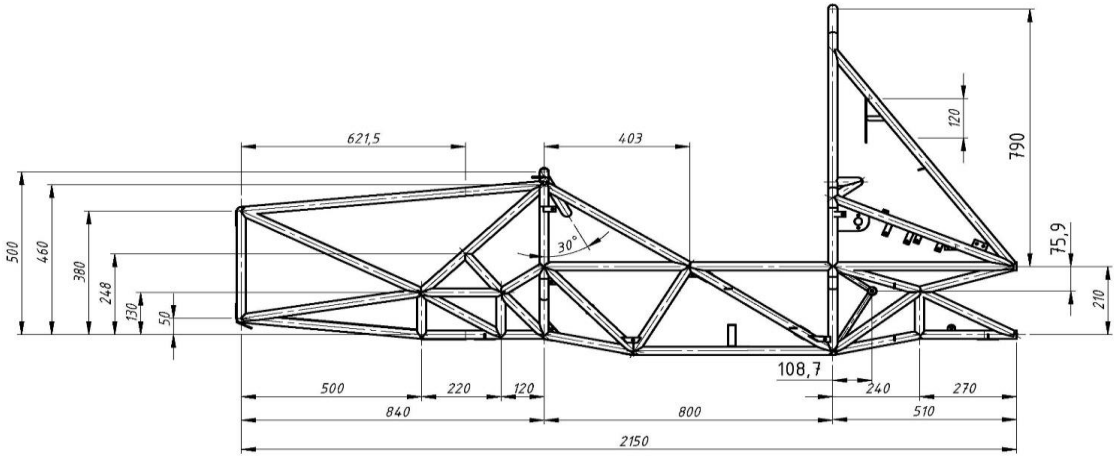
ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0012-00032	Tube Frame	Student Made Tube steel Frame	1



DETAIL G
SCALE 1 : 2







Corresponding symbols		▽	▼	▽▽	▼▼	▽▽▽	▼▼▼	
Roughness Classes (NBN 88-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4
Roughness Value "Ra" in µm (NBN 88-02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2

Allowable deviations for dimensions without tolerance indication (machined surfaces)

For measurements (deviations in mm)									Fillets and chamfers					Angles (in ° and ')					
	Dimensions in mm								Dimensions in mm					Length of the shortest leg					
Accuracyclass ISO 2768.1	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	to 10	>10 to 50	>50 to 120	>120 to 400	above 400	
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	±0,2	±0,5	±1	±2	±4	±1°	±30'	±20'	±10'	±5'	
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2											
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±5	±0,4	±1	±2	±4	±8	±1°30'	±1°	±30'	±15'	±10'	
v Very Rough		±0,5	±1	±1,5	±2,5	±4	±6	±8						±3°	±2°	±1°	±30'	±20'	

SCALE : 1 : 12	DRAWN : TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 15-05-2016	APPROVE : RW		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GUT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 3.72
System	Frame and Body	FileLink1				**Qty**	4
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Front A-Arm Upper Bracket	**FileLink3**		**FileLink2**		**Extended Cost**	$ 14.87
P/N Base	00033			**FileLink3**			
Suffix	AA						
Details	Bracket for Front A-Arm Upper						

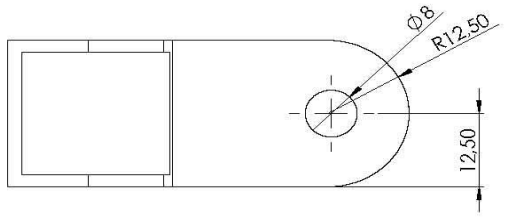
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Front A-Arm Upper Bracket	$ 2.25	0.12	kg			Rectangular pipe	2.44	6.50	0.00785	1	$ 0.28
												Sub Total	**$ 0.280**

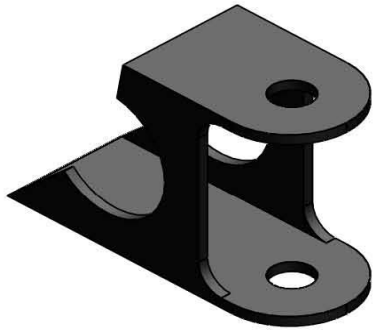
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Saw or tubing cuts	Cutting material	$ 0.40	cm	4.74			$ 1.90
20	Sheet Metal Saw Cut	Hole sawing material	$ 0.20	cm	2.54			$ 0.51
30	Hand Finish - Material Removal	Grinding to contour material	$ 0.20	cm^3	3.01			$ 0.60
40	Drilled holes < 25.4 mm dia.	Drilling for Front A-Arm Upper Bracket hole	$ 0.35	hole	1			$ 0.35
50	Hand Finish - Material Removal	Grinding to fillet material	$ 0.20	cm^3	0.41			$ 0.08
							Sub Total	**$ 3.44**

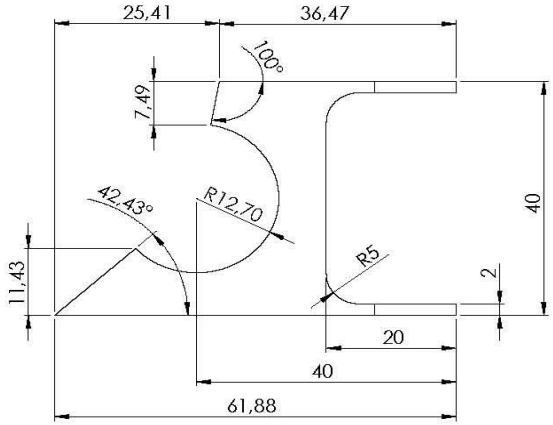
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

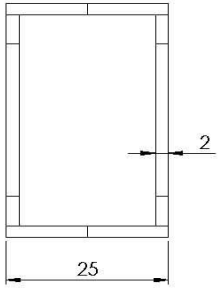
ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**0**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR - A0009 - 00033	Front A-Arm Upper Bracket	Bracket for Front A-Arm Upper	4









Allowable deviations for dimensions without tolerance indication (machined surfaces)

	SCALE : 1,5 : 1	DRAWN : DESIGNER TEAM	NOTE:	
	UNIT : MM	CHECK : ZN, TP		
	DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME		NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 3.89
System	Frame and Body	FileLink1				**Qty**	4
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Front A-Arm Lower Bracket	**FileLink3**		**FileLink2**		**Extended Cost**	$ 15.54
P/N Base	00034			**FileLink3**			
Suffix	AA						
Details	Bracket for Front A-Arm Lower						

ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Front A-Arm Lower Bracket	$ 2.25	0.14	kg			Rectangular pipe	2.44	7.51	0.00785	1	$ 0.32
												Sub Total	**$ 0.324**

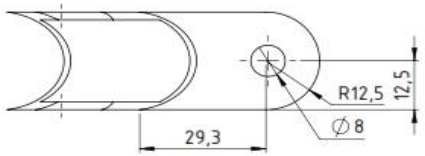
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Saw or tubing cuts	Cutting material	$ 0.40	cm	5.05			$ 2.02
20	Sheet Metal Saw Cut	Hole sawing material	$ 0.20	cm	2.54			$ 0.51
40	Hand Finish - Material Removal	Grinding to contour material	$ 0.20	cm^3	3.01			$ 0.60
50	Drilled holes < 25.4 mm dia.	Drilling for Front A-Arm Lower Bracket hole	$ 0.35	hole	1			$ 0.35
60	Hand Finish - Material Removal	Grinding to fillet material	$ 0.20	cm^3	0.41			$ 0.08
							Sub Total	**$ 3.56**

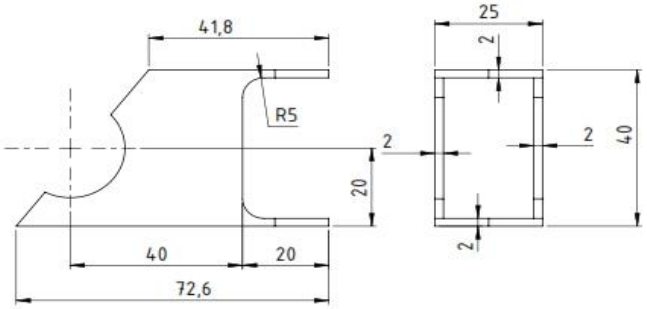
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncId	Sub Total
							Sub Total	**$ -**

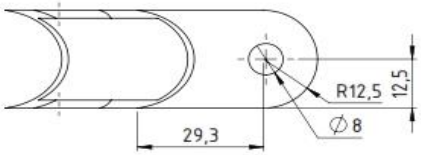
ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00034	Front A-Arm Lower Bracket	Bracket for Front A-Arm Lower	4

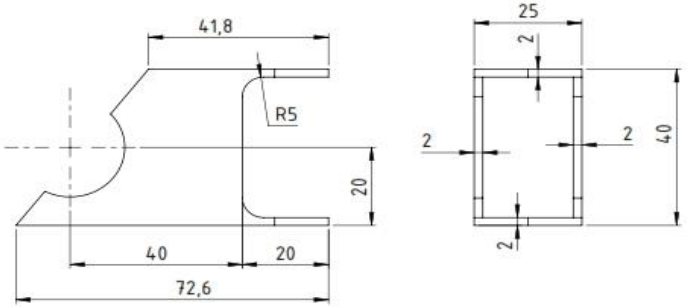
Bracket 1





Bracket 2





Allowable deviations for dimensions without tolerance indication (machined surfaces)

SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:
UNIT : MM	CHECK : ZN, TP	
DATE : 12-05-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 4.75
System	Frame and Body	FileLink1				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Rear A-Arm Steel Upper Bracket	**FileLink3**		**FileLink2**		**Extended Cost**	$ 9.49
P/N Base	00035			**FileLink3**			
Suffix	AA						
Details	Bracket for Rear A-Arm Upper						

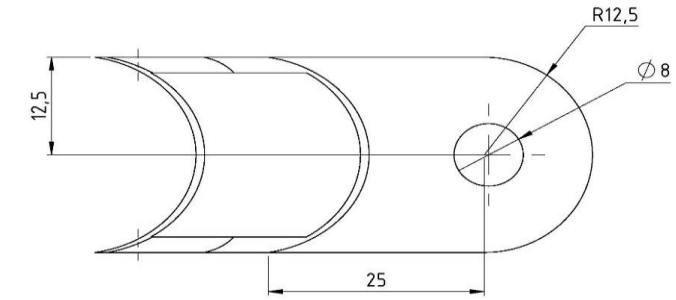
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Rear A-Arm Steel Upper Bracket	$ 2.25	0.11	kg			Rectangular pipe	2.44	5.74	0.00785	1	$ 0.25
												Sub Total	**$ 0.247**

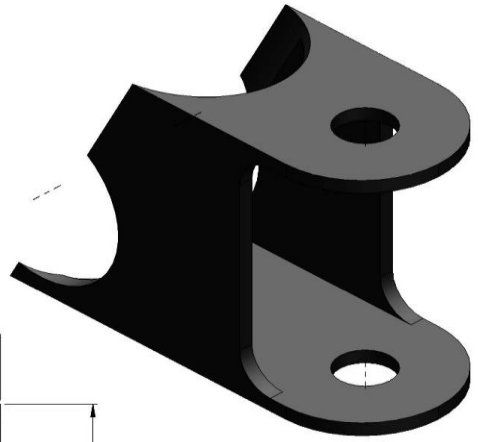
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Saw or tubing cuts	Cutting material	$ 0.40	cm	4.38			$ 1.75
20	Sheet Metal Saw Cut	Hole sawing material	$ 0.20	cm	2.54			$ 0.51
40	Hand Finish - Material Removal	Grinding to contour material	$ 0.20	cm^3	3.01	Repeat 3	3	$ 1.81
50	Drilled holes < 25.4 mm dia.	Drilling for Rear A-Arm Steel Upper Bracket	$ 0.35	hole	1			$ 0.35
60	Hand Finish - Material Removal	Grinding to fillet material	$ 0.20	cm^3	0.41			$ 0.08
							Sub Total	**$ 4.50**

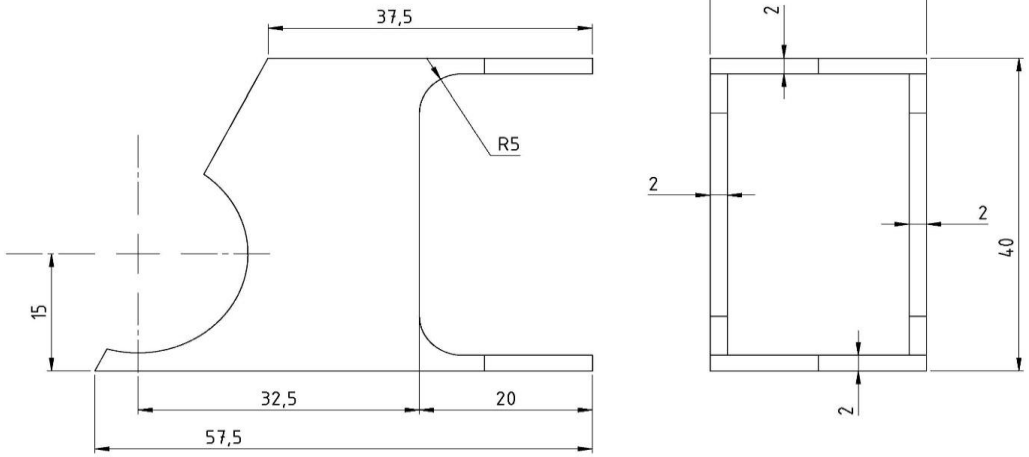
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00037	Rear A-Arm Steel Lower Bracket	Bracket for Rear A-Arm Lower	2







Corresponding symbols									
Roughness Classes (NEN 88-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4	
Roughness Value "Ra" in µm (NEN 88-02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2	

Allowable deviations for dimensions without tolerance indication (machined surfaces)

For measurements (deviations in mm)

Accuracyclass ISO 2768/3	Dimensions in mm							
	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±4
v Very Rough	–	±0,5	±1	±1,5	±2,5	±4	±6	±8

Fillets and chamfers

Dimensions in mm					
0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400
±0,2	±0,5	±1	±2	±4
±0,4	±1	±2	±4	±8

Angles (in ° and ')

Lengths of the shortest leg				
up to 10	>10 to 50	>50 to 120	>120 to 400	above 400
±1°	±10'	±20'	±10'	±5'
±1°30'	±1°	±30'	±15'	±10'
±3°	±2°	±1°	±30'	±20'

	SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : –	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 7.12
System	Frame and Body	FileLink1				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Rear A-Arm Aluminum Upper Bracket	**FileLink3**		**FileLink2**		**Extended Cost**	$ 14.25
P/N Base	00036			**FileLink3**			
Suffix	AA						
Details	Bracket for Rear A-Arm Upper						

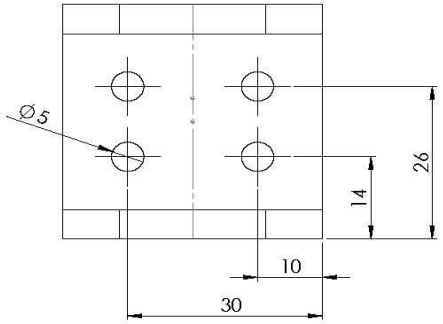
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Aluminum, Premium	Material for Rear A-Arm Aluminum Upper Bracket	$ 4.20	0.2	kg			Rectangular	18.49	3.90	0.00281	1	$ 0.85
												Sub Total	**$ 0.851**

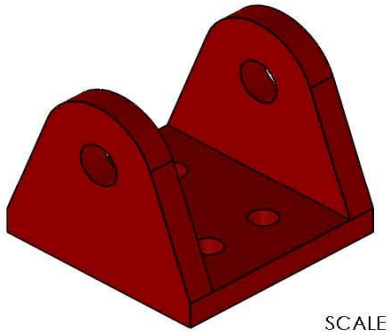
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Machining Setup, Install and remove	Setting machine and material	$ 1.30	unit	1			$ 1.30
20	Machining	Facing and contouring	$ 0.04	cm^3	52.81	Material - Aluminum	1	$ 2.11
30	Drilled holes < 25.4 mm dia.	Drilling for bracket holes	$ 0.35	hole	6	Drill, Tap		$ 2.10
40	Machining Setup, Change	Setting material	$ 0.65	unit	1			$ 0.65
50	Machining	Facing	$ 0.04	cm^3	2.78	Material - Aluminum		$ 0.11
60	Annodize		$ -	unit	1			$ -
							Sub Total	**$ 6.27**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR - A0009 - 00036	Rear A-Arm Aluminum Upper Bracket	Bracket for Rear A-Arm Upper	2





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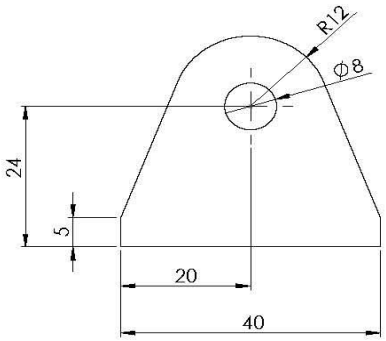
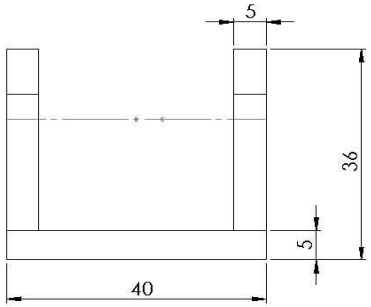




Corresponding symbols

	▽	▼	▽▽	▼▼	▽▽▽	▼▼▼	N
Roughness Classes	N11	N10	N9	N8	N7	N6	N5
Roughness Value Ra in µm	50	25	12,5	6,3	3,2	1,6	0,8

Allowable deviations for dimensions without tolerance indication (machined surfaces)

Accuracy Grades ISO 2768-1	For measurements / deviations in mm: Dimension in mm 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000	Rounded edges and chamfers: Dimension in mm 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	For angles (in ° and mm): Length of the shortest leg 0 to 10	>10 to 50	>50 to 120	>120 to 400	>400
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	±0,2	±0,5	±1	±2	±4	±0°	±30'	±20'	±10'	±5'
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±0,4	±1	±2	±4	±8	±1°	±30'	±20'	±10'	±5'
c Coarse	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±4	±0,8	±2	±4	±8	±16	±1° 30'	±1°	±30'	±15'	±10'
v Very Rough	–	±0,5	±1	±1,5	±2,5	±4	±6	±8						±3°	±1° 30'	±1°	±30'	±20'

	SCALE : 1,5 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 7.14
System	Frame and Body	FileLink1				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Rear A-Arm Steel Lower Bracket	**FileLink3**		**FileLink2**		**Extended Cost**	$ 14.28
P/N Base	00037			**FileLink3**			
Suffix	AA						
Details	Bracket for Rear A-Arm Lower						

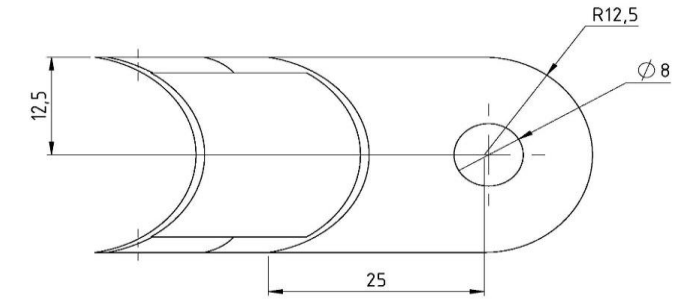
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Rear A-Arm Steel Lower Bracket	$ 2.25	0.12	kg			Rectangular pipe	2.44	60.50	0.00785	1	$ 2.61
												Sub Total	**$ 2.607**

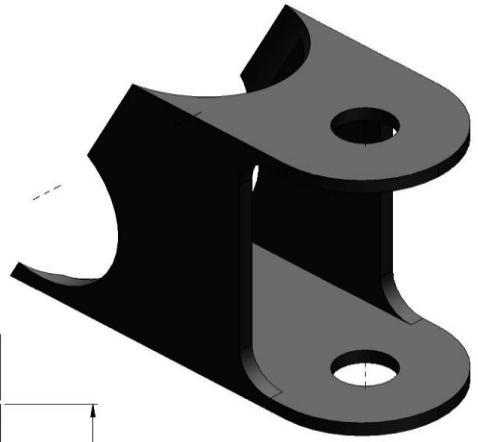
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Saw or tubing cuts	Cutting material	$ 0.40	cm	4.47			$ 1.79
20	Sheet Metal Saw Cut	Hole sawing material	$ 0.20	cm	2.54			$ 0.51
40	Hand Finish - Material Removal	Grinding to contour material	$ 0.20	cm^3	3.01	Repeat 3	3	$ 1.81
50	Drilled holes < 25.4 mm dia.	Drilling for Rear A-Arm Steel Lower Bracket	$ 0.35	hole	1			$ 0.35
60	Hand Finish - Material Removal	Grinding to fillet material	$ 0.20	cm^3	0.41			$ 0.08
							Sub Total	**$ 4.53**

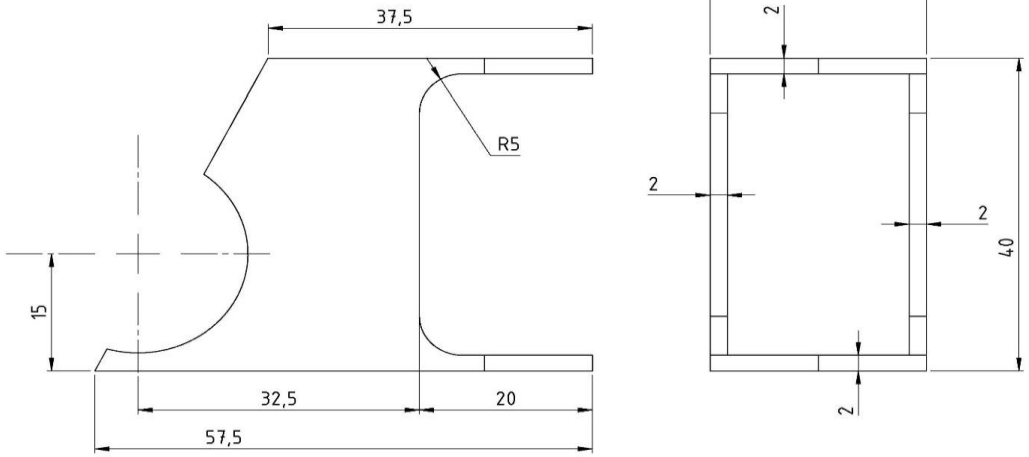
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00037	Rear A-Arm Steel Lower Bracket	Bracket for Rear A-Arm Lower	2







Corresponding symbols									
Roughness Classes (NEN 88-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4	
Roughness Value "Ra" in µm (NEN 88-02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2	

Allowable deviations for dimensions without tolerance indication (machined surfaces)

For measurements (deviations in mm)

Accuracyclass ISO 2768/3	Dimensions in mm							
	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±4
v Very Rough	–	±0,5	±1	±1,5	±2,5	±4	±6	±8

Fillets and chamfers

Dimensions in mm					
0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400
±0,2	±0,5	±1	±2	±4
±0,4	±1	±2	±4	±8

Angles (in ° and ')

Lengths of the shortest leg				
up to 10	>10 to 50	>50 to 120	>120 to 400	above 400
±1°	±10'	±20'	±10'	±5'
±1°30'	±1°	±30'	±15'	±10'
±3°	±2°	±1°	±30'	±20'

	SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : –	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 7.12
System	Frame and Body	FileLink1				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Rear A-Arm Aluminum Lower Bracket	**FileLink3**		**FileLink2**		**Extended Cost**	$ 14.25
P/N Base	00038			**FileLink3**			
Suffix	AA						
Details	Bracket for Rear A-Arm Lower						

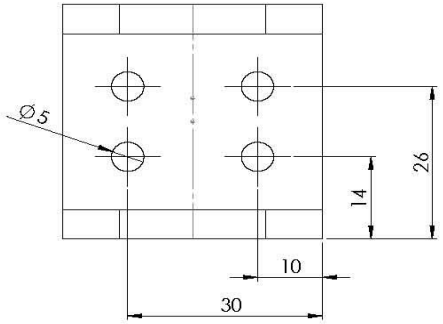
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Aluminum, Premium	Material for Rear A-Arm Aluminum Upper Bracket	$ 4.20	0.2	kg			Rectangular	18.49	3.90	0.00281	1	$ 0.85
												Sub Total	**$ 0.851**

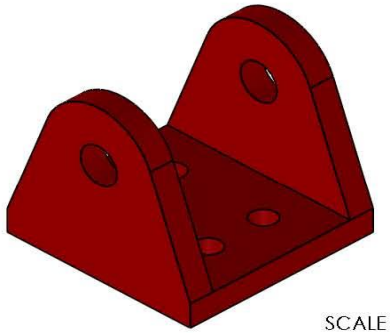
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Machining Setup, Install and remove	Setting machine and material	$ 1.30	unit	1			$ 1.30
20	Machining	Facing and contouring	$ 0.04	cm^3	52.81	Material - Aluminum	1	$ 2.11
30	Drilled holes < 25.4 mm dia.	Drilling for bracket holes	$ 0.35	hole	6			$ 2.10
40	Machining Setup, Change	Setting material	$ 0.65	unit	1			$ 0.65
50	Machining	Facing	$ 0.04	cm^3	2.78	Material - Aluminum	1	$ 0.11
60	Annodize		$ -	unit	1			$ -
							Sub Total	**$ 6.27**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR - A0009 - 00038	Rear A-Arm Aluminum Lower Bracket	Bracket for Rear A-Arm Lower	2





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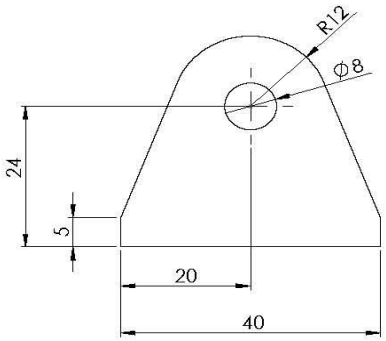
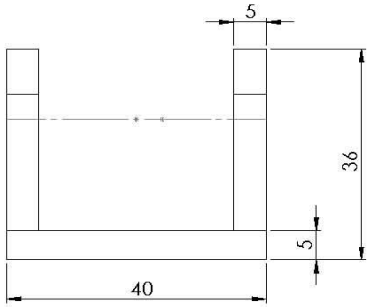




Allowable deviations for dimensions without tolerance indication (machined surfaces)

	SCALE : 1,5 : 1	DRAWN : DESIGNER TEAM	NOTE:	
	UNIT : MM	CHECK : ZN, TP		
	DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME		NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 2.28
System	Frame and Body	FileLink1				**Qty**	4
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Front Bellcrank Bracket	**FileLink3**		**FileLink2**		**Extended Cost**	$ 9.11
P/N Base	00039			**FileLink3**			
Suffix	AA						
Details	Bracket for Front Bellcrank						

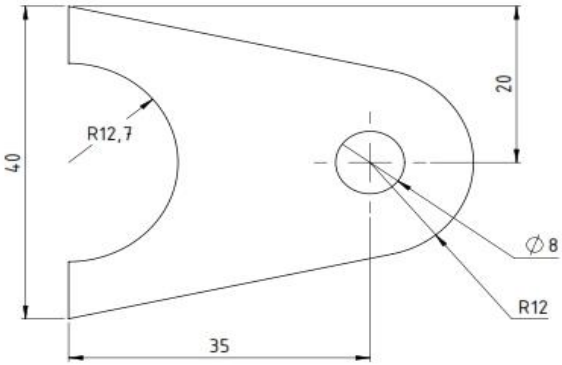
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Front Bellcrank Mounting	$ 2.25	0.03	kg			Rectangular	20.00	0.20	0.00785	1	$ 0.07
												Sub Total	**$ 0.071**

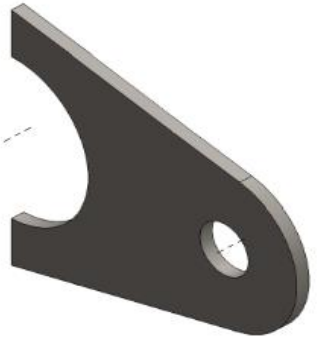
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Drilled holes < 25.4 mm dia.	Drilling material	$ 0.35	hole	1			$ 0.35
20	Sheet Metal Saw Cut	Cutting and hole sawing material	$ 0.20	cm	7.99			$ 1.60
30	Hand Finish - Material Removal	Contouring material	$ 0.20	cm^3	1.29			$ 0.26
							Sub Total	**$ 2.21**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00039	Front Bellcrank Bracket	Bracket for Front Bellcrank	4





Allowable deviations for dimensions without tolerance indication (machined surfaces)

	SCALE : 2: 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 3.59
System	Frame and Body	FileLink1				**Qty**	4
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Front Suspension Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 14.37
P/N Base	00040			**FileLink3**			
Suffix	AB						
Details	Mounting for Front Suspension						

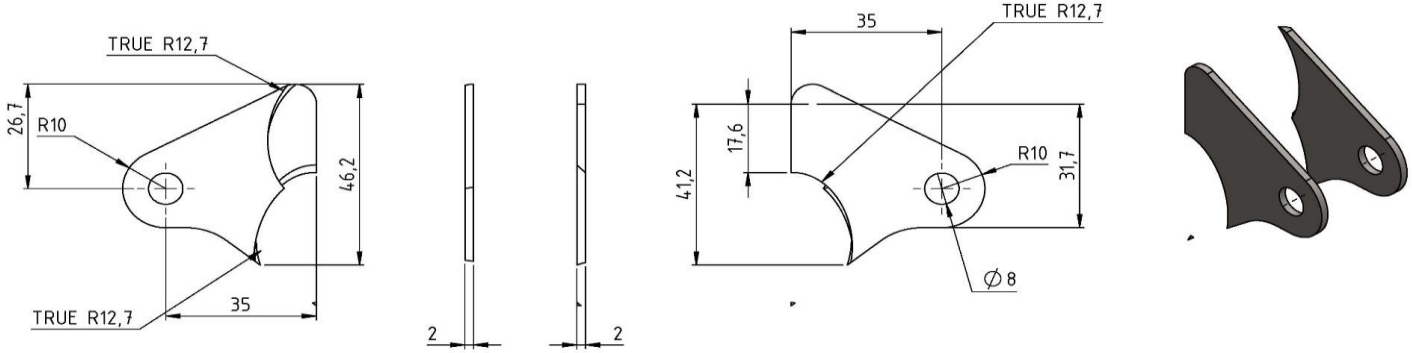
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Front Suspension Mounting	$ 2.25	0.04	kg			Rectangular	24.00	0.20	0.00785	1	$ 0.08
												Sub Total	**$ 0.085**

ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Machining Setup, Install and remove	Setting machine and material	$ 1.30	unit	**1**			$ 1.30
20	Drilled holes < 25.4 mm dia.	Drilling material	$ 0.35	hole	1			$ 0.35
30	Sheet Metal Saw Cut	Cutting and hole sawing material	$ 0.20	cm	6.995			$ 1.40
40	Hand Finish - Material Removal	Contouring material	$ 0.20	cm^3	1.93			$ 0.39
50	Hand Finish - Material Removal	Contouring material	$ 0.20	cm^3	0.36			$ 0.07
							Sub Total	**$ 3.51**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FG16-Front Shock Absorber Bracket	Front Suspension Mounting	Mounting for Front Suspension	2



Corresponding symbols		▽	▼	▽▽	▼▼	▽▽▽	▼▼▼	
Roughness Classes (NBN 88-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4
Roughness Value "Ra" in µm (NBN 88-02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2

Allowable deviations for dimensions without tolerance indication (machined surfaces)

Accuracyclass ISO 2768-1	For measurements (deviations in mm) Dimensions in mm 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000	Fillets and chamfers Dimensions in mm 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	Angles (in ° and ') Length of the shortest leg to 10	>10 to 50	>50 to 120	>120 to 400	above 400
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	±0,2	±0,5	±1	±2	±4	±1°	±30'	±20'	±10'	±5'
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2										
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±5	±0,4	±1	±2	±5	±8	±1°30'	±1°	±30'	±15'	±10'
v Very rough	-	±0,5	±1	±1,5	±2,5	±4	±6	±8						±3°	±2°	±1°	±30'	±20'

SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$	4.35
System	Frame and Body	FileLink1				**Qty**		2
Assembly	Frame	**FileLink2**		**FileLink1**				
Part	Rear Suspension Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$	8.70
P/N Base	00041			**FileLink3**				
Suffix	AA							
Details	Mounting for Rear Suspension							

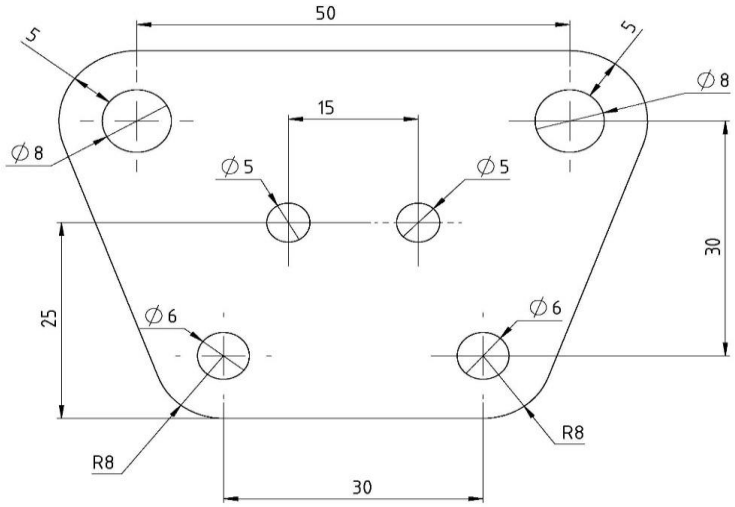
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Aluminum, Premium	Material for Rear Suspension Mounting	$ 4.20	0.03	kg			Rectangular	35.50	0.32	0.00281	1	$ 0.13
												Sub Total	**$ 0.134**

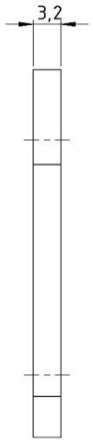
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Drilled holes < 25.4 mm dia.	Drilling for Rear Suspension Mounting clamping holes	$ 0.35	hole	4			$ 1.40
20	Machining Setup, Install and remove	Machine setup for Jack Member Bracket	$ 1.30	unit	1			$ 1.30
30	Machining	Pocketing and contouring material	$ 0.04	cm^3	2.84	Material - Aluminum	1	$ 0.11
40	Drilled holes < 25.4 mm dia.	Drilling for Rear Suspension Mounting holes	$ 0.35	hole	4			$ 1.40
50	Annodize		$ -	unit	1			$ -
							Sub Total	**$ 4.21**

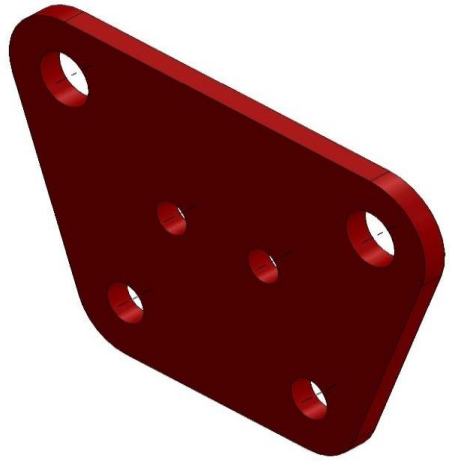
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00041	Rear Suspension Mounting	Mounting for Rear Suspension	2







Corresponding symbols		▽	▼	▽▽	▼▼	▽▽▽	▼▼▼	
Roughness Classes (NBN 88-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4
Roughness Value "Ra" in µm (NBN 88-02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2

Allowable deviations for dimensions without tolerance indication (machined surfaces)

For measurements (deviations in mm)

Accuracyclass ISO 2768/3	Dimensions in mm								
	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000	
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2	
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±4	
v Very Rough	–	±0,5	±1	±1,5	±2,5	±4	±6	±8	

Fillets and chamfers

Dimensions in mm					
0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	
±0,2	±0,5	±1	±2	±4	
±0,4	±1	±2	±4	±8	

Angles (in ° and ')

Lengths of the shortest leg				
to 10	>10 to 50	>50 to 120	>120 to 400	above 400
±1°	±30'	±20'	±10'	±5'
±1°30'	±1°	±30'	±15'	±10'
±3°	±2°	±1°	±30'	±20'

	SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : –	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 13.08
System	Frame and Body	FileLink1				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Pedal Box Hole Adjuster	**FileLink3**		**FileLink2**		**Extended Cost**	$ 26.15
P/N Base	00042			**FileLink3**			
Suffix	AA						
Details	Plate for Adjusting Pedal Box						

ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy (per kg)	Material for Pedal Box Hole Adjuster	$ 2.25	0.3	kg			Profile L	0.76	50.55	0.00785	1	$ 0.68
												Sub Total	**$ 0.679**

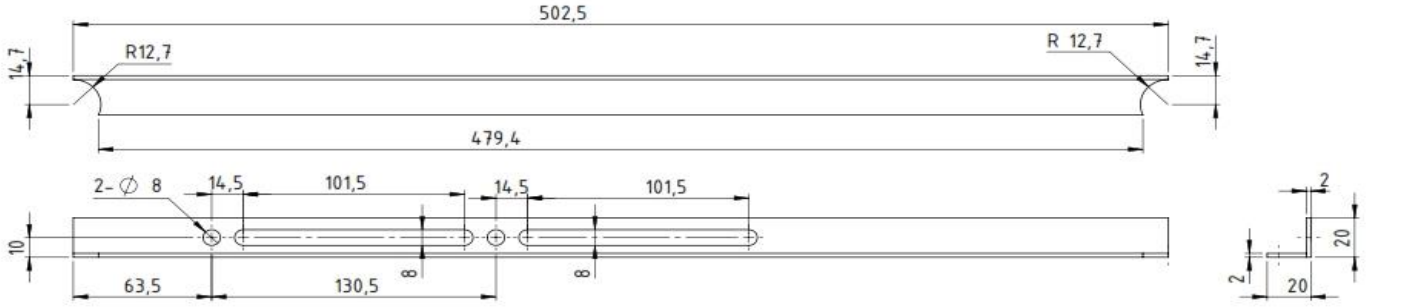
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting Material	$ 0.20	cm	2			$ 0.40
20	Sheet Metal Saw Cut	Hole sawing material	$ 0.20	cm	3.99			$ 0.80
30	Drilled holes < 25.4 mm dia.	Drilling material	$ 0.35	hole	32			$ 11.20
							Sub Total	**$ 12.40**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

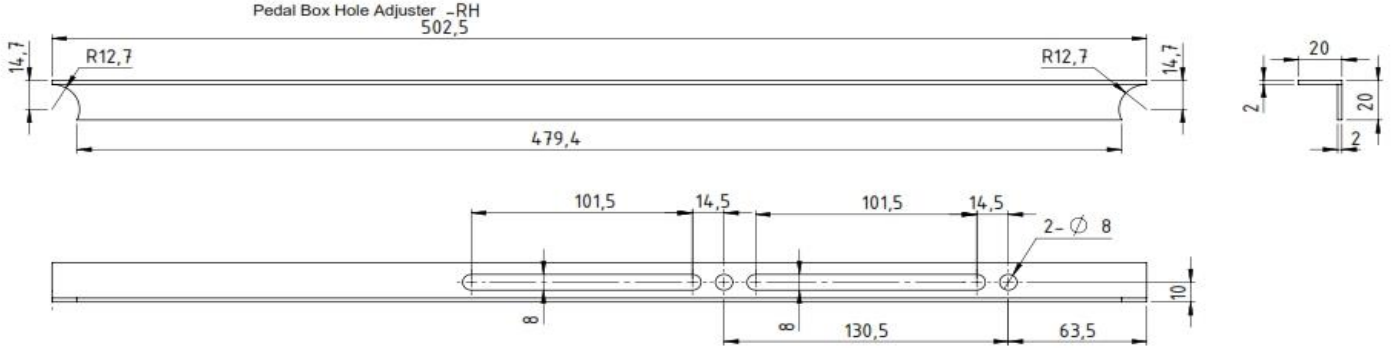
ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00042	Pedal Box Hole Adjuster	Plate for Adjusting Pedal Box	2

Pedal Box Hole Adjuster -LH



Pedal Box Hole Adjuster -RH



Allowable deviations for dimensions without tolerance indication (machined surfaces)

Accuracy class ISO 2768-1	For measurements (deviations in mm): Dimensions in mm: 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000	Fillets and chamfers: Dimensions in mm: 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	Angles (in ° and '): Length of the shortest leg: up to 10	>10 to 50	>50 to 120	>120 to 400	above 400
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	±0,2	±0,5	±1	±2	±4	±1°	±30'	±20'	±10'	±5'
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2										
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±4	±0,4	±1	±2	±4	±8	±1°30'	±1°	±30'	±15'	±10'
v Very Rough		±0,5	±1	±1,5	±2,5	±4	±6	±8						±3°	±2°	±1°	±30'	±20'

	SCALE : 1 : 2	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 2.70
System	Frame and Body	FileLink1				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Gear Box Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 5.39
P/N Base	00043			**FileLink3**			
Suffix	AA						
Details	Plate for Adjusting Gear Box						

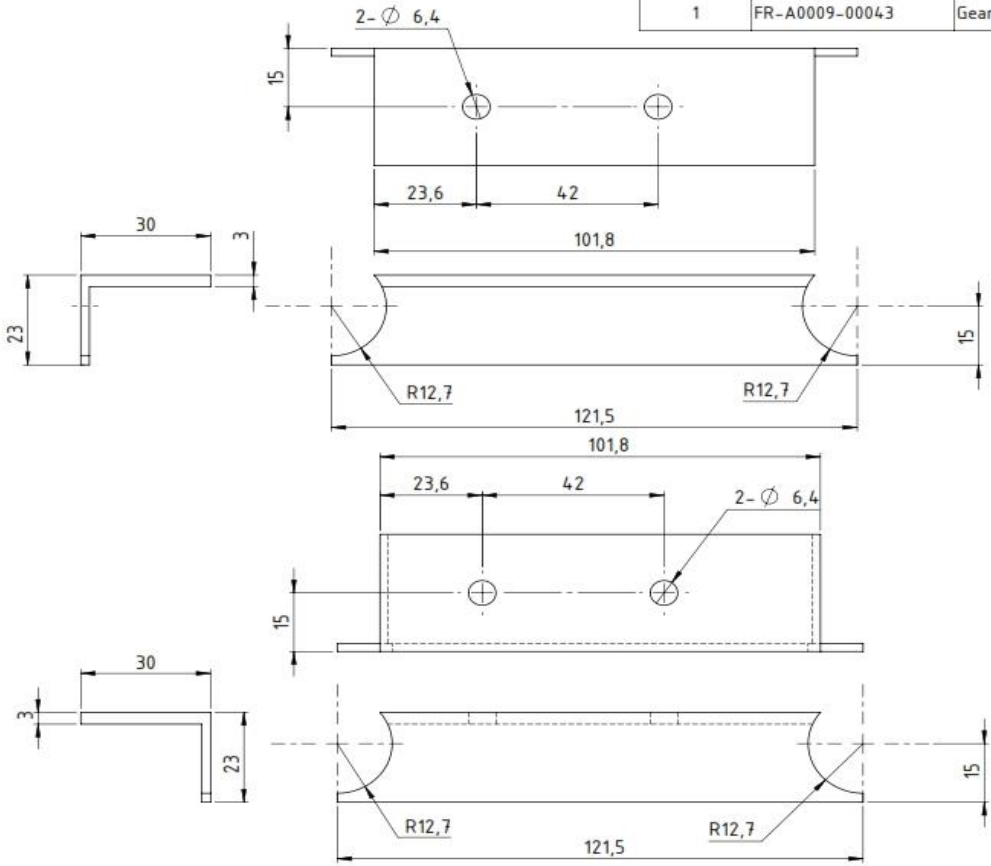
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy (per kg)	Material for Gear Box Mounting	$ 2.25	0.11	kg			Profile L	1.16	12.30	0.00785	1	$ 0.25
												Sub Total	**$ 0.252**

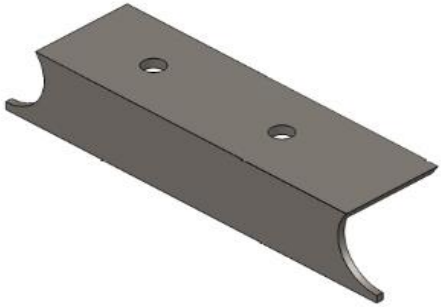
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting Material	$ 0.20	cm	3			$ 0.60
20	Sheet Metal Saw Cut	Hole sawing material	$ 0.20	cm	5.72			$ 1.14
30	Drilled holes < 25.4 mm dia.	Drilling material	$ 0.35	hole	2			$ 0.70
							Sub Total	**$ 2.44**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00043	Gear Box Mounting	Plate for Adjusting Gear Box	2





Allowable deviations for dimensions without tolerance indication (machined surfaces)

SCALE	: 1 : 1	DRAWN	: DESIGNER TEAM	NOTE:
UNIT	: MM	CHECK	: ZN, TP	
DATE	: 12-05-2016	APPROVE	: -	

FACULTY OF ENGINEERING
YOGYAKARTA STATE UNIVERSITY

FRAME

NO:01/GURT

A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 6.12
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Steering Shaft Bearing Housing	**FileLink3**		**FileLink2**		**Extended Cost**	$ 6.12
P/N Base	00044			**FileLink3**			
Suffix	AA						
Details	Steering Shaft Bearing Housing on Frame						

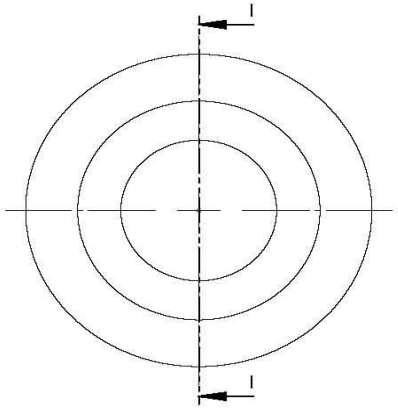
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Steering Shaft Bearing Housing	$ 2.25	0.31	kg			Circular	11.95	3.30	0.00785	1	$ 0.70
												Sub Total	**$ 0.697**

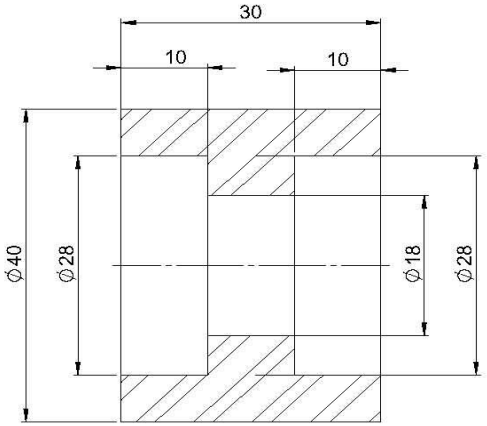
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Machining Setup, Install and remove	Machine setup for Steering Shaft Bearing Housing	$ 1.30	unit	1			$ 1.30
20	Drilled holes < 25.4 mm dia.	Drilling for Steering Shaft Bearing Housing holes	$ 0.35	hole	1			$ 0.35
50	Machining	Facing, contouring material for Steering Shaft Bearing Housing	$ 0.04	cm^3	24.21	Material - Steel	3	$ 2.91
40	Machining Setup, Change	Workpice setup for Steering Shaft Bearing Housing	$ 0.65	unit	1			$ 0.65
60	Machining	Facing material for Steering Shaft Bearing Housing	$ 0.04	cm^3	1.8	Material - Steel	3	$ 0.22
							Sub Total	**$ 5.42**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

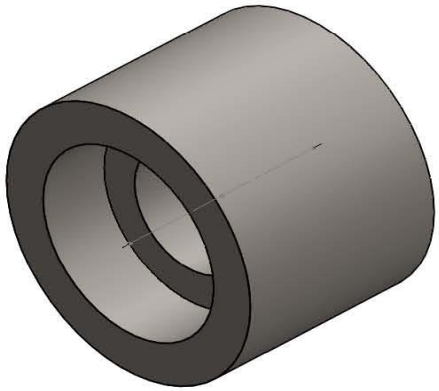
ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncId	Sub Total
							Sub Total	**$ -**

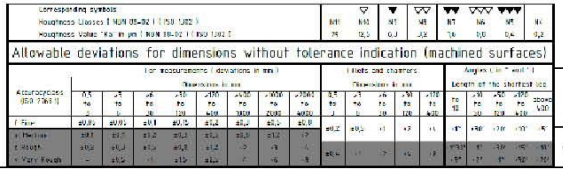
ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR - A0009 - 00044	Steering Shaft Bearing Housing	Steering Shaft Bearing Housing on Frame	1





SECTION I-I
SCALE 2 : 1





SCALE : 2 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 3.76
System	Frame and Body	**FileLink1**				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Front Seat Belt Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 7.52
P/N Base	00045			**FileLink3**			
Suffix	AA						
Details	Mounting for Seat Belt						

ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
													$ -
												Sub Total	**$ -**

ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Drilled holes < 25.4 mm dia.	Drilling to make hole on the frame	$ 0.35	hole	1			$ 0.35
20	Assemble, 1 kg, Line-on-Line	Put eyebolt into the hole	$ 0.13	unit	1			$ 0.13
30	Weld	Joining eyebolt and frame	$ 0.15	cm	5.03			$ 0.75
							Sub Total	**$ 1.23**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
10	Eyebolt, Threaded, Steel	Seat belt mounting	2.365	20	mm			1	$ 2.37
								Sub Total	**$ 2.37**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncId	Sub Total
10	Welds	Welding Fixture	$ 500	point	1	3000	1	$ 0.17
							Sub Total	**$ 0.17**

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 3.76
System	Frame and Body	**FileLink1**				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Middle Seat Belt Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 7.52
P/N Base	00046			**FileLink3**			
Suffix	AA						
Details	Mounting for Seat Belt						

ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
													$ -
												Sub Total	**$ -**

ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Drilled holes < 25.4 mm dia.	Drilling to make hole on the frame	$ 0.35	hole	1			$ 0.35
20	Assemble, 1 kg, Line-on-Line	Put eyebolt into the hole	$ 0.13	unit	1			$ 0.13
30	Weld	Joining eyebolt and frame	$ 0.15	cm	5.03			$ 0.75
							Sub Total	**$ 1.23**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
10	Eyebolt, Threaded, Steel	Seat belt mounting	2.365	20	mm			1	$ 2.37
								Sub Total	**$ 2.37**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncId	Sub Total
10	Welds	Welding Fixture	$ 500	point	1	3000	1	$ 0.17
							Sub Total	**$ 0.17**

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 3.76
System	Frame and Body	**FileLink1**				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Rear Seat Belt Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 7.52
P/N Base	00047			**FileLink3**			
Suffix	AA						
Details	Mounting for Seat Belt						

ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
													$ -
												Sub Total	**$ -**

ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Drilled holes < 25.4 mm dia.	Drilling to make hole on the frame	$ 0.35	hole	1			$ 0.35
20	Assemble, 1 kg, Line-on-Line	Put eyebolt into the hole	$ 0.13	unit	1			$ 0.13
30	Weld	Joining eyebolt and frame	$ 0.15	cm	5.03			$ 0.75
							Sub Total	**$ 1.23**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
10	Eyebolt, Threaded, Steel	Seat belt mounting	2.365	20	mm			1	$ 2.37
								Sub Total	**$ 2.37**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncId	Sub Total
10	Welds	Welding Fixture	$ 500	point	1	3000	1	$ 0.17
							Sub Total	**$ 0.17**

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 14.11
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	FileLink2		**FileLink1**			
Part	Battery Seat	**FileLink3**		**FileLink2**		**Extended Cost**	$ 14.11
P/N Base	00048			**FileLink3**			
Suffix	BA						
Details	Seat for Battery						

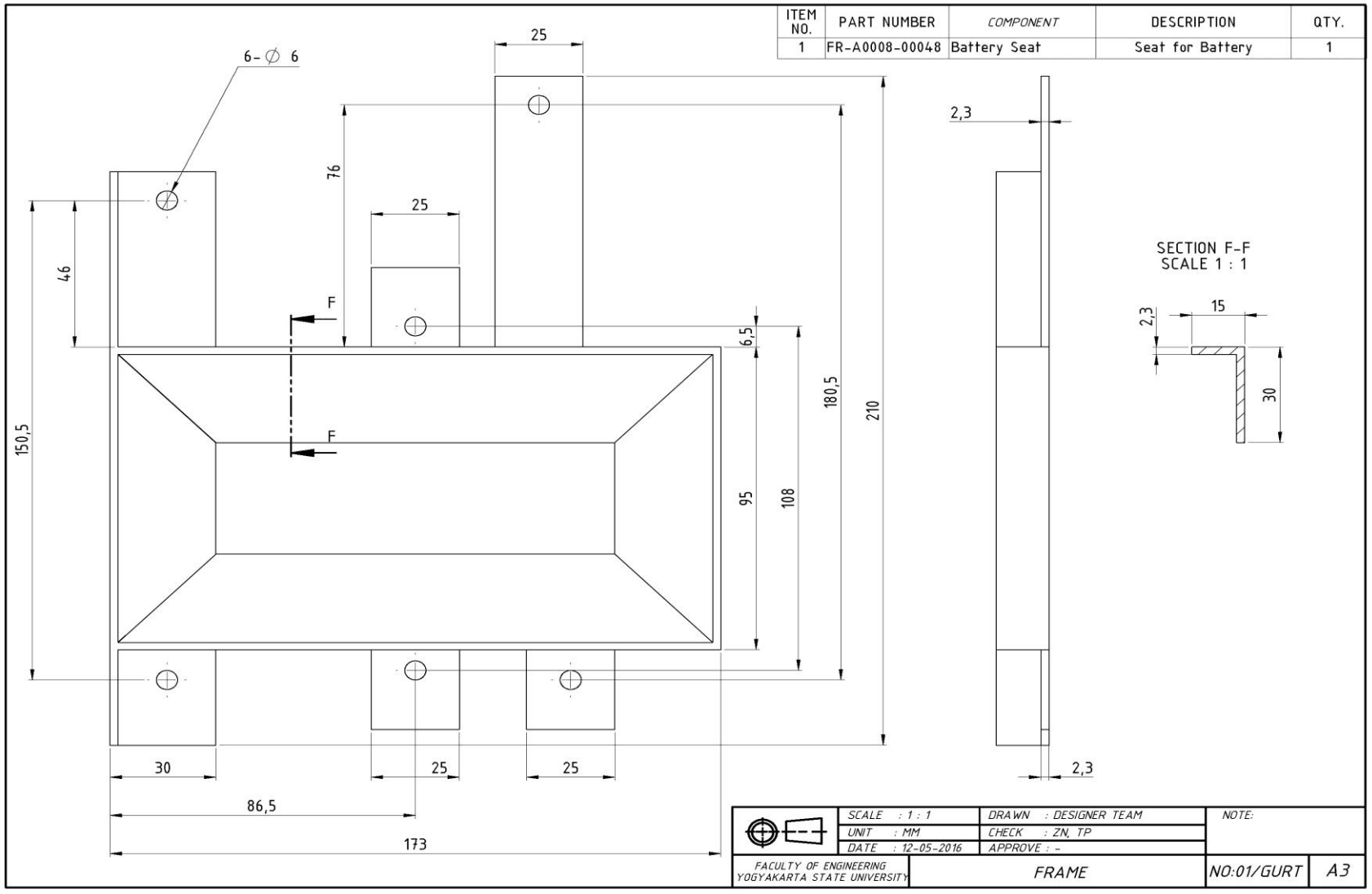
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Aluminum, Normal	Material for Battery Seat	$ 4.20	0.13	kg			L Profile	1.16	41.00	0.00281	1	$ 0.56
20	Aluminum, Normal	Material for Battery Seat	$ 4.20	0.06	kg			Rectangular	66.24	0.32	0.00281	1	$ 0.25
30	Aluminum, Normal	Material for Battery Clamp	$ 4.20	0.055	kg			Rectangular	61.77	0.32	0.00281	1	$ 0.23
40	Steel, Alloy	Material for Battery Clamp	$ 2.25	0.065	kg			Circular	0.20	42.50	0.00281	1	$ 0.05
												Sub Total	**$ 1.098**

ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting L Profile material	$ 0.20	cm	3	Repeat 4	4	$ 2.40
20	Sheet metal shearing	Shearing aluminum plate material	$ 0.25	cut	10			$ 2.50
30	Sheet metal bends	Bending Battery Clamp Material	$ 0.25	bend	2			$ 0.50
40	Drilled holes < 25.4 mm dia.	Drilling battery seat fastener holes	$ 0.35	hole	8			$ 2.80
50	Weld	Joining material for battery seat	$ 0.15	cm	15			$ 2.25
60	Tube cut	Cutting Battery Clamp Material	$ 0.15	cm	0.5	Repeat 2	2	$ 0.15
70	Tube bends	Bending Battery Clamp Material	$ 0.75	bend	2			$ 1.50
80	Threading, External	Threading Battery clamp material	$ 0.10	cm	2			$ 0.20
							Sub Total	**$ 12.30**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2	Unit2	Quantity	Sub Total
10	Nut, Grade 8.8 (SAE 5)	Battery clamping fasteners	0.024	5	mm			2	$ 0.05
								Sub Total	**$ 0.05**

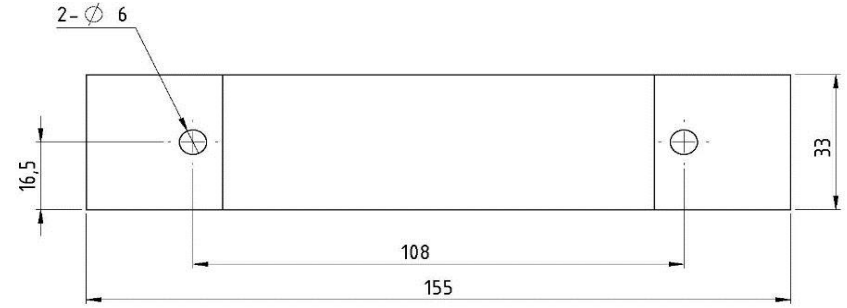
ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
10	Welds	welding material	$ 500	point	4	3000	1	$ 0.67
							Sub Total	**$ 0.67**

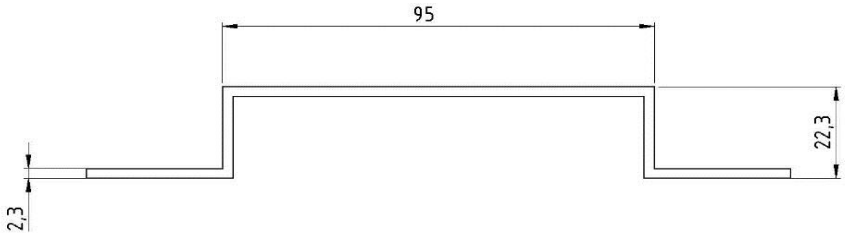
ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0008-00048	Battery Seat	Seat for Battery	1

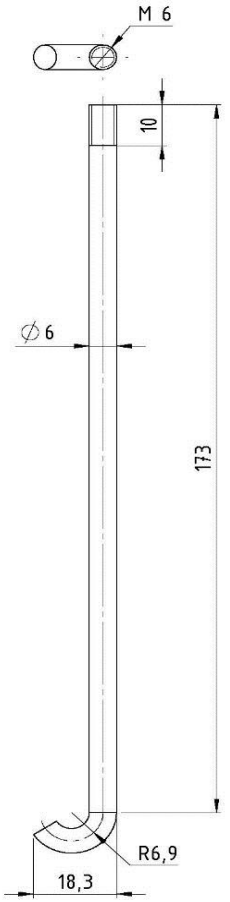


SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0008-00048	Battery Seat	Seat for Battery	1







SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 8.10
System	Frame and Body	FileLink1				**Qty**	4
Assembly	Frame	FileLink2		**FileLink1**			
Part	Radiator Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 32.39
P/N Base	00049			**FileLink3**			
Suffix	BA						
Details	Mounting for Radiator						

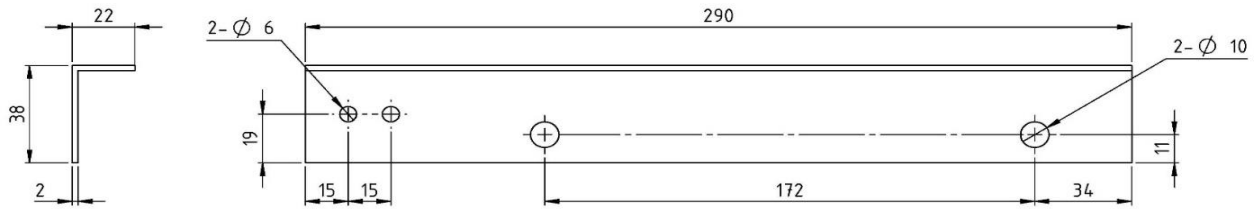
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Radiator Mounting	$ 2.25	0.02	kg			Rectangular	39.60	0.20	0.00785	1	$ 0.14
20	Steel, Alloy	Material for Radiator Mounting	$ 2.25	0.06	kg			Rectangular	19.8	0.40	0.00785	1	$ 0.14
30	Steel, Alloy	Material for Radiator Mounting	$ 2.25	0.37	kg			L Profile	1.56	30.00	0.00785	1	$ 0.83
40	Aluminum, Normal	Radiator support	$ 4.20	0.1	kg			Circular Tube	0.87	40.00	0.00280	1	$ 0.41
												Sub Total	**$ 0.140**

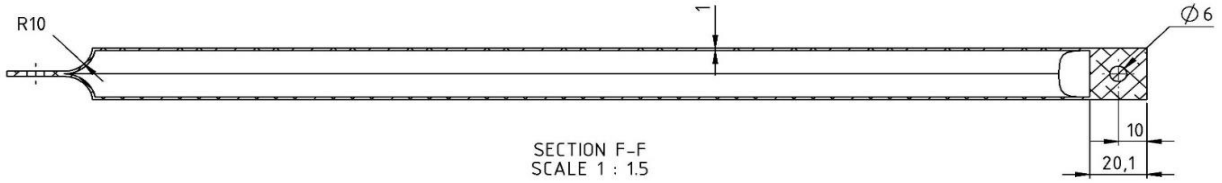
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet metal shearing	Shearing sheet metal material	$ 0.25	cut	7			$ 1.75
20	Sheet Metal Saw Cut	Cutting L profile material	$ 0.20	cm	4			$ 0.80
30	Sheet Metal Saw Cut	Hole sawing material	$ 0.20	cm	2.54			$ 0.51
40	Drilled holes < 25.4 mm dia.	Drilling radiator mounting	$ 0.35	hole	14			$ 4.90
50	Sheet metal bends	Bending material	$ 0.25	bend	3			$ 0.75
							Sub Total	**$ 7.96**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
10									$ -
								Sub Total	**$ -**

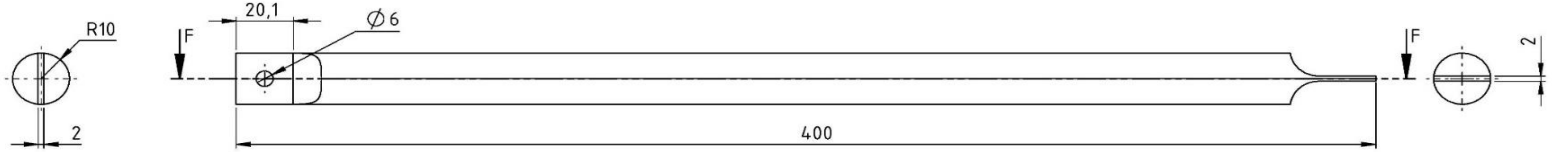
ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00049	Radiator Mounting	Mounting for Radiator	1





SECTION F-F
SCALE 1 : 1.5



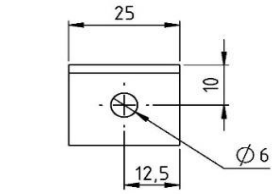
Corresponding Symbols		▽	▼	▽▽	▼▼	▽▽▽	▼▼▼	
Roughness Classes (NBN 88-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4
Roughness Value "Ra" in µm (NBN 88 02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2

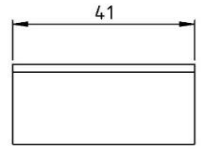
Allowable deviations for dimensions without tolerance indication (machined surfaces)

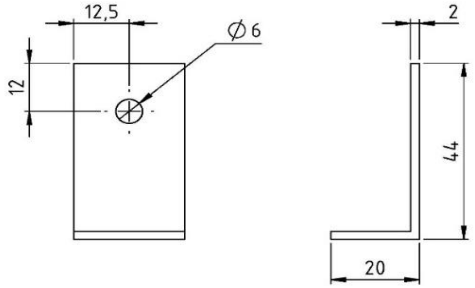
Accuracyclass ISO 2768/1	For measurements (deviations in mm) Dimensions in mm 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000	Fillets and chamfers Dimensions in mm 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	Angles (in ° and ') Length of the shortest leg to 10	>10 to 50	>50 to 120	>120 to 400	above 400
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	±0,2	±0,5	±1	±2	±4	±1°	±30'	±20'	±10'	±5'
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2										
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±5	±0,4	±1	±2	±4	±8	±1°30'	±1°	±30'	±15'	±10'
v Very Rough	-	±0,5	±1	±1,5	±2,5	±4	±6	±8						±3°	±2°	±1°	±10'	±20'

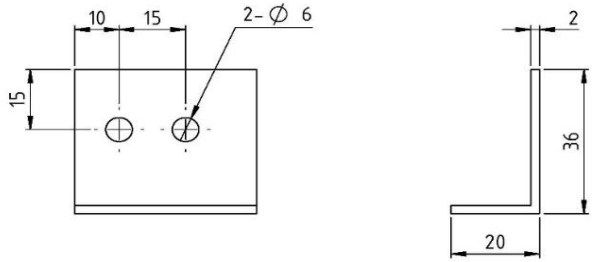
SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	RADIATOR	NO:01/GURT	A3

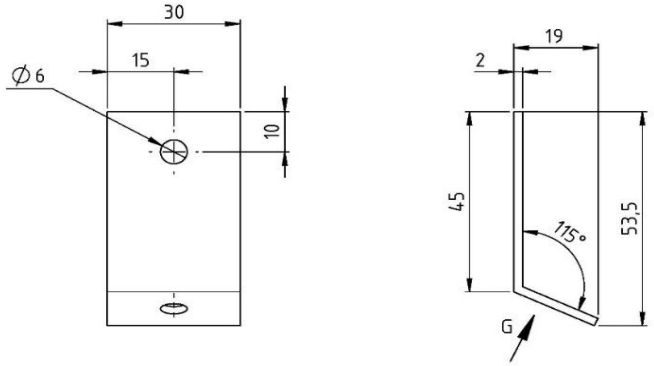
ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00049	Radiator Mounting	Mounting for Radiator	1

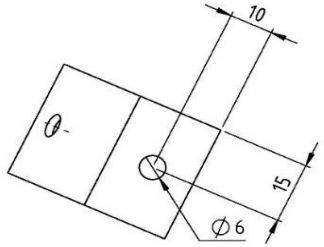












VIEW G
SCALE 1 : 1

Corresponding symbols

Roughness Classes (NBN 88-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4
Roughness Value "Ra" in µm (NBN 88-02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2

Allowable deviations for dimensions without tolerance indication (machined surfaces)

Accuracyclass (ISO 2768-1)	For measurements (deviations in mm) Dimensions in mm								Fillets and chamfers Dimensions in mm					Angles (in ° and ') Length of the shortest leg				
	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	to 10	>10 to 50	>50 to 120	>120 to 400	above 400
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	±0,2	±0,5	±1	±2	±4	±1°	±30'	±20'	±10'	±5'
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,5	±2										
c Rough	±0,2	±0,3	±0,5	±0,8	±1,5	±2	±3	±4	±0,4	±1	±2	±4	±8	±1°30'	±1°	±30'	±15'	±10'
v Very Rough	-	±0,5	±1	±1,5	±2,5	±4	±6	±8						±3°	±2°	±1°	±30'	±20'

	SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	RADIATOR	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 1.47
System	Frame and Body	FileLink1				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Muffler Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 2.94
P/N Base	00050			**FileLink3**			
Suffix	AB						
Details	Mounting for muffler						

ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Muffler Mounting	$ 2.25	0.01	kg			Circular	5.00	0.20	0.00785	1	$ 0.02
												Sub Total	**$ 0.018**

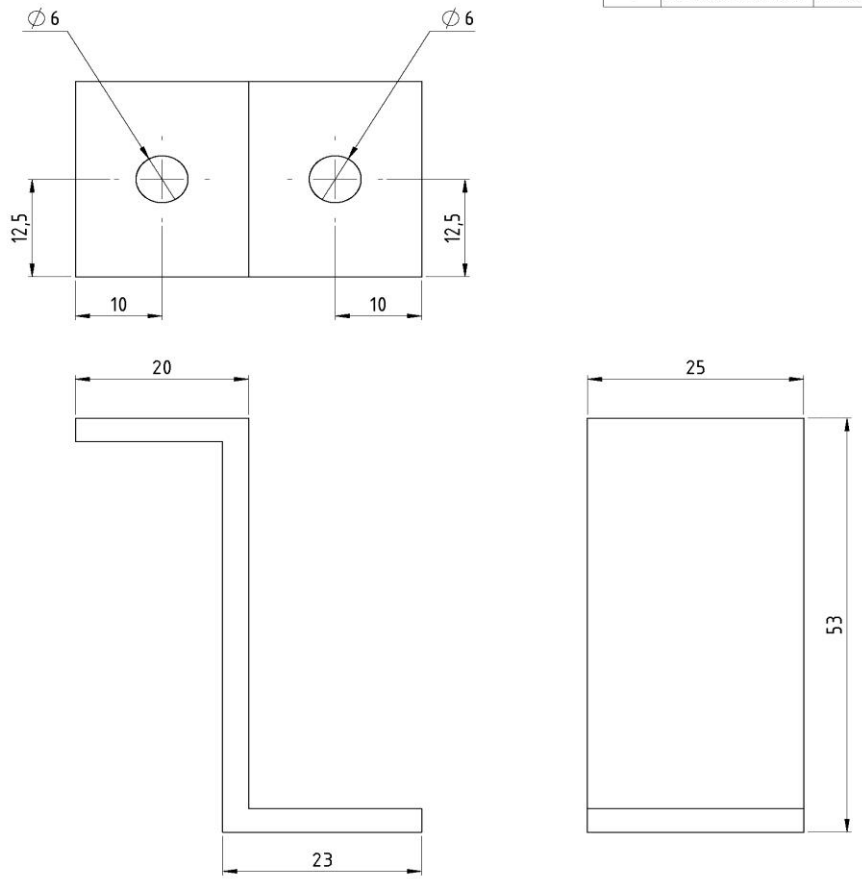
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet metal shearing	Shearing material	$ 0.25	cut	1			$ 0.25
20	Sheet metal bends	Bending material	$ 0.25	bend	2			$ 0.50
30	Drilled holes < 25.4 mm dia.	Drilling material	$ 0.35	hole	2			$ 0.70
							Sub Total	**$ 1.45**

0

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity
								Sub Total

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0008-00050	Muffler Mounting	Mounting for muffler	1



SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	MUFFLER	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 1.76
System	Frame and Body	FileLink1				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Head Rest Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 3.52
P/N Base	00051			**FileLink3**			
Suffix	AB						
Details	Mounting for Head Rest						

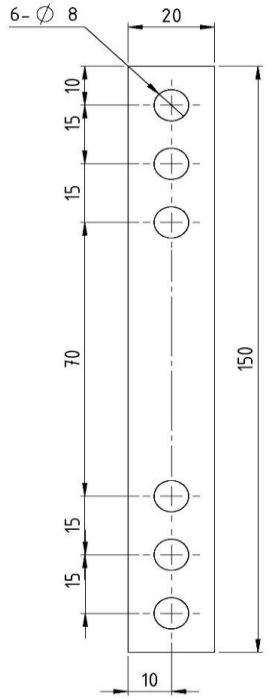
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Head Rest Mounting	$ 2.25	0.05	kg			Circular	30.60	0.20	0.00785	1	$ 0.11
												Sub Total	**$ 0.108**

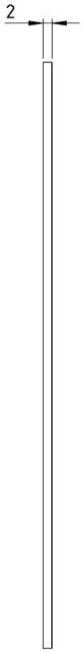
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet metal shearing	Cutting material	$ 0.25	cm	1			$ 0.25
20	Drilled holes < 25.4 mm dia.	Drilling Head Rest Mounting hole	$ 0.35	hole	4			$ 1.40
							Sub Total	**$ 1.65**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00051	Head Rest Mounting	Mounting for Head Rest	2





Corresponding symbols		▽	▼	▽▽	▼▼	▽▽▽	▼▼▼	
Roughness Classes (NBN 88-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4
Roughness Value "Ra" in µm (NBN 88-02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2

Allowable deviations for dimensions without tolerance indication (machined surfaces)

Accuracyclass ISO 2768-1	For measurements (deviations in mm) Dimensions in mm 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000	Fillets and chamfers Dimensions in mm 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	Angles (in ° and ') Length of the shortest leg to 10	>10 to 50	>50 to 120	>120 to 400	above 400
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	±0,2	±0,5	±1	±2	±4	±1°	±30'	±20'	±10'	±5'
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2										
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±5	±0,4	±1	±2	±4	±8	±1°30	±1°	±30'	±15'	±10'
v Very Rough	–	±0,5	±1	±1,5	±2,5	±4	±6	±8						±3°	±2°	±1°	±30'	±20'

SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 2.07
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Pressure Regulator Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 2.07
P/N Base	00052			**FileLink3**			
Suffix	AA						
Details	Mounting for Pressure Regulator						

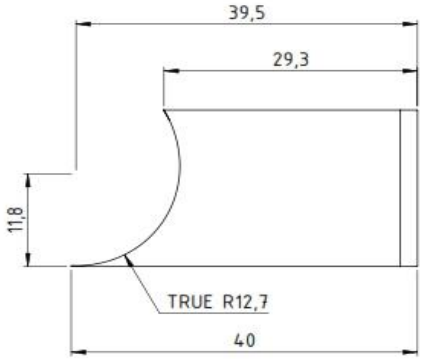
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy (per kg)	Material for Pressure Regulator Mounting	$ 2.25	0.03	kg			Profile L	1.56	2.30	0.00785	1	$ 0.06
												Sub Total	**$ 0.063**

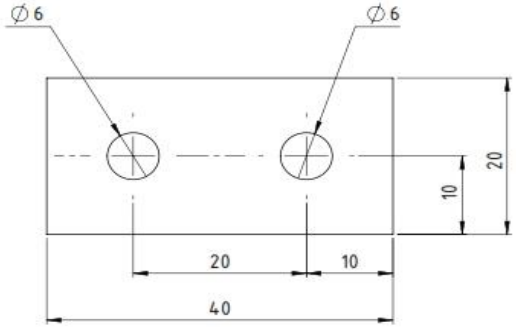
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting Material	$ 0.20	cm	4			$ 0.80
20	Drilled holes < 25.4 mm dia.	Drilling material	$ 0.35	hole	2			$ 0.70
30	Sheet Metal Saw Cut	Hole sawing material for welding side	$ 0.20	cm	2.54			$ 0.51
							Sub Total	**$ 2.01**

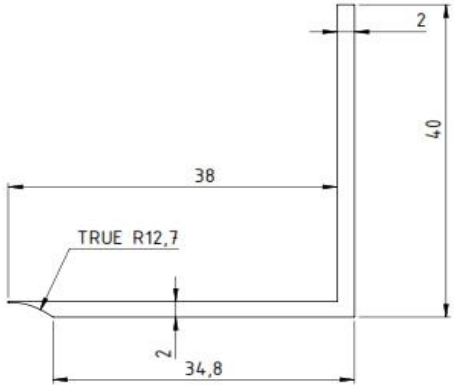
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

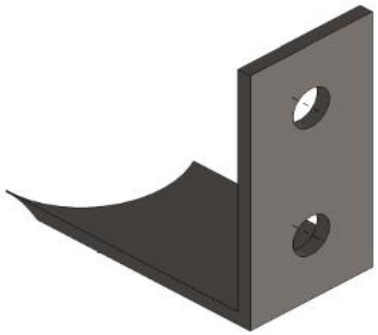
ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncId	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00051	Pressure Regulator Mounting	Mounting for Pressure Regulator	1









Allowable deviations for dimensions without tolerance indication (machined surfaces)

	SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 2.43
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Shifter Solenoid Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 2.43
P/N Base	00053			**FileLink3**			
Suffix	AA						
Details	Mounting for Shifter Solenoid						

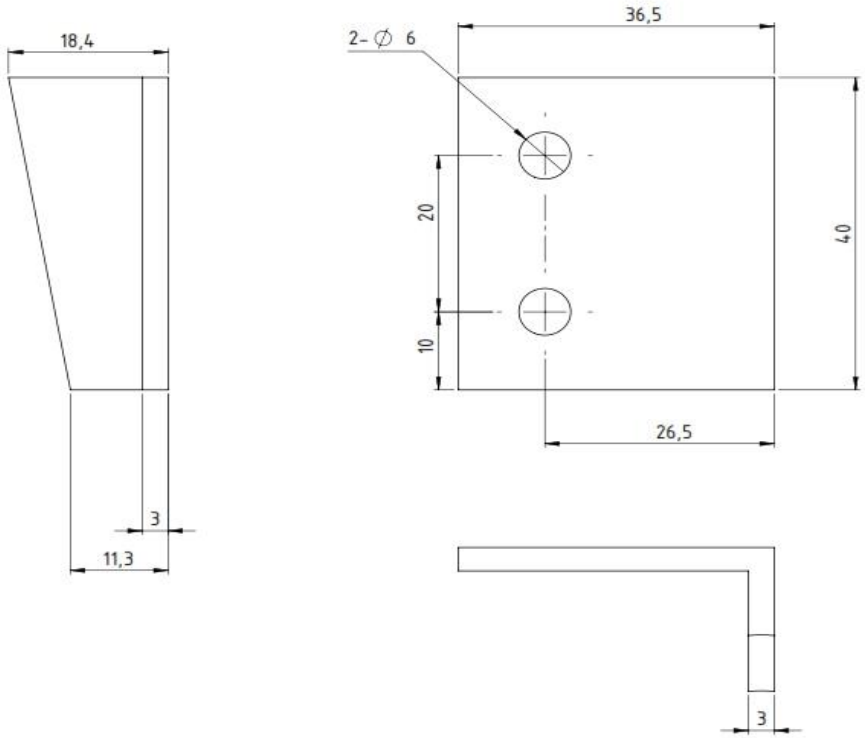
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy (per kg)	Material for Shifter Solenoid Mounting	$ 2.25	0.05	kg			Profile L	1.56	4.30	0.00785	1	$ 0.12
												Sub Total	**$ 0.118**

ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting Material	$ 0.20	cm	4			$ 0.80
20	Drilled holes < 25.4 mm dia.	Drilling material	$ 0.35	hole	2			$ 0.70
30	Sheet Metal Saw Cut	Cutting material	$ 0.20	cm	4.06			$ 0.81
							Sub Total	**$ 2.31**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncId	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	*FR - A0009 - 00053*	*Shifter Solenoid Mounting*	*Mounting for Shifter Solenoid*	1



Allowable deviations for dimensions without tolerance indication (machined surfaces)

	SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 4.83
System	Frame and Body	FileLink1				**Qty**	4
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Fuel Tank Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 19.33
P/N Base	00054			**FileLink3**			
Suffix	AA						
Details	Mounting for Fuel Tank						

ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Fuel Tank Mounting	$ 2.25	0.07	kg			Rectangular	45.20	0.20	0.00785	1	$ 0.16
												Sub Total	**$ 0.160**

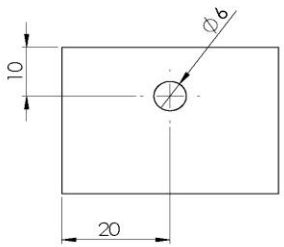
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material	$ 0.20	cm	4	Repeat 2	2	$ 1.60
20	Sheet Metal Saw Cut	Cutting material	$ 0.20	cm	3.54			$ 0.71
30	Drilled holes < 25.4 mm dia.	Drilling radiator mounting hole	$ 0.35	hole	1			$ 0.35
40	Weld	Joining fuel tank mounting	$ 0.15	cm	8.98			$ 1.35
							Sub Total	**$ 4.01**

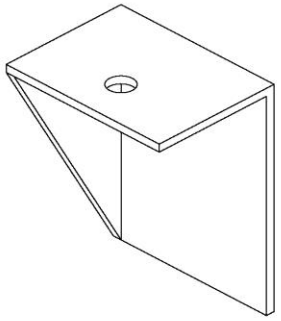
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

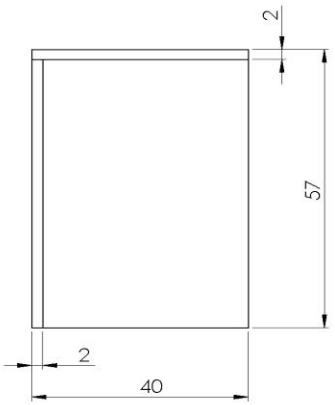
ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
10	Welds	welding material	$ 500	point	4	3000	1	$ 0.67
							Sub Total	**$ 0.67**

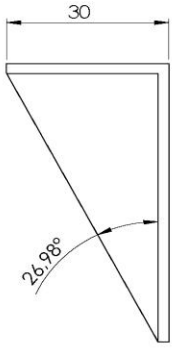
0

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR - A0009 - 00054	Fuel Tank Mounting	Mounting for Fuel Tank	4









SCALE : 1,25 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 05-04-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 1.24
System	Frame and Body	FileLink1				**Qty**	4
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Impact Attenuator Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 4.96
P/N Base	00055			**FileLink3**			
Suffix	AA						
Details	Mounting for Impact Attenuator						

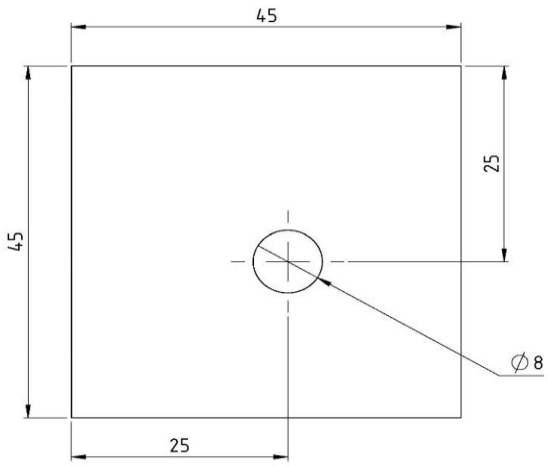
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Impact Attenuator Mounting	$ 2.25	0.04	kg			Rectangular	17.20	0.30	0.00785	1	$ 0.09
												Sub Total	**$ 0.091**

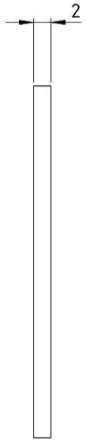
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material for Impact Attenuator Mounting	$ 0.20	cm	4			$ 0.80
20	Drilled holes < 25.4 mm dia.	Drilling for Impact Attenuator Mounting hole	$ 0.35	hole	1			$ 0.35
							Sub Total	**$ 1.15**

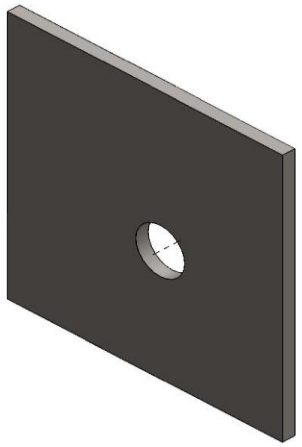
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2	Unit2	Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00055	Impact Attenuator Mounting	Mounting for Impact Attenuator	4







Corresponding symbols		▽	▼	▽▽	▼▼	▽▽▽	▼▼▼	
Roughness Classes (NBN 88-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4
Roughness Value "Ra" in µm (NBN 88 02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2

Allowable deviations for dimensions without tolerance indication (machined surfaces)

Accuracyclass ISO 2768:1	For measurements (deviations in mm) Dimensions in mm								Fillets and chamfers Dimensions in mm					Angles (in ° and ') Length of the shortest leg				
	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	to 10	>10 to 50	>50 to 120	>120 to 400	above 400
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	±0,2	±0,5	±1	±2	±4	±1°	±30'	±20'	±10'	±5'
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2										
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±4	±0,4	±1	±2	±5	±8	±1°30'	±1°	±30'	±15'	±10'
v Very rough	-	±0,5	±1	±1,5	±2,5	±4	±6	±8						±3°	±2°	±1°	±30'	±20'

	SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 159.08
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Rear Bulk Head	**FileLink3**		**FileLink2**		**Extended Cost**	$ 159.08
P/N Base	00056			**FileLink3**			
Suffix	AA						
Details	Aluminum Rear Bulk Head						

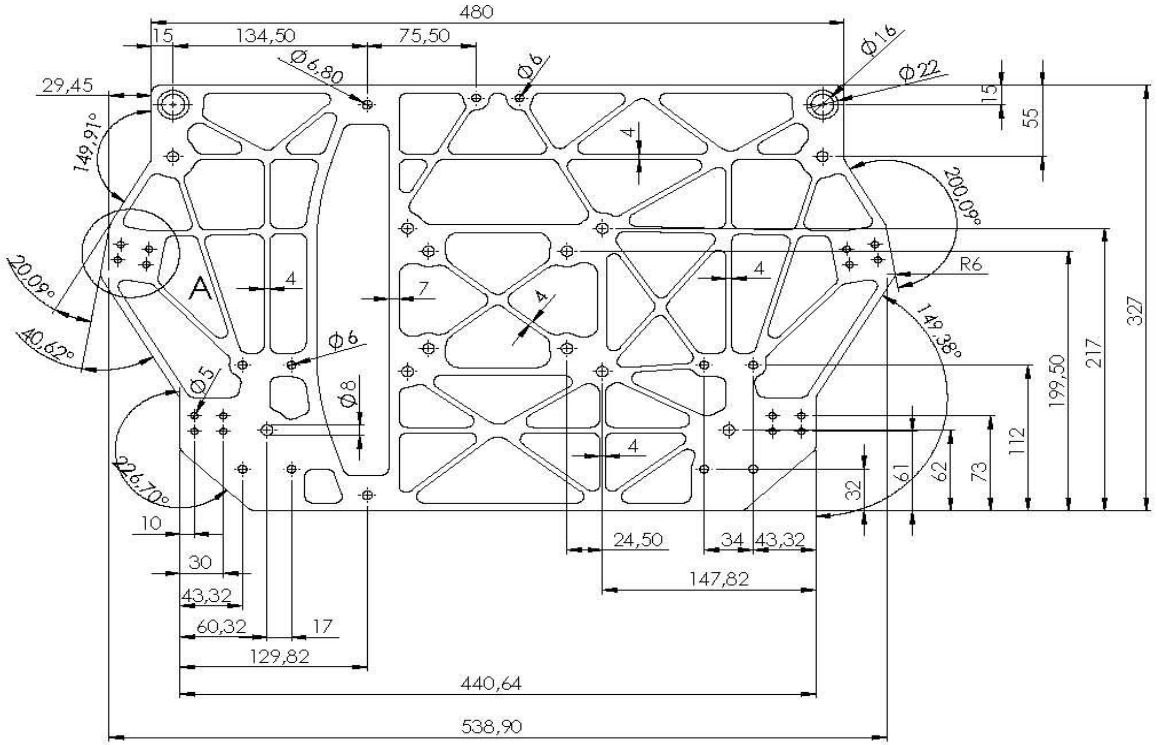
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Aluminum, Premium	Material for Rear Bulk Head	$ 4.20	9.76	kg			Rectangular	1,827.87	1.80	0.00281	1	$ 38.83
												Sub Total	**$ 38.831**

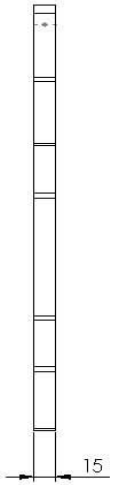
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Machining Setup, Install and remove	Machine setup for Rear Bulk Head	$ 1.30	unit	1			$ 1.30
20	Drilled holes < 25.4 mm dia.	Drilling for Rear Bulk Head clamping holes	$ 0.35	hole	4	Drill, Tap		$ 1.40
30	Machining Setup, Change	Machine setup for Rear Bulk Head	$ 0.65	unit	1			$ 0.65
40	Machining	Facing, pocketing and contouring material for Rear Bulk Head	$ 0.04	cm^3	1935.85	Material - Aluminum	1	$ 77.43
50	Drilled holes < 25.4 mm dia.	Drilling for Rear Bulk Head holes	$ 0.35	hole	48	Drill, Tap		$ 16.80
60	Machining Setup, Change	Machine setup for Rear Bulk Head	$ 0.65	unit	1			$ 0.65
70	Machining	Facing and pocketing material for Rear Bulk Head	$ 0.04	cm^3	550.5	Material - Aluminum	1	$ 22.02
							Sub Total	**$ 120.25**

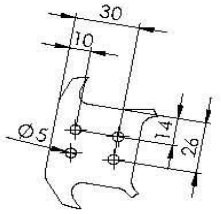
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2	Unit2	Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR - A0009 - 00056	Rear Bulkhead	Aluminum Rear Bulkhead	1







DETAIL A
SCALE 1 : 2

Allowable deviations for dimensions without tolerance indication (machined surfaces)

SCALE : 1 : 3	DRAWN : DESIGNER TEAM	NOTE:
UNIT : MM	CHECK : ZN, TP	
DATE : 05-04-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT — A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 0.97
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Jacking Point	**FileLink3**		**FileLink2**		**Extended Cost**	$ 0.97
P/N Base	00057			**FileLink3**			
Suffix	AA						
Details	Student Made Jacking Point						

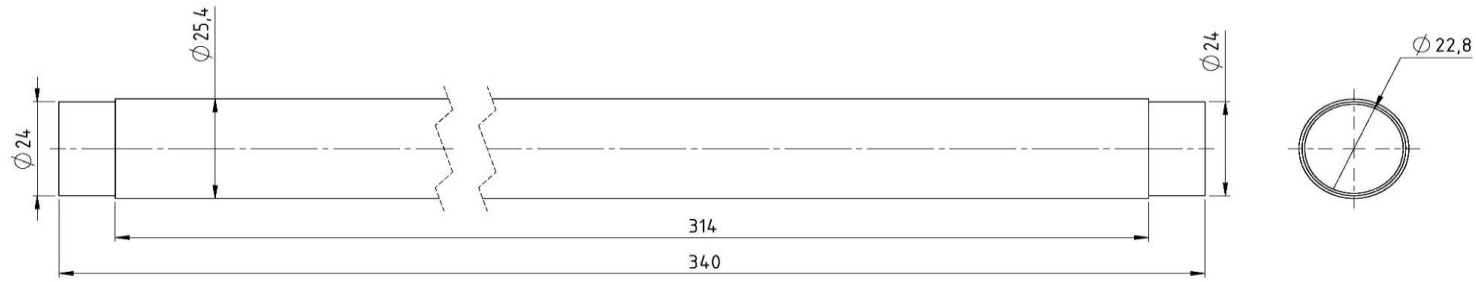
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Tubing, Steel	Material for Jacking Point	$ 2.25	0.27	kg			Circular pipe	0.98	34.30	0.00785	1	$ 0.59
												Sub Total	**$ 0.594**

ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Tube cut	Cutting tube	$ 0.15	cm	2.54			$ 0.38
20	Hand Finish - Material Removal	Tube end finishing	$ 0.20	cm^3	0.001			$ 0.00
							Sub Total	**$ 0.38**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2	Unit2	Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncId	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00057	Jacking Point	Student Made Jacking Point	1



Corresponding symbols		▽	▼	▽▽	▼▼	▽▽▽	▼▼▼	
Roughness Classes (NBN 88-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4
Roughness Value "Ra" in µm (NBN 88-02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2

Allowable deviations for dimensions without tolerance indication (machined surfaces)

Accuracyclass ISO 2768-1)	For measurements (deviations in mm) Dimensions in mm 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000	Fillets and chamfers Dimensions in mm 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	Angles (in ° and ') Length of the shortest leg to 10	>10 to 50	>50 to 120	>120 to 400	above 400
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	±0,2	±0,5	±1	±2	±4	±1°	±30'	±20'	±10'	±5'
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2										
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±5	±0,4	±1	±2	±4	±8	±1°30'	±1°	±30'	±15'	±10'
v Very rough	-	±0,5	±1	±1,5	±2,5	±4	±6	±8						±3°	±2°	±1°	±30'	±20'

SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 5.75
System	Frame and Body	FileLink1				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Jack Member	**FileLink3**		**FileLink2**		**Extended Cost**	$ 11.49
P/N Base	00058			**FileLink3**			
Suffix	AA						
Details	Member for Jacking Point						

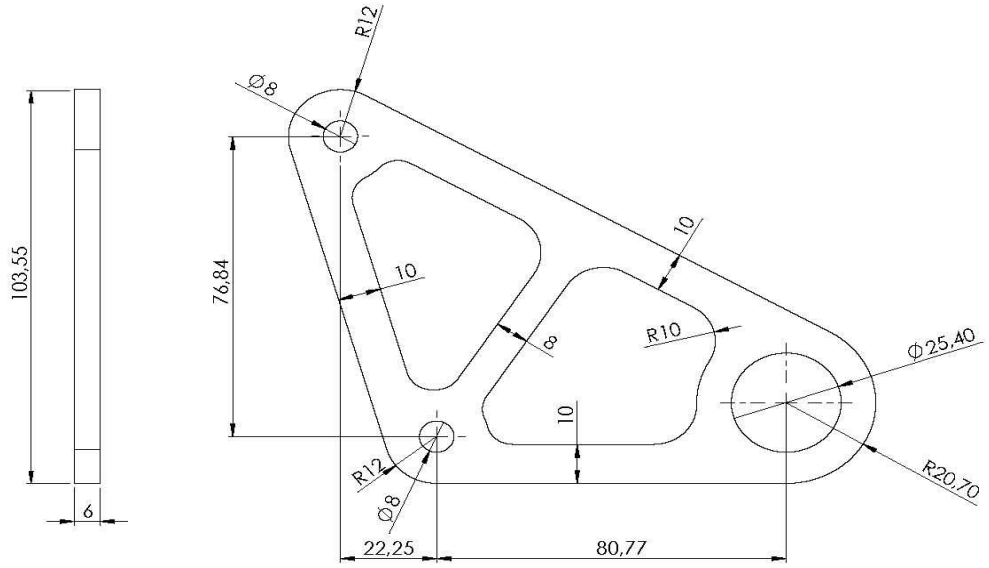
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Aluminum, Premium	Material for Jack Member	$ 4.20	0.22	kg			Rectangular	131.86	0.60	0.00281	1	$ 0.93
												Sub Total	**$ 0.934**

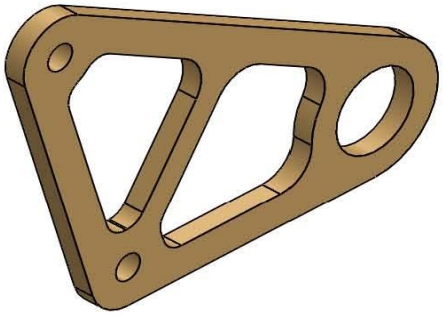
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Drilled holes < 25.4 mm dia.	Drilling for Jack Member clamping holes	$ 0.35	hole	4			$ 1.40
20	Machining Setup, Install and remove	Machine setup for Jack Member	$ 1.30	unit	1			$ 1.30
30	Machining	Pocketing and contouring material	$ 0.04	cm^3	52.83	Material - Aluminum	1	$ 2.11
							Sub Total	**$ 4.81**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR - A0009 - 00058	Jack Member	Member for Jacking Point	2





SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 4.92
System	Frame and Body	FileLink1				**Qty**	4
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Jacking Member Bracket	**FileLink3**		**FileLink2**		**Extended Cost**	$ 19.70
P/N Base	00059			**FileLink3**			
Suffix	AA						
Details	Bracket for Jack Member						

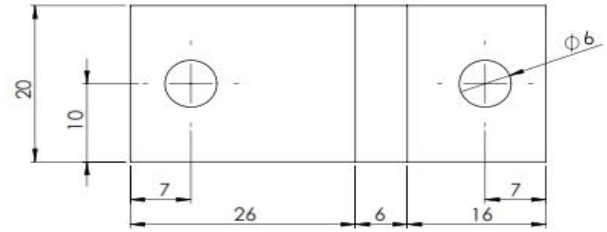
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Aluminum, Premium	Material for Jack Member Bracket	$ 4.20	0.13	kg			Rectangular	11.73	3.80	0.00281	1	$ 0.53
												Sub Total	**$ 0.526**

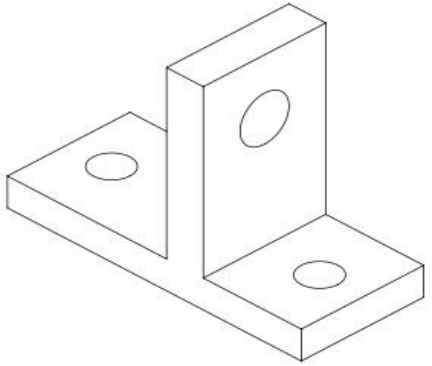
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Machining Setup, Install and remove	Machine setup for Jack Member Bracket	$ 1.30	unit	1			$ 1.30
20	Machining	Pocketing and contouring material	$ 0.04	cm^3	33.21	Material - Aluminum	1	$ 1.33
30	Drilled holes < 25.4 mm dia.	Drilling for Jack Member clamping holes	$ 0.35	hole	2			$ 0.70
40	Machining Setup, Change	Setting material	$ 0.65	unit	1			$ 0.65
50	Machining	Pocketing and contouring material	$ 0.04	cm^3	1.76	Material - Aluminum	1	$ 0.07
60	Drilled holes < 25.4 mm dia.	Drilling for Jack Member clamping holes	$ 0.35	hole	1			$ 0.35
70	Annodize		$ -	unit	1		1	$ -
							Sub Total	**$ 4.40**

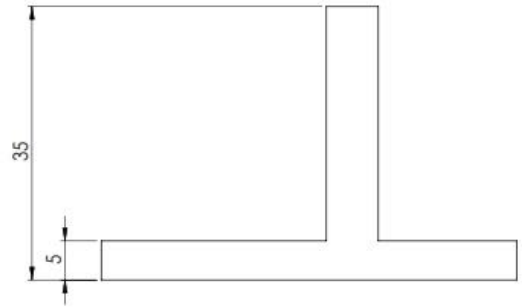
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

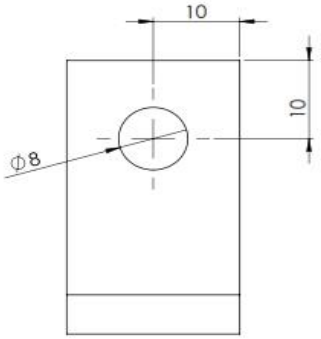
ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR - A0009 - 00059	Jacking Member Bracket	Bracket for Jack Member	4









SCALE : 2 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 05-04-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 10.94
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Fire Wall Bracket	**FileLink3**		**FileLink2**		**Extended Cost**	$ 10.94
P/N Base	00060			**FileLink3**			
Suffix	AA						
Details	Bracket for Fire Wall						

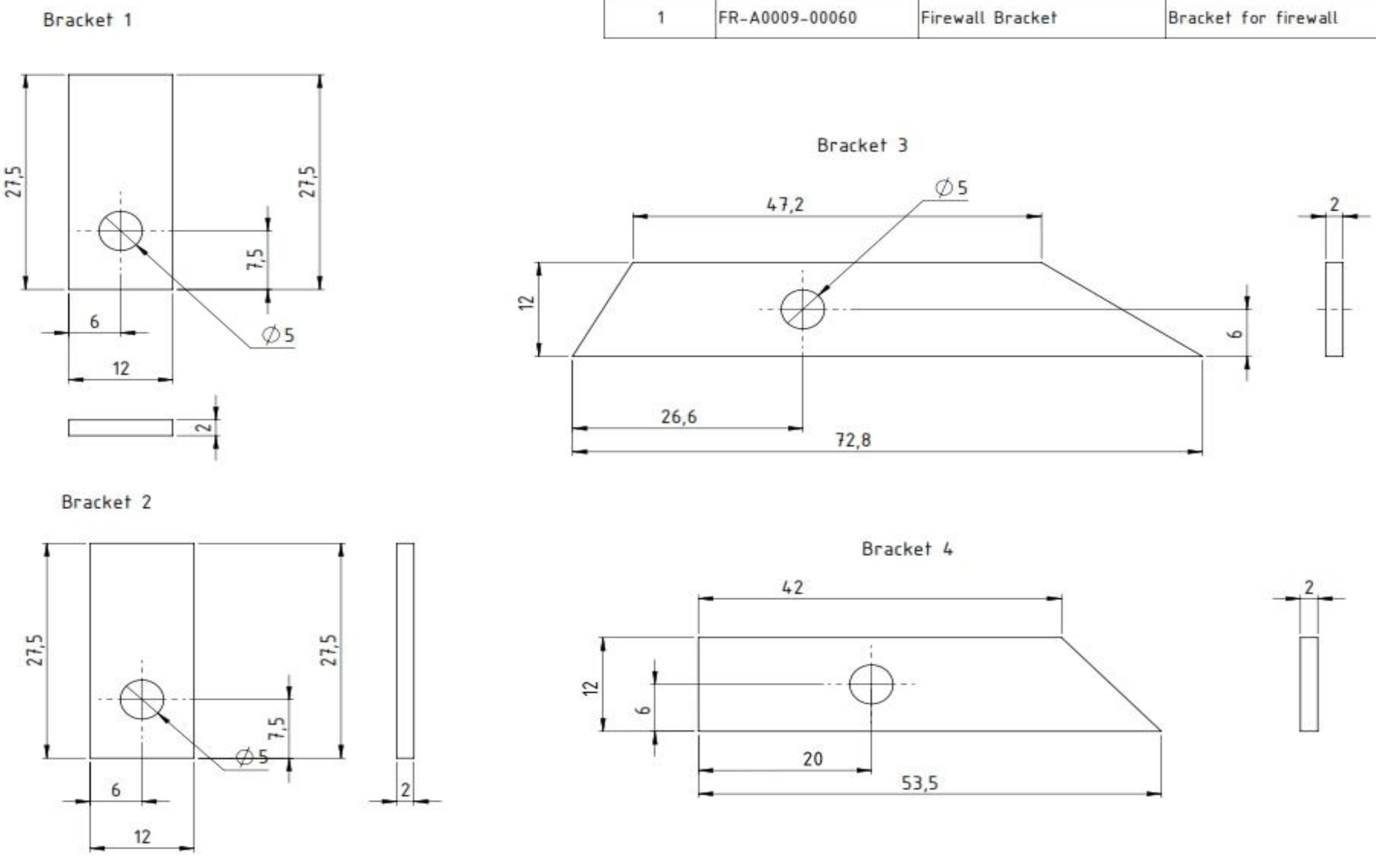
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Ignition Coil Mounting	$ 2.25	0.03	kg			Rectangular	66.00	0.20	0.00785	1	$ 0.23
												Sub Total	**$ 0.233**

ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material for Firewall bracket	$ 0.20	cm	1.2	Repeat 16	16	$ 3.84
20	Drilled holes < 25.4 mm dia.	Drilling for Firewall bracket hole	$ 0.35	hole	8			$ 2.80
30	Sheet Metal Saw Cut	Hole sawing for welding side	$ 0.20	cm	2.54	Repeat 8	8	$ 4.06
							Sub Total	**$ 10.70**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00060	Firewall Bracket	Bracket for firewall	1



Corresponding symbols		▽	▼	▽▽	▼▼	▽▽▽	▼▼▼	
Roughness Classes (NBN 98-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4
Roughness Value "Ra" in µm (NBN 98-02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2

Allowable deviations for dimensions without tolerance indication (machined surfaces)

Accuracy class ISO 2768.1	For measurements (deviations in mm) — Dimensions in mm: 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000	Fillets and chamfers — Dimensions in mm: 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	Angles (in ° and ') — Length of the shortest leg: to 10	>10 to 50	>50 to 120	>120 to 400	above 400
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	±0,2	±0,5	±1	±2	±4	±1°	±30'	±20'	±10'	±5'
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2										
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±4	±0,4	±1	±2	±4	±8	±1°30'	±1°	±30'	±15'	±10'
v Very Rough	-	±0,5	±1	±1,5	±2,5	±4	±6	±8						±3°	±2°	±1°	±30'	±20'

SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 3.72
System	Frame & Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Manual Shifter Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 3.72
P/N Base	00061			**FileLink3**			
Suffix	BA						
Details	Mounting for manual shifter						

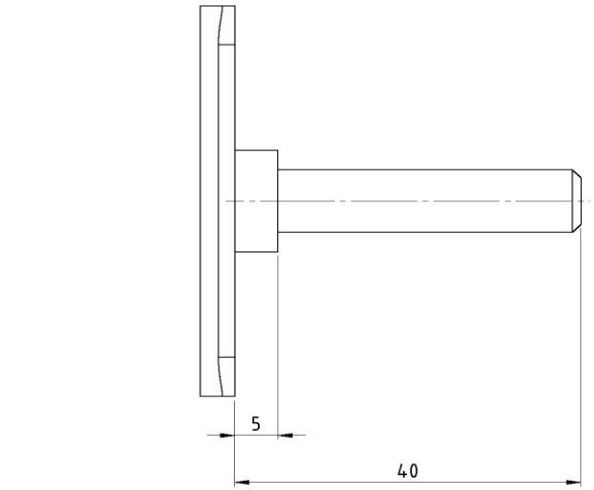
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Mild	Raw steel material	$ 2.25	0.08	kg			Circular	2.26	4.30	0.00790	1	$ 0.17
20	Steel, Mild	Steel Plate	$ 2.25	0.04	kg			Rectangular	13.25	0.40	0.00790	1	$ 0.09
													$ 0.267

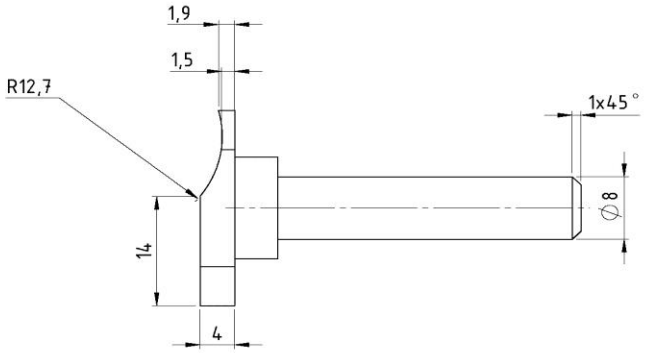
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Machining Setup, Install and remove	Setting machine and material	$ 1.30	unit	1		1	$ 1.30
20	Machining	Contouring material	$ 0.04	cm^3	7.34	Machining-Steel	3	$ 0.29
30	Threading, External (machining)	Threading shifter mounting material	$ 0.10	cm	3.3		1	$ 0.33
40	Sheet metal shearing	Shearing material	$ 0.25	cut	1		1	$ 0.25
60	Weld	Welding shifter lever mounting	$ 0.15	cm	4.08		1	$ 0.61
							Sub Total	**$ 2.79**

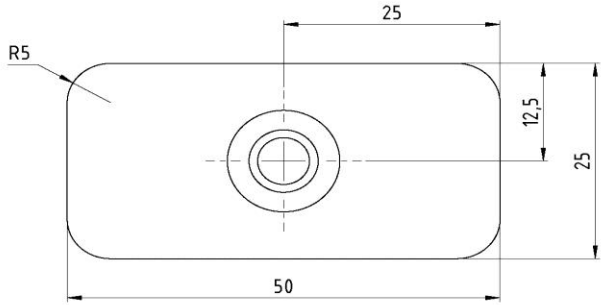
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2	Unit2	Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
10	Welds	welding material	$ 500.00	point	4	3000	1	$ 0.67
							Sub Total	**$ 0.67**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0008-00061	Manual Shifter Mounting	Mounting for manual shifter	1







SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 8.58
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Main switch mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 8.58
P/N Base	00062			**FileLink3**			
Suffix	AA						
Details	Mounting for power switch						

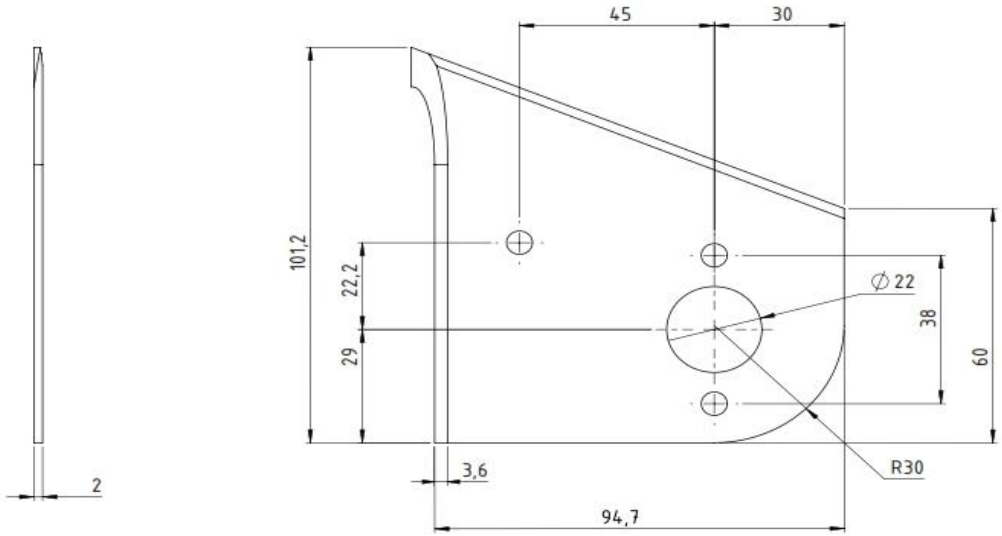
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy (per kg)	Material for Main switch mounting	$ 2.25	0.17	kg			Profile L	1.56	2.30	0.00785	1	$ 0.06
												Sub Total	**$ 0.063**

ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting Material	$ 0.20	cm	36.94			$ 7.39
20	Drilled holes < 25.4 mm dia.	Drilling material	$ 0.35	hole	3			$ 1.05
30	Hand Finish - Material Removal	Filleting material	$ 0.20	cm^3	0.38			$ 0.08
							Sub Total	**$ 8.51**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00062	Main switch mounting	Mounting for power switch	1



Allowable deviations for dimensions without tolerance indication (machined surfaces)

SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:
UNIT : MM	CHECK : ZN, TP	
DATE : 12-05-2016	APPROVE : -	

FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 3.02
System	Frame and Body	FileLink1				**Qty**	4
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Anti Roll Bar Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 12.08
P/N Base	00063			**FileLink3**			
Suffix	AA						
Details	Mounting for Anti Roll Bar						

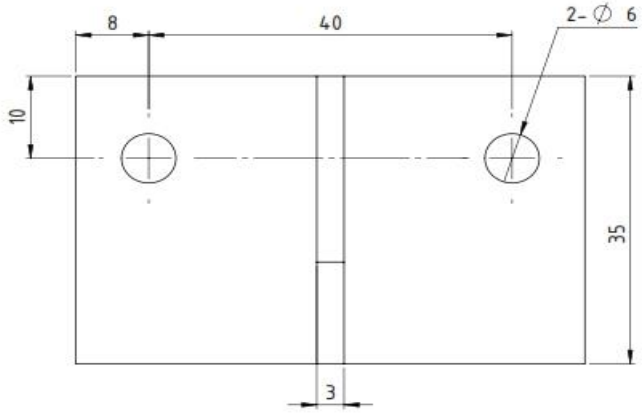
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Anti Roll Bar Mounting	$ 2.25	0.03	kg			Circular	23.08	0.20	0.00785	1	$ 0.08
												Sub Total	**$ 0.082**

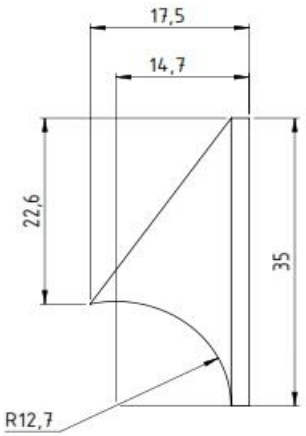
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material	$ 0.20	cm	3.5			$ 0.70
20	Drilled holes < 25.4 mm dia.	Drilling Anti Roll Bar Mounting hole	$ 0.35	hole	2			$ 0.70
30	Sheet Metal Saw Cut	Cutting material	$ 0.20	cm	4.24			$ 0.85
40	Weld	Joining material	$ 0.15	cm	3.5			$ 0.53
							Sub Total	**$ 2.77**

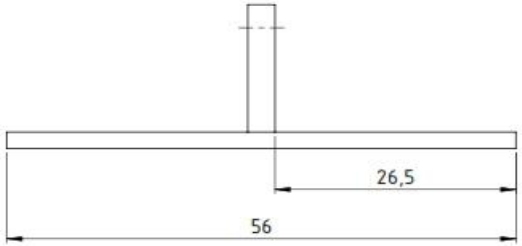
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

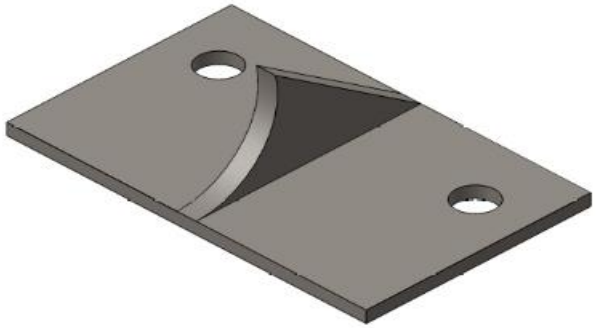
ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
10	Welds	welding material	$ 500	point	1	3000	1	$ 0.17
							Sub Total	**$ 0.17**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00063	Anti Roll Bar Mounting	Mounting for Anti Roll Bar	4









Allowable deviations for dimensions without tolerance indication (machined surfaces)

Corresponding symbols		▽	▼	▽▽	▼▼	▽▽▽	▼▼▼	
Roughness Classes (								
Roughness Value "Ra" in µm (		25	12,5	6,3	3,2	1,6	0,8	0,4	0,2

Accuracy class ISO 2768-1	For measurements (deviations in mm)								Fillets and chamfers				Angles (in ° and ')				
	Dimensions in mm								Dimensions in mm				Length of the shortest leg				
	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	to 10	>10 to 50	>50 to 120	>120 to 400	above 400
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	±0,2	±0,5	±1	±2	±4	±1°	±30'	±20'	±10'	±5'
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2										
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±4	±0,4	±1	±2	±4	±8	±1° 30'	±1°	±30'	±15'	±10'
v Very Rough		±0,5	±1	±1,5	±2,5	±4	±6	±8						±3°	±2°	±1°	±30'	±20'

	SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 5.82
System	Frame and Body	**FileLink1**				**Qty**	4
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Rear Bellcrank Bearing	**FileLink3**		**FileLink2**		**Extended Cost**	$ 23.28
P/N Base	00064			**FileLink3**			
Suffix	AA						
Details	Bearing for Rear Bellcrank						

ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Bearing, Ball, Radial	Bearing for Rear Bellcrank	$ 5.82	22	mm	7	mm					1	$ 5.82
												Sub Total	**$ 5.820**

ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
							Sub Total	**$ -**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 1.01
System	Frame and Body	FileLink1				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Upper Seat Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 2.01
P/N Base	00065			**FileLink3**			
Suffix	AA						
Details	Mounting for Seat						

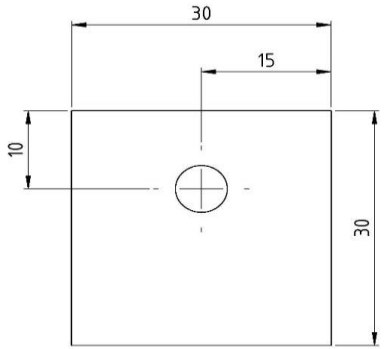
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Upper Seat Mounting	$ 2.25	0.02	kg			Rectangular	15.90	0.20	0.00785	1	$ 0.06
												Sub Total	**$ 0.056**

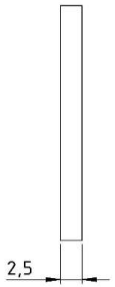
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material for Upper Seat Mounting	$ 0.20	cm	3			$ 0.60
20	Drilled holes < 25.4 mm dia.	Drilling for Upper Seat Mounting hole	$ 0.35	hole	1			$ 0.35
							Sub Total	**$ 0.95**

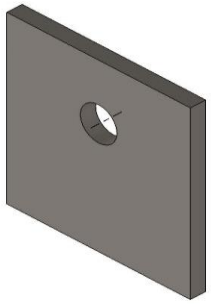
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00065	Upper Seat Mounting	Mounting for Seat	2







Corresponding symbols		▽	▼	▽▽	▼▼	▽▽▽	▼▼▼	
Roughness Classes (NBN 88-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4
Roughness Value "Ra" in µm (NBN 88 02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2

Allowable deviations for dimensions without tolerance indication (machined surfaces)

For measurements (deviations in mm)

Accuracyclass ISO 2768/3	Dimensions in mm								
	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4.000	
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2	
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±4	
v Very rough	-	±0,5	±1	±1,5	±2,5	±4	±6	±8	

Fillets and chamfers

Dimensions in mm					
0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	
±0,2	±0,5	±1	±2	±4	
±0,4	±1	±2	±5	±8	

Angles (in ° and ')

Length of the shortest leg				
to 10	>10 to 50	>50 to 120	>120 to 400	above 400
±1°	±30'	±20'	±10'	±5'
±1°30'	±1°	±30'	±20'	±10'
±3°	±2°	±1°	±30'	±20'

FACULTY OF ENGINEERING
YOGYAKARTA STATE UNIVERSITY

SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FRAME		NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 0.97
System	Frame and Body	FileLink1				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Lower Seat Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 1.94
P/N Base	00066			**FileLink3**			
Suffix	BA						
Details	Mounting for Seat						

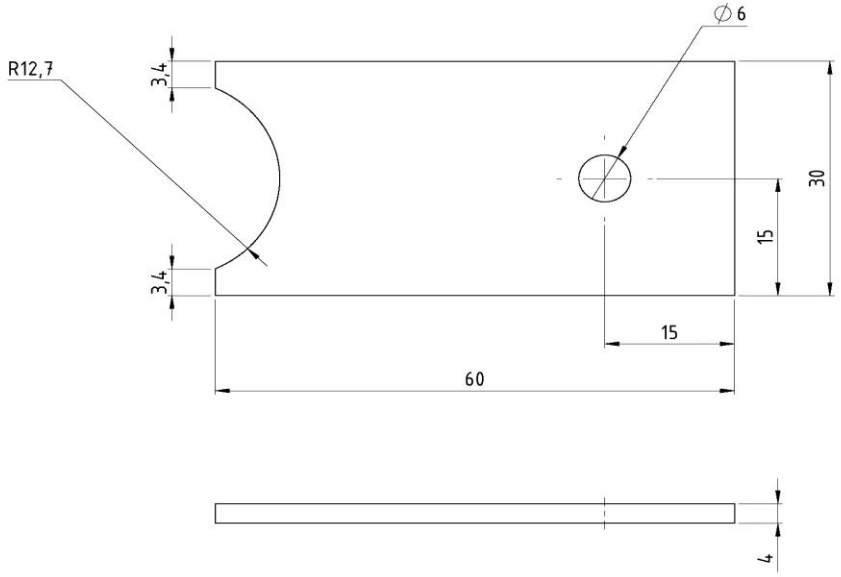
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Lower Seat Mounting	$ 2.25	0.05	kg			Rectangular	15.25	0.40	0.00785	1	$ 0.11
												Sub Total	**$ 0.108**

ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet metal shearing	Cutting material for Lower Seat Mounting	$ 0.25	cut	2			$ 0.50
20	Drilled holes < 25.4 mm dia.	Drilling for Lower Seat Mounting hole	$ 0.35	hole	1			$ 0.35
30	Hand Finish - Material Removal		$ 0.20	cm^3	0.06			$ 0.01
							Sub Total	**$ 0.86**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0008-00066	Lower Seat Mounting	Mounting for Seat	2



SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 5.08
System	Frame and Body	FileLink1				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Front Mounting Engine Adapter	**FileLink3**		**FileLink2**		**Extended Cost**	$ 10.17
P/N Base	00067			**FileLink3**			
Suffix	BA						
Details	Steel Adapter for Front Mounting Engine						

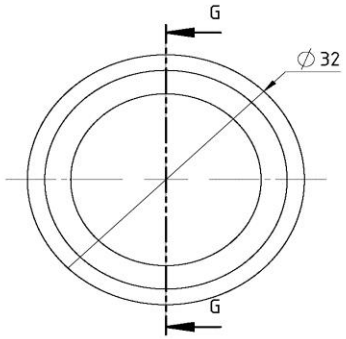
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Front Mounting Engine Adapter	$ 2.25	0.22	kg			Circular	11.40	2.50	0.00785	1	$ 0.50
												Sub Total	**$ 0.503**

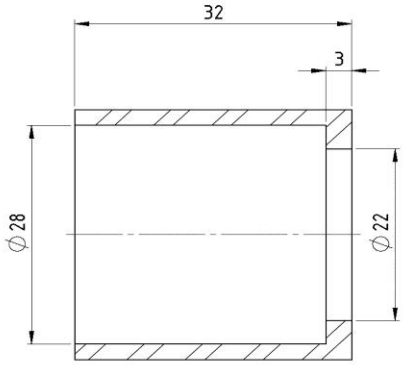
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Machining Setup, Install and remove	Setting machine and material	$ 1.30	unit	1			$ 1.30
20	Machining	Contouring material	$ 0.04	cm^3	22.09	Material - Steel	3	$ 2.65
30	Drilled holes < 25.4 mm dia.	Drilling material	$ 0.35	hole	1			$ 0.35
40	Machining	Boring and cutting off material	$ 0.04	cm^3	2.32	Material - Steel	3	$ 0.28
							Sub Total	**$ 4.58**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0008-00067	Front Mounting Engine Adapter	Steel Adapter for Front Mounting Engine	1





SECTION G-G

	SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 6.54
System	Frame and Body	FileLink1				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Bottom Engine Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 13.09
P/N Base	00068			**FileLink3**			
Suffix	BA						
Details	Mounting for Bottom Side Engine						

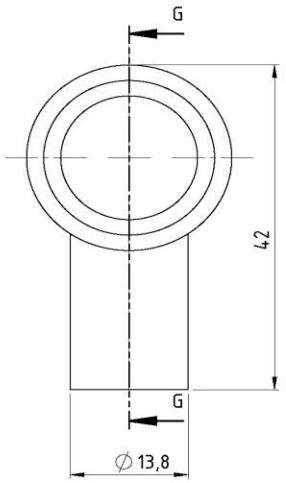
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Bottom Engine Mounting	$ 2.25	0.01	kg			Rectangular	6.66	0.20	0.00785	1	$ 0.02
												Sub Total	**$ 0.024**

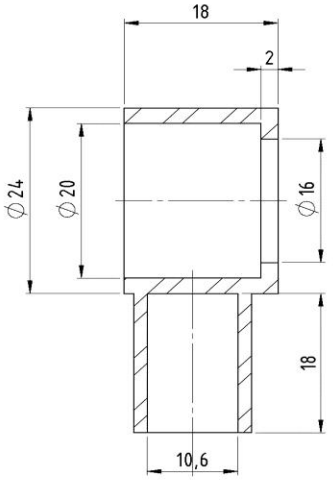
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Machining Setup, Install and remove	Setting machine and material	$ 1.30	unit	1			$ 1.30
20	Machining	Contouring material	$ 0.04	cm^3	22.09	Material - Steel	3	$ 2.65
30	Drilled holes < 25.4 mm dia.	Drilling material	$ 0.35	hole	1			$ 0.35
40	Machining	Boring and cutting off material	$ 0.04	cm^3	2.32	Material - Steel	3	$ 0.28
50	Tube cut	Cutting material	$ 0.15	cm	1.38			$ 0.21
60	Tube end preperation for welding	Preparation for joining bottom engine mounting material	$ 0.75	end	1			$ 0.75
70	Weld	Joining bottom engine mounting material	$ 0.15	cm	4.34			$ 0.65
							Sub Total	**$ 6.19**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
10	Welds	Welding Fixture	$ 500	point	2	3000	1	$ 0.33
							Sub Total	**$ 0.33**

ITEM NO.	PART NUMBER	*COMPONENT*	DESCRIPTION	QTY.
1	FR-A0008-00068	Bottom Engine Mounting	Mounting for Bottom Side Engine	2





SECTION G-G

	SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 2.42
System	Frame and Body	FileLink1				**Qty**	2
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Oil Catchtank Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 4.84
P/N Base	00069			**FileLink3**			
Suffix	AA						
Details	Mounting for Oil Catchtank						

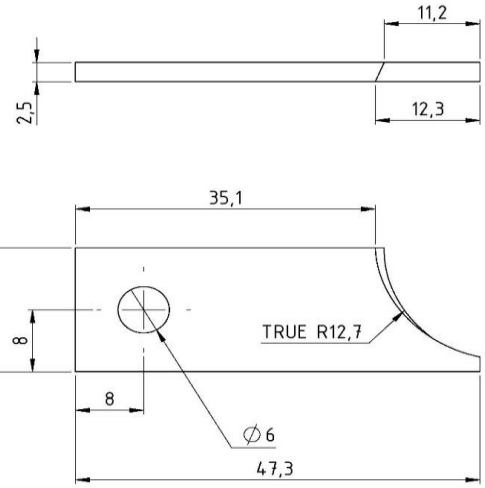
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Upper and Lower Oil Catchtank Mounting	$ 2.25	0.03	kg			Rectangular	17.42	0.20	0.00785	1	$ 0.06
												Sub Total	**$ 0.062**

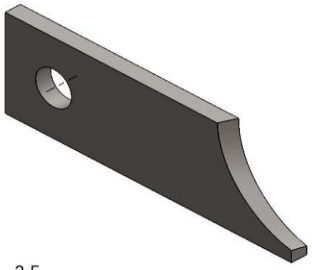
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material for Upper and Lower Oil Catchtank Mounting	$ 0.20	cm	1.6	Repeat 2	2	$ 0.64
20	Drilled holes < 25.4 mm dia.	Drilling for Upper and Lower Oil Catchtank Mounting hole	$ 0.35	hole	2			$ 0.70
30	Sheet Metal Saw Cut	Hole sawing for welding side	$ 0.20	cm	2.54	Repeat 2	2	$ 1.02
							Sub Total	**$ 2.36**

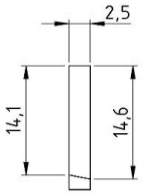
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00069	Oil Catchtank Mounting	Mounting for Oil Catchtank	2







Corresponding symbols		▽	▼	▽▽	▼▼	▽▽▽	▼▼▼	
Roughness Classes (NBN 88-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4
Roughness Value "Ra" in µm (NBN 88.02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2

Allowable deviations for dimensions without tolerance indication (machined surfaces)

Accuracyclass ISO 2768.1)	For measurements (deviations in mm) Dimensions in mm 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000	Fillets and chamfers Dimensions in mm 0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	Angles (in ° and ') Length of the shortest leg to 10	>10 to 50	>50 to 120	>120 to 400	above 400
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	±0,2	±0,5	±1	±2	±4	±1°	±30'	±20'	±10'	±5'
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2										
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±5	±0,4	±1	±2	±4	±8	±1°30'	±1°	±30'	±15'	±10'
v Very Rough	–	±0,5	±1	±1,5	±2,5	±4	±6	±8						±3°	±2°	±1°	±10'	±20'

SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 1.75
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Cooling Additional Bottle Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 1.75
P/N Base	00070			**FileLink3**			
Suffix	AA						
Details	Mounting for Cooling Additional Bottle						

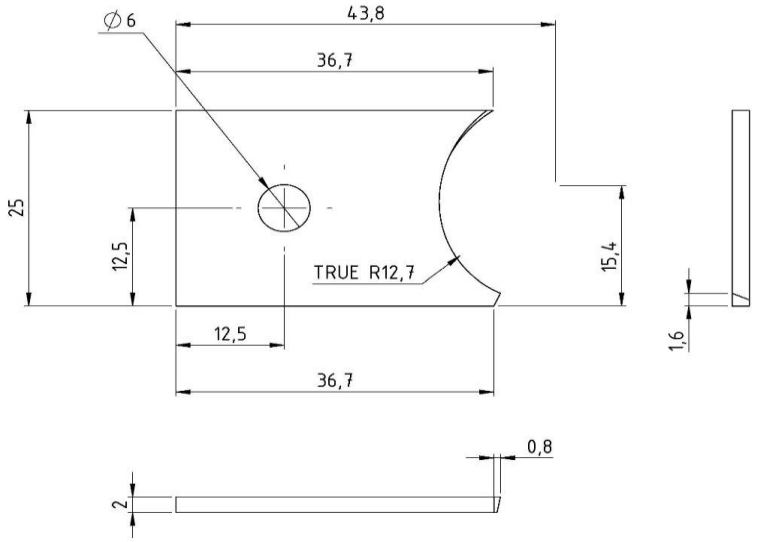
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Cooling Additional Bottle Mounting	$ 2.25	0.02	kg			Rectangular	12.75	0.20	0.00785	1	$ 0.05
												Sub Total	**$ 0.045**

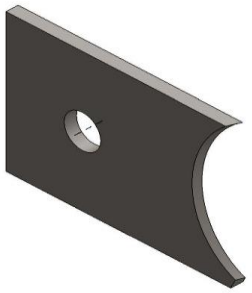
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material for Cooling Additional Bottle Mounting	$ 0.20	cm	2.5			$ 0.50
20	Drilled holes < 25.4 mm dia.	Drilling for Cooling Additional Bottle Mounting	$ 0.35	hole	2			$ 0.70
30	Sheet Metal Saw Cut	Hole sawing for welding side	$ 0.20	cm	2.54			$ 0.51
							Sub Total	**$ 1.71**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00070	Cooling Additional Bottle Mounting	Mounting for Cooling Additional Bottle	1





Corresponding symbols		▽	▼	▽▽	▼▼	▽▽▽	▼▼▼	
Roughness Classes (NBN 88-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4
Roughness Value "Ra" in µm (NBN 88-02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2

Allowable deviations for dimensions without tolerance indication (machined surfaces)

For measurements (deviations in mm)

Accuracyclass ISO 2768/3	Dimensions in mm								Fillets and chamfers					Angles (in ° and ')				
	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4.000	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	Length of the shortest leg: to 10	>10 to 50	>50 to 120	>120 to 400	above 400
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	±0,2	±0,5	±1	±2	±4	±1°	±30'	±20'	±10'	±5'
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2										
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±5	±0,4	±1	±2	±5	±9	±1°30'	±1°	±30'	±15'	±10'
v Very rough	-	±0,5	±1	±1,5	±2,5	±4	±6	±8						±3°	±2°	±1°	±30'	±20'

SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$	2.42
System	Frame and Body	FileLink1				**Qty**		1
Assembly	Frame	**FileLink2**		**FileLink1**				
Part	Overflow Bottle Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$	2.42
P/N Base	00071			**FileLink3**				
Suffix	AA							
Details	Mounting for Overflow Bottle							

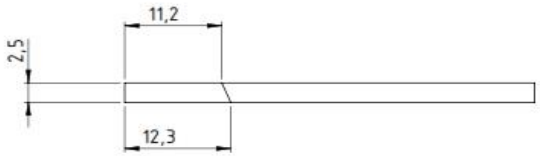
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Upper and Lower Overflow Bottle Mounting	$ 2.25	0.03	kg			Rectangular	17.90	0.20	0.00785	1	$ 0.06
												Sub Total	**$ 0.063**

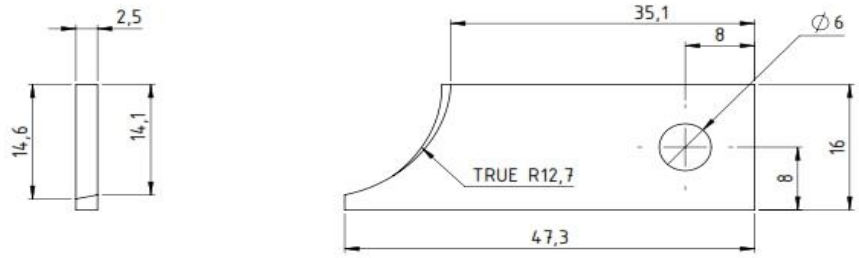
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material for Upper and Lower Overflow Bottle Mounting	$ 0.20	cm	1.6	Repeat 2	2	$ 0.64
20	Drilled holes < 25.4 mm dia.	Drilling for Upper and Lower Overflow Bottle Mounting hole	$ 0.35	hole	2			$ 0.70
30	Sheet Metal Saw Cut	Hole sawing for welding side	$ 0.20	cm	2.54	Repeat 2	2	$ 1.02
							Sub Total	**$ 2.36**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00071	Overflow Bottle Mounting	Mounting for Overflow Bottle	1





Allowable deviations for dimensions without tolerance indication (machined surfaces)

SCALE	: 1 : 1	DRAWN	: DESIGNER TEAM	NOTE:
UNIT	: MM	CHECK	: ZN, TP	
DATE	: 12-05-2016	APPROVE	: -	

FACULTY OF ENGINEERING
YOGYAKARTA STATE UNIVERSITY

FRAME

NO:01/GURT

A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 2.52
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Dashboard Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 2.52
P/N Base	00072			**FileLink3**			
Suffix	BA						
Details	Mounting for Dashboard						

ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Dashboard Mounting	$ 2.25	0.035	kg			Rectangular	24.24	0.30	0.00785	1	$ 0.13
												Sub Total	**$ 0.128**

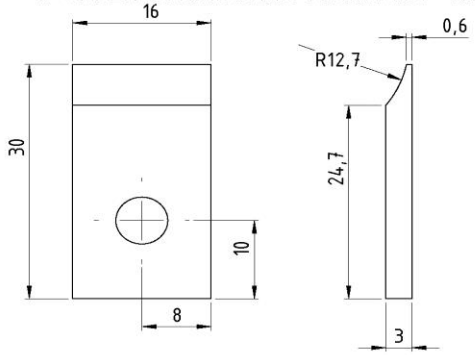
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet metal shearing	Cutting material for Upper Dashboard Mounting	$ 0.25	cut	5			$ 1.25
20	Drilled holes < 25.4 mm dia.	Drilling fo rUpper Dashboard Mounting Hole	$ 0.35	hole	3			$ 1.05
30	Hand Finish - Material Removal	Preparation for welding	$ 0.20	cm^3	0.11	Repeat 4	4	$ 0.09
							Sub Total	**$ 2.39**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

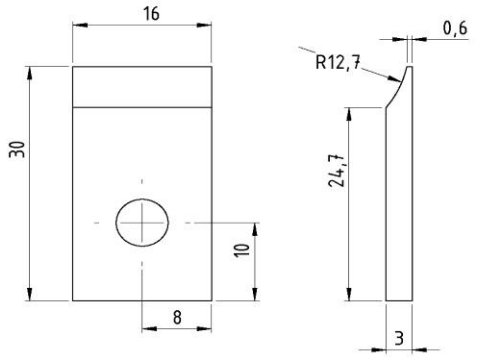
ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR – A0009 – 00072	Dashboard Mounting	Mounting for Dashboard	1

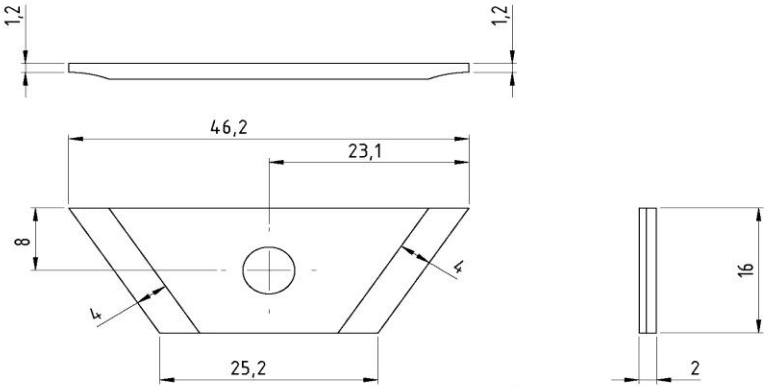
1. UPPER DASHBOARD MOUNTING –RH



2. UPPER DASHBOARD MOUNTING –LH



3. LOWER DASHBOARD MOUNTING



SCALE : 2 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 05-04-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 0.80
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Resonator Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 0.80
P/N Base	00073			**FileLink3**			
Suffix	AA						
Details	Mounting for Resonator						

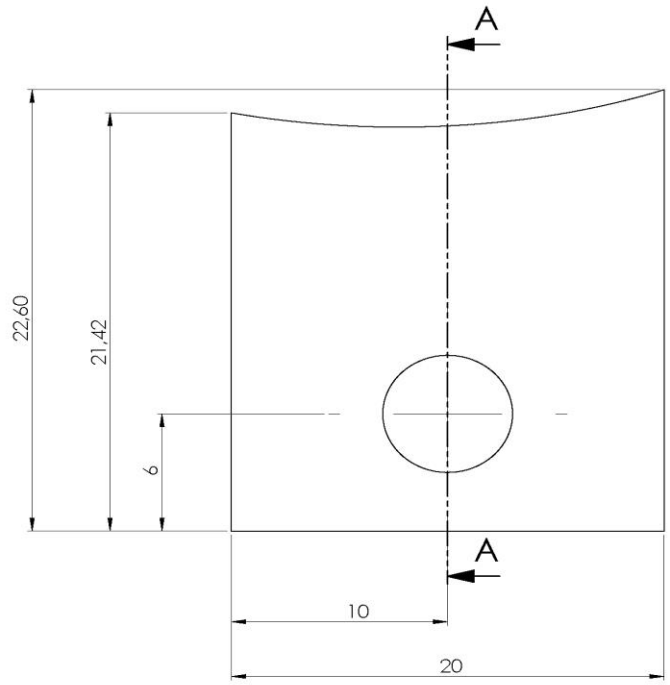
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Resonator Mounting	$ 2.25	0.01	kg			Rectangular	5.12	0.20	0.00785	1	$ 0.02
												Sub Total	**$ 0.018**

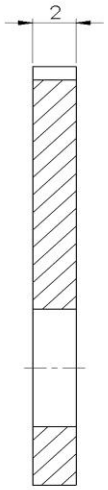
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material for Resonator Mounting	$ 0.20	cm	2			$ 0.40
20	Drilled holes < 25.4 mm dia.	Drilling for Resonator Mounting hole	$ 0.35	hole	1			$ 0.35
30	Hand Finish - Material Removal	Filleting material	$ 0.20	cm^3	0.17			$ 0.03
							Sub Total	**$ 0.78**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncId	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR - A0009 - 00073	Resonator Mounting	Mounting for Resonator	1





SECTION A-A

	SCALE : 5 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 05-04-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 17.46
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Diffuser Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 17.46
P/N Base	00074			**FileLink3**			
Suffix	AA						
Details	Mounting for Front, Middle and Rear Diffuser						

ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Diffuser Mounting	$ 2.25	0.03	kg			Rectangular	39.80	0.20	0.00785	1	$ 0.14
												Sub Total	**$ 0.141**

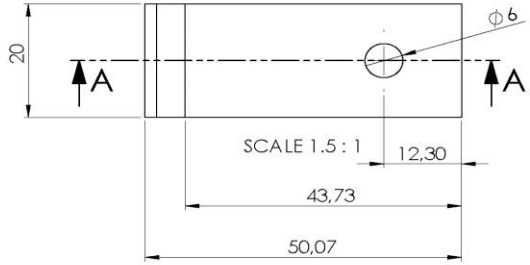
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material for Diffuser Mounting	$ 0.20	cm	2	Repeat 4	4	$ 1.60
20	Sheet Metal Saw Cut	Cutting material for Diffuser Mounting	$ 1.20	cm	1.61	Repeat 2	2	$ 3.86
30	Sheet Metal Saw Cut	Cutting material for Diffuser Mounting	$ 2.20	cm	2.16	Repeat 2	2	$ 9.50
40	Drilled holes < 25.4 mm dia.	Drilling for Diffuser Mounting hole	$ 0.35	hole	6			$ 2.10
50	Sheet metal bends	Bending material	$ 0.25	bend	1			$ 0.25
							Sub Total	**$ 17.32**

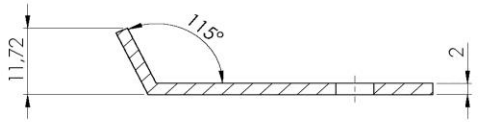
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR - A0009 - 00074	Diffuser Mounting	Mounting for Front, Middle and Rear Diffuser	1

1. DIFFUSER FRONT MOUNTING

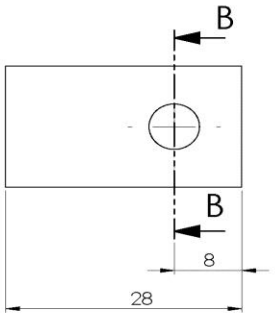


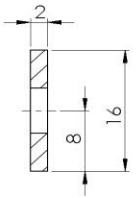


SECTION A-A

SCALE 1.5 : 1

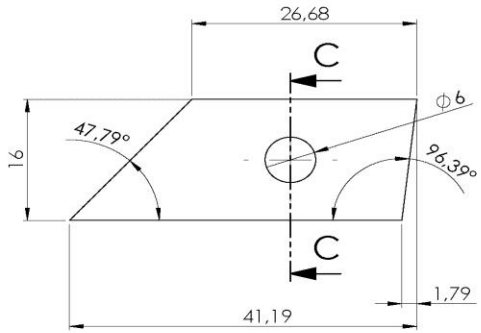
2. DIFFUSER MIDDLE MOUNTING





SECTION B-B

3. DIFFUSER REAR MOUNTING



SECTION C-C

	SCALE : 2 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 05-04-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$	1.54
System	Frame and Body	FileLink1				**Qty**		1
Assembly	Frame	**FileLink2**		**FileLink1**				
Part	Front Side Body Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$	1.54
P/N Base	00075			**FileLink3**				
Suffix	AA							
Details	Mounting for Body							

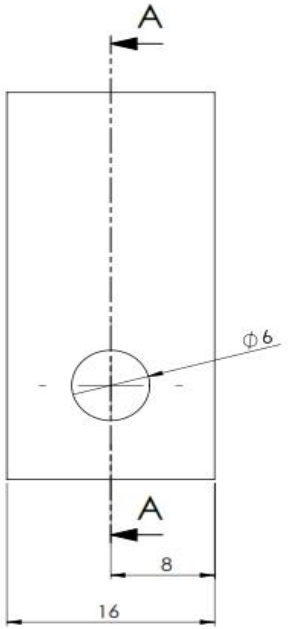
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Front Side Body Mounting	$ 2.25	0.01	kg			Rectangular	12.10	0.20	0.00785	1	$ 0.04
												Sub Total	**$ 0.043**

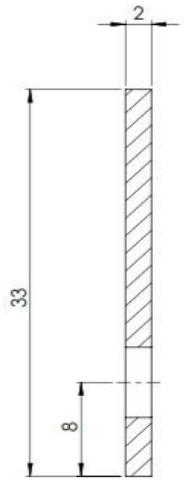
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material for Front Side Body Mounting	$ 0.20	cm	2	Repeat 2	2	$ 0.80
20	Drilled holes < 25.4 mm dia.	Drilling for Front Side Body Mounting hole	$ 0.35	hole	1	Repeat 2	2	$ 0.70
							Sub Total	**$ 1.50**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncId	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR - A0009 - 00075	Front Side Body Mounting	Mounting for Body	1





SECTION A-A
SCALE 3 : 1

SCALE : 3 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 05-04-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 8.41
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Inner Side Body Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 8.41
P/N Base	00076			**FileLink3**			
Suffix	AA						
Details	Mounting for Body						

ItemOrder	Material	76	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Inner Side Body Mounting	$ 2.25	0.1	kg			Rectangular	60.80	0.20	0.00785	1	$ 0.21
												Sub Total	**$ 0.215**

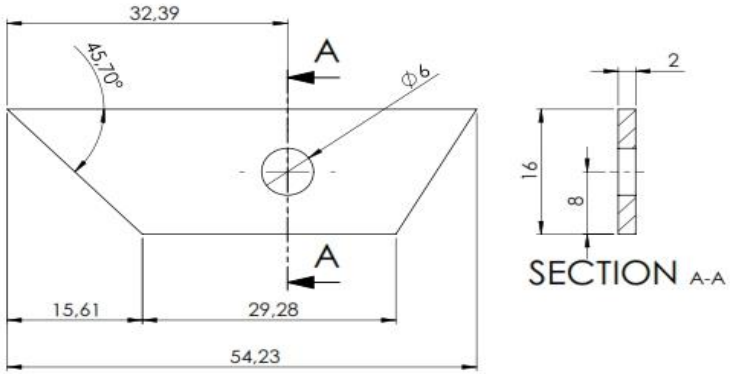
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material for Inner Side Body Mounting	$ 0.20	cm	1.6	Repeat 8	8	$ 2.56
20	Sheet Metal Saw Cut	Cutting material for Inner Side Body Mounting	$ 0.20	cm	2.24	Repeat 2	2	$ 0.90
30	Sheet Metal Saw Cut	Cutting material for Inner Side Body Mounting	$ 0.20	cm	1.85	Repeat 2	2	$ 0.74
40	Sheet Metal Saw Cut	Cutting material for Inner Side Body Mounting	$ 0.20	cm	3	Repeat 2	2	$ 1.20
50	Drilled holes < 25.4 mm dia.	Drilling for Inner Side Body Mounting hole	$ 0.35	hole	8			$ 2.80
							Sub Total	**$ 8.20**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

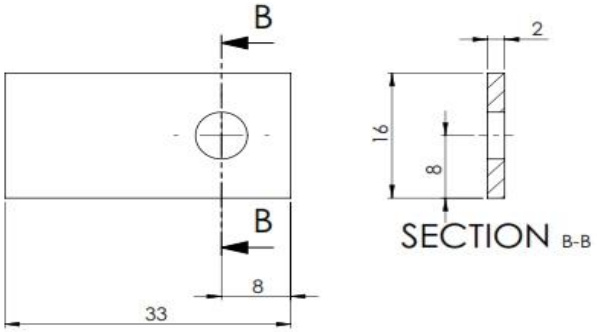
ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR - A0009 - 00076	Inner Side Body Mounting	Mounting for Body	1

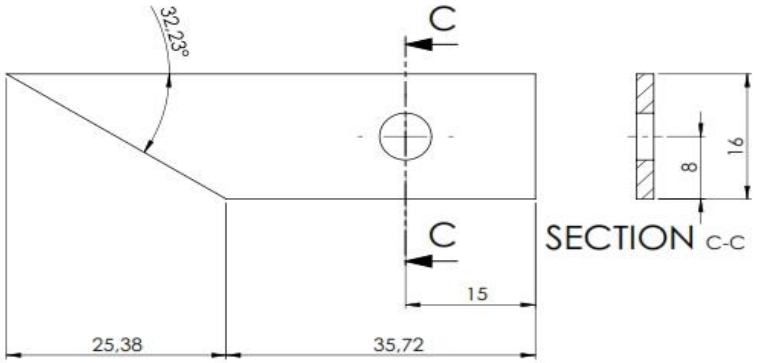
1. INNER SIDE BODY MOUNTING 1



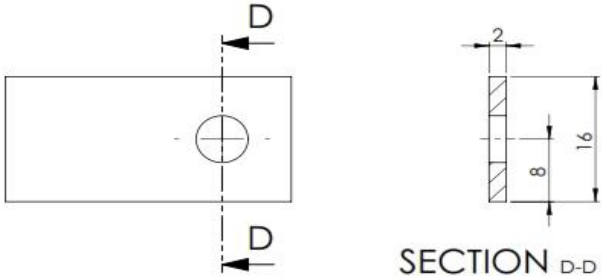
2. INNER SIDE BODY MOUNTING 2



3. INNER SIDE BODY MOUNTING 3



4. INNER SIDE BODY MOUNTING 4



	SCALE : 2 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 05-04-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$	2.06
System	Frame and Body	FileLink1				**Qty**		1
Assembly	Frame	**FileLink2**		**FileLink1**				
Part	Battery Seat Bracket	**FileLink3**		**FileLink2**		**Extended Cost**	$	2.06
P/N Base	00077			**FileLink3**				
Suffix	AA							
Details	Bracket for Battery Seat							

ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Baterry Seat Bracket	$ 2.25	0.03	kg			Rectangular	21.60	0.20	0.00785	1	$ 0.08
												Sub Total	**$ 0.076**

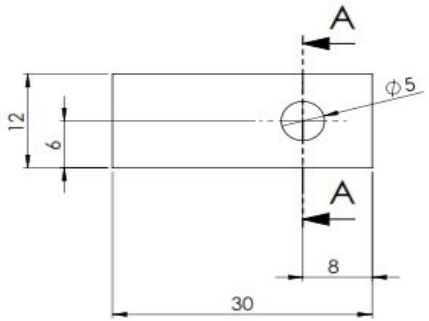
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material for Baterry Seat Bracket	$ 0.20	cm	1.6	Repeat 4	4	$ 1.28
20	Drilled holes < 25.4 mm dia.	Drilling for Baterry Seat Bracket hole	$ 0.35	hole	4			$ 0.70
							Sub Total	**$ 1.98**

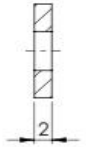
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR - A0009 - 00077	Battery Seat Bracket	Bracket for Battery Seat	1

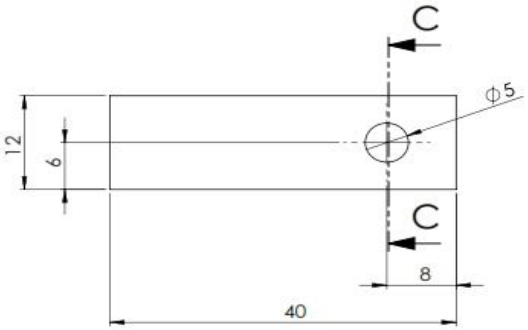
1. BATTERY SEAT BRACKET 1

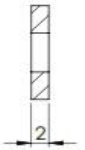




SECTION A-A
SCALE 2 : 1

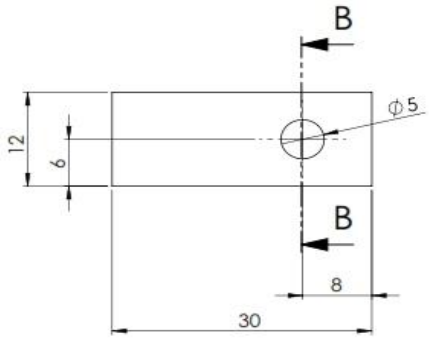
3. BATTERY SEAT BRACKET 3

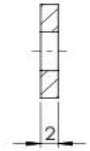




SECTION C-C
SCALE 2 : 1

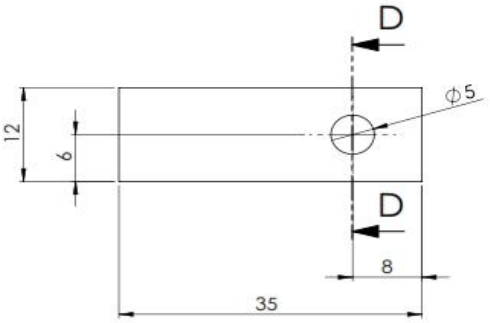
2. BATTERY SEAT BRACKET 2

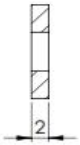




SECTION B-B
SCALE 2 : 1

4. BATTERY SEAT BRACKET 4





SECTION D-D
SCALE 2 : 1

	SCALE : 2 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 05-04-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 1.39
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Fuel Tank Mounting Support	**FileLink3**		**FileLink2**		**Extended Cost**	$ 1.39
P/N Base	00078			**FileLink3**			
Suffix	BA						
Details	Support for Fuel Tank Mounting						

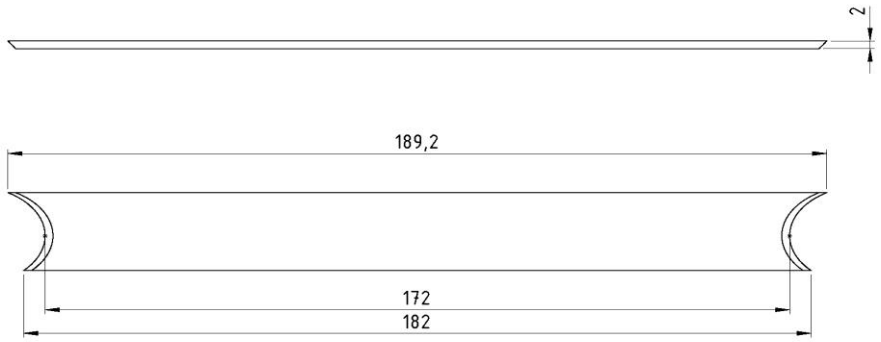
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Fuel Tank Mounting Support	$ 2.25	0.053	kg			Rectangular	34.00	0.20	0.00785	1	$ 0.12
												Sub Total	**$ 0.120**

ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet metal shearing	Cutting material for Fuel Tank Mounting Support	$ 0.25	cut	1			$ 0.25
20	Sheet Metal Saw Cut	Hole sawing for welding side	$ 0.20	cm	2.54	Repeat 2	2	$ 1.02
							Sub Total	**$ 1.27**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	*COMPONENT*	DESCRIPTION	QTY.
1	FR-A0008-00078	Fuel Tank Mounting Support	Support for Fuel Tank Mounting	1



	SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : -	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 2.39
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Regulator Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 2.39
P/N Base	00079			**FileLink3**			
Suffix	AA						
Details	Mounting for Regulator						

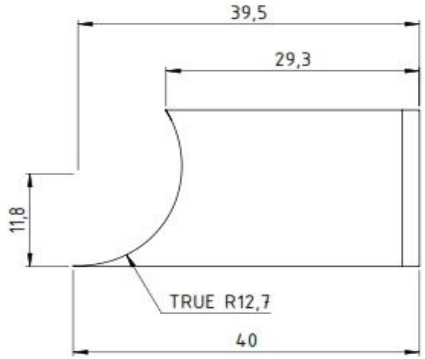
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Regulator Mounting	$ 2.25	0.03	kg			Rectangular	10.68	0.20	0.00785	1	$ 0.04
												Sub Total	**$ 0.038**

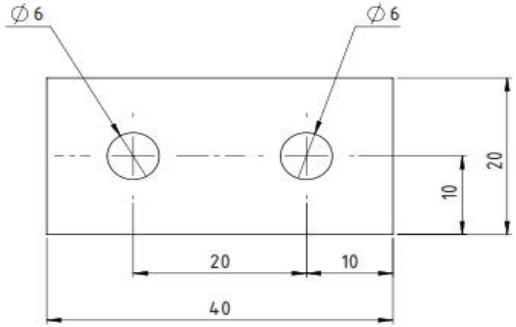
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material for Regulator Mounting	$ 0.20	cm	1.6	Repeat 2	2	$ 0.64
20	Drilled holes < 25.4 mm dia.	Drilling for Regulator Mounting hole	$ 0.35	hole	2			$ 0.70
30	Sheet Metal Saw Cut	Hole sawing for welding side	$ 0.20	cm	2.54	Repeat 2	2	$ 1.02
							Sub Total	**$ 2.36**

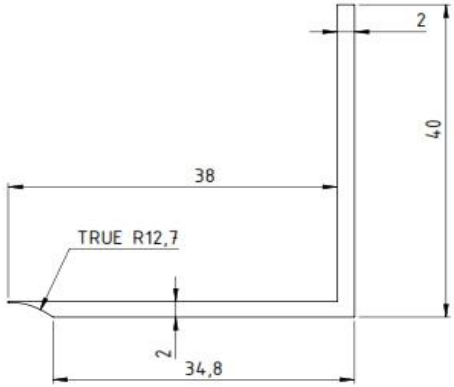
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

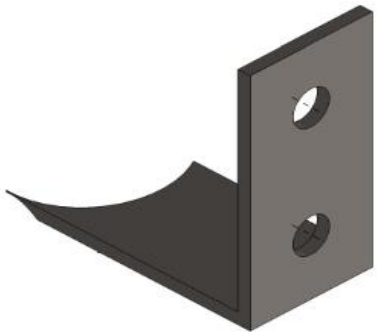
ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00079	Regulator Mounting	Mounting for Regulator	1









Allowable deviations for dimensions without tolerance indication (machined surfaces)

SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:
UNIT : MM	CHECK : ZN, TP	
DATE : 12-05-2016	APPROVE : -	

FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 2.41
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Ignition Coil Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 2.41
P/N Base	00080			**FileLink3**			
Suffix	AA						
Details	Mounting for Ignition Coil						

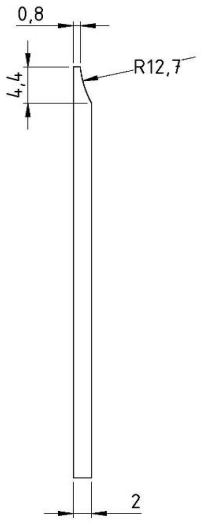
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Ignition Coil Mounting	$ 2.25	0.03	kg			Rectangular	14.43	0.20	0.00785	1	$ 0.05
												Sub Total	**$ 0.051**

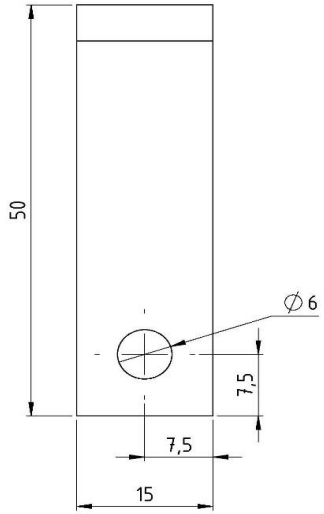
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material for Ignition Coil Mounting	$ 0.20	cm	1.6	Repeat 2	2	$ 0.64
20	Drilled holes < 25.4 mm dia.	Drilling for Ignition Coil Mounting hole	$ 0.35	hole	2			$ 0.70
30	Sheet Metal Saw Cut	Hole sawing for welding side	$ 0.20	cm	2.54	Repeat 2	2	$ 1.02
							Sub Total	**$ 2.36**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00080	Ignition Coil Mounting	Mounting for Ignition Coil	1





Corresponding symbols		▽	▼	▽▽	▼▼	▽▽▽	▼▼▼	
Roughness Classes (NBN 88-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4
Roughness Value "Ra" in µm (NBN 88-02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2

Allowable deviations for dimensions without tolerance indication (machined surfaces)

Accuracyclass ISO 2768.1)	For measurements (deviations in mm) Dimensions in mm								Fillets and chamfers Dimensions in mm					Angles (in ° and ') Length of the shortest leg				
	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4.000	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	to 10	>10 to 50	>50 to 120	>120 to 400	above 400
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8	±0,2	±0,5	±1	±2	±4	±1°	±30'	±20'	±10'	±5'
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2										
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±5	±0,4	±1	±2	±4	±8	±1°30'	±1°	±30'	±15'	±10'
v Very Rough	-	±0,5	±1	±1,5	±2,5	±4	±6	±8						±3°	±2°	±1°	±30'	±20'

SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 3.98
System	Frame and Body	FileLink1				**Qty**	4
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Rear Bulkhead Adapter	**FileLink3**		**FileLink2**		**Extended Cost**	$ 15.93
P/N Base	00081			**FileLink3**			
Suffix	AA						
Details	Adapter for Rear Bulkhead						

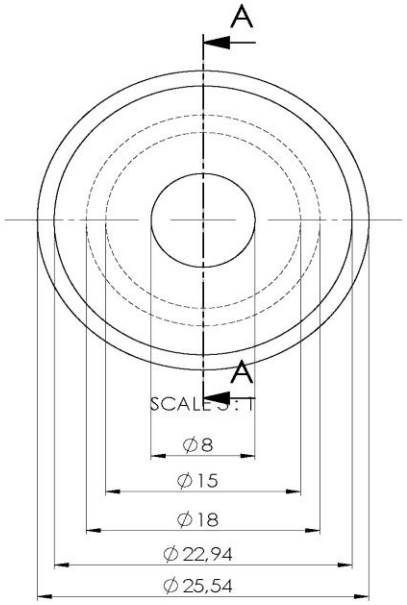
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Rear Bulkhead Adapter	$ 2.25	0.15	kg			Circular	6.33	2.95	0.00785	1	$ 0.33
												Sub Total	**$ 0.330**

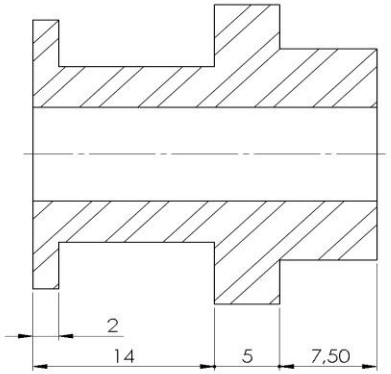
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Machining Setup, Install and remove	Setting machine and material	$ 1.30	unit	1			$ 1.30
20	Machining	Facing and contouring	$ 0.04	cm^3	4.4	Material - Steel	3	$ 0.53
30	Drilled holes < 25.4 mm dia.	Drilling for adapter holes	$ 0.35	hole	1			$ 0.35
40	Machining Setup, Change	Setting material position	$ 0.65	unit	1			$ 0.65
50	Machining	Facing and contouring	$ 0.04	cm^3	6.87	Material - Steel	3	$ 0.82
							Sub Total	**$ 3.65**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR - A0009 - 00081	Rear Bulkhead Adapter	Adapter for Rear Bulkhead	1





SECTION A-A

SCALE 3 : 1

SCALE : 3 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 05-04-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$ 0.97
System	Frame and Body	FileLink1				**Qty**	1
Assembly	Frame	**FileLink2**		**FileLink1**			
Part	Plenum Holder Mounting	**FileLink3**		**FileLink2**		**Extended Cost**	$ 0.97
P/N Base	00082			**FileLink3**			
Suffix	BA						
Details	Mounting for Plenum Holder						

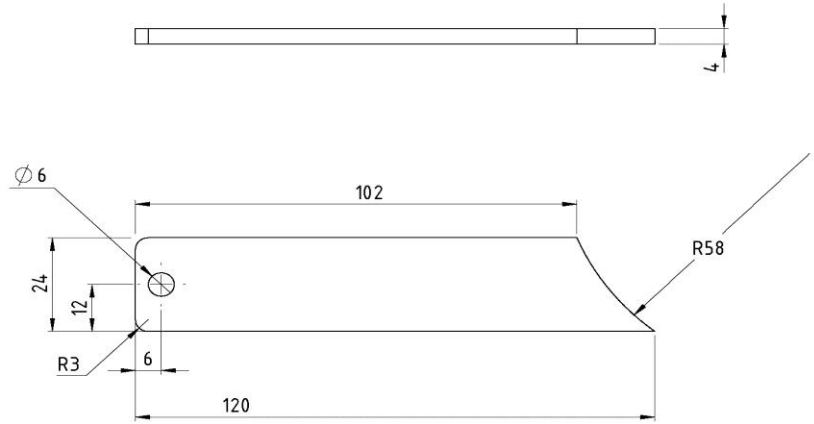
ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Plenum Holder Mounting	$ 2.25	0.07	kg			Circular	31.92	0.30	0.00785	1	$ 0.17
												Sub Total	**$ 0.169**

ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Shearing	Shearing material for Plenum Holder Mounting	$ 0.25	cut	1			$ 0.25
20	Drilled holes < 25.4 mm dia.	Drilling for Plenum Holder Mounting	$ 0.35	hole	1			$ 0.35
30	Hand Finish - Material Removal	Filleting material	$ 0.20	cm^3	1			$ 0.20
							Sub Total	**$ 0.80**

ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncId	Sub Total
							Sub Total	**$ -**

ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0008-00082	Plenum Holder Mounting	Mounting for Plenum Holder	1



SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:	
UNIT : MM	CHECK : ZN, TP		
DATE : 12-05-2016	APPROVE : -		
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

University	Universitas Negeri Yogyakarta			**Car #**	29	**Part Cost**	$	2.37
System	Frame and Body	FileLink1				**Qty**		1
Assembly	Frame	**FileLink2**		**FileLink1**				
Part	Capacitor Bank Bracket	**FileLink3**		**FileLink2**		**Extended Cost**	$	2.37
P/N Base	00083			**FileLink3**				
Suffix	AA							
Details	Bracket for capacitor bank							

ItemOrder	Material	Use	UnitCost	Size1	Unit1	Size2	Unit2	Area Name	Area	Length	Density	Quantity	Sub Total
10	Steel, Alloy	Material for Capacitor Bank Bracket	$ 2.25	0.03	kg			Rectangular	14.74	0.20	0.00785	1	$ 0.05
												Sub Total	**$ 0.052**

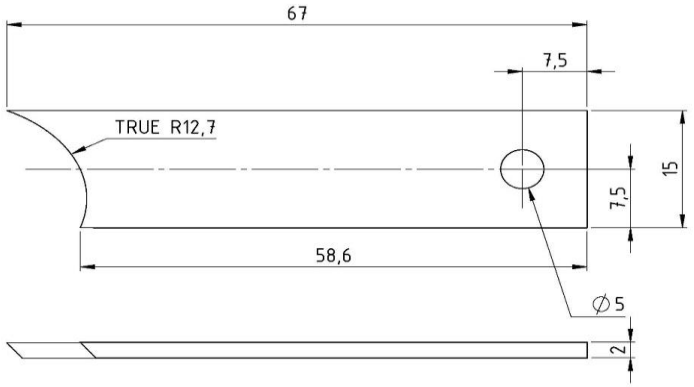
ItemOrder	Process	Use	UnitCost	Unit	Quantity	Multiplier	Mult. Val.	Sub Total
10	Sheet Metal Saw Cut	Cutting material for Capacitor Bank Bracket	$ 0.20	cm	1.5	Repeat 2	2	$ 0.60
20	Drilled holes < 25.4 mm dia.	Drilling for Capacitor Bank Bracket hole	$ 0.35	hole	2			$ 0.70
30	Sheet Metal Saw Cut	Hole sawing for welding side	$ 0.20	cm	2.54	Repeat 2	2	$ 1.02
							Sub Total	**$ 2.32**

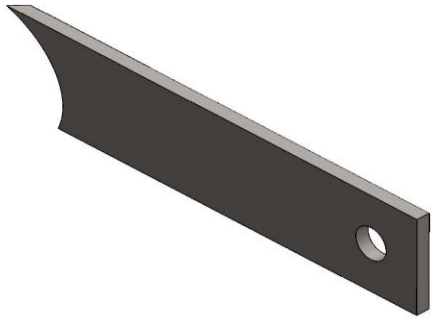
ItemOrder	Fastener	Use	UnitCost	Size1	Unit1	Size2		Quantity	Sub Total
									$ -
								Sub Total	**$ -**

ItemOrder	Tooling	Use	UnitCost	Unit	Quantity	PVF	FracIncld	Sub Total
							Sub Total	**$ -**

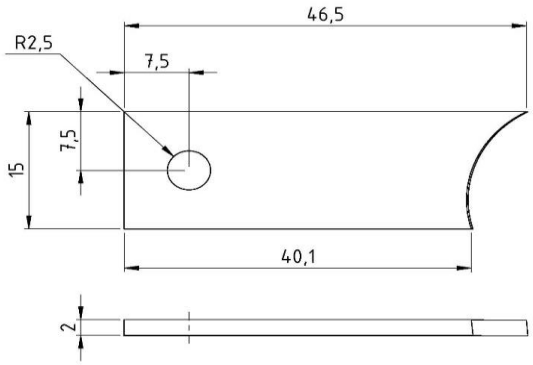
ITEM NO.	PART NUMBER	COMPONENT	DESCRIPTION	QTY.
1	FR-A0009-00053	Capacitor Bank Bracket	Bracket for Capacitor Bank	1

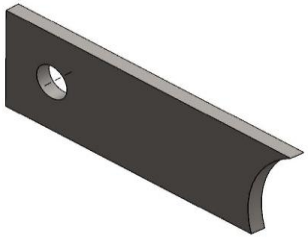
Capacitor Bank Baracket-LH





Capacitor Bank Baracket-RH





Corresponding symbols									
Roughness Classes (NBN 88-02) (ISO 1302)	N11	N10	N9	N8	N7	N6	N5	N4	
Roughness Value "Ra" in µm (NBN 88-02) (ISO 1302)	25	12,5	6,3	3,2	1,6	0,8	0,4	0,2	

Allowable deviations for dimensions without tolerance indication (machined surfaces)

For measurements (deviations in mm)

Accuracyclass ISO 2768/1	Dimensions in mm							
	0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	>400 to 1000	>1000 to 2000	>2000 to 4000
f Fine	±0,05	±0,05	±0,1	±0,15	±0,2	±0,3	±0,5	±0,8
m Medium	±0,1	±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2
c Rough	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±4
v Very Rough	–	±0,5	±1	±1,5	±2,5	±4	±6	±8

Fillets and chamfers

Dimensions in mm					
0,5 to 3	>3 to 6	>6 to 30	>30 to 120	>120 to 400	
±0,2	±0,5	±1	±2	±4	
±0,4	±1	±2	±4	±8	

Angles (in ° and ')

Lengths of the shortest leg				
up to 10	>10 to 50	>50 to 120	>120 to 400	above 400
±1°	±10'	±20'	±10'	±5'
±1°30'	±1°	±30'	±15'	±10'
±3°	±2°	±1°	±30'	±20'

	SCALE : 1 : 1	DRAWN : DESIGNER TEAM	NOTE:
	UNIT : MM	CHECK : ZN, TP	
	DATE : 12-05-2016	APPROVE : –	
FACULTY OF ENGINEERING YOGYAKARTA STATE UNIVERSITY	FRAME	NO:01/GURT	A3

Lampiran 6

University	Universitas Negeri Yogyakarta
Competition Code	SFJ
Year	2016
Car #	29

Total Vehicle Cost	16971.81

Line Num.	Area of Commodity	Asm/Prt #	Rev. Lvl.	Asm	Component	Description	Unit Cost	Quantity	Material Cost	Process Cost	Fastener Cost	Tooling Cost	Total Cost	Details Page Number
1	Brake System	A0001	AA		Brake Rotor	Iron Brake Rotor	30.39	4	$ 2.456	$ 27.55	$ 0.38		121.54	1
2	Brake System	A0002	AA		Brake Fluid	Brake Fluid	0.30	1	$ 0.30				0.30	4
3	Brake System	A0003	AB		Brake Line	Brake Line Assembly	42.50	1		$ 41.62	$ 0.88		42.50	5
4	Brake System	00001	AA	Brake Line	Brake Line - Flexible	Flexible Hose for Brake Line	35.32	1	$ 35.32				35.32	6
5	Brake System	00002	AA	Brake Line	Fittings	Fitting for Brake Line	18.76	1	$ 18.76				18.76	7
6	Brake System	A0004	AA		Brake Master Cylinder	Brake Master Cylinder Assembly	15.12	2		$ 11.04	$ 4.08		30.24	8
7	Brake System	00003	AA	Brake Master Cylinder	Brake Master Cylinder	Brake Master Cylinder	33.50	2	$ 33.50				67.00	9
8	Brake System	00004	AA	Brake Master Cylinder	Brake Fluid Reservoir	Reservoir for Brake Master Cylinder	5.00	2	$ 5.00				10.00	11
9	Brake System	00005	AA	Brake Master Cylinder	Reservoir hose	Flexible Hose to Reservoir	0.32	2	$ 0.32				0.64	14
10	Brake System	A0005	AA		Caliper	Student Purchase Caliper	0.96	4		$ 0.64	$ 0.32		3.84	16
11	Brake System	00006	AA	Caliper	Brake Caliper	Willwood PS-1 Caliper	46.00	4	$ 46.00				184.00	19
12	Brake System	00007	AA	Caliper	Brake Pads	Willwood Brake Pad	0.25	8	$ 0.25				1.97	22
13	Brake System	A0006	AA		Balance Bar	Brake Balance bar	2.57	1	$ 0.10	$ 2.40	$ 0.07		2.57	25
	Brake System				Area Total				327.91	178.86	11.91	0.00	518.68	
14	Engine & Drivetrain	A0001	AA		Engine	Husqvarna SM630 Engine	1,225.70	1	1200	8.01	17.69		1225.70	28
15	Engine & Drivetrain	A0002	AB		Exhaust Header	Exhaust header Assembly	5.93	1		5.72	0.21		5.93	31
16	Engine & Drivetrain	00001	AB	Exhaust Header	Exhaust Header	Student Made Header	100.49	1	4.348	95.64		0.5	100.49	33
17	Engine & Drivetrain	00002	AA	Exhaust Header	Exhaust Flange	Flange for Header	3.59	2	0.606	2.98			7.17	35
18	Engine & Drivetrain	A0003	BA		Muffler	Student Purchased Muffler	9.68	1	2	7.56	0.12		9.68	38
19	Engine & Drivetrain	00003	BA	Muffler	Muffler Body	FMF Muffler Body	55.01	1	3.422	51.02	0.24	0.33	55.01	40
20	Engine & Drivetrain	00004	AA	Muffler	Muffler Silincer	Muffler Silincer	6.51	1	1.139	5.2		0.17	6.51	42
21	Engine & Drivetrain	00005	BA	Muffler	Muffler Tab and Mounting	Tab fot mounting	7.26	1	2.826	4.43			7.26	43
22	Engine & Drivetrain	00006	AA	Muffler	Muffler Divertor Adapter	Student Build Divertor Adapter	6.26	1	0.713	5.55			6.26	45
23	Engine & Drivetrain	00007	BA	Muffler	Muffler Divertor	Student Build Divertor	21.29	1	0.388	20.57		0.333	21.29	47
24	Engine & Drivetrain	00008	AA	Muffler	DB Killer	DB killer on Muffler	3.65	1	2.171	1.48			3.65	49
25	Engine & Drivetrain	A0004	BA		Resonator	Student Made Resonator	18.86	1		18.53		0.33	18.86	52
26	Engine & Drivetrain	00009	BA	Resonator	Inner Pipe	Inner Pipe In Resonator	32.41	1	0.053	32.03		0.33	32.41	54
27	Engine & Drivetrain	00010	AA	Resonator	Sound Insulator	Sound Insulator In Resonator	7.14	1	7.14				7.14	56
28	Engine & Drivetrain	00011	BA	Resonator	End Housing	End Resonator Housing	59.81	1	2.488	56.99		0.33	59.81	57
29	Engine & Drivetrain	00012	BA	Resonator	Middle Housing	Middle Resonator Housing	9.21	1	2.651	6.23		0.33	9.21	59
30	Engine & Drivetrain	A0005	AA		Air Filter	Student Purchase Air Filter	61.06	1	58.904	1.38	0.78		61.06	61
31	Engine & Drivetrain	A0006	AA		Throttle Body	AT Power Throttle Body	6.68	1	0.6	5.95	0.13		6.68	63
32	Engine & Drivetrain	00013	AA	Throttle Body	Throttle Body Bellmouth	Bellmouth on Throttle Body	13.18	1	2.217	10.96			13.18	66
33	Engine & Drivetrain	00014	AA	Throttle Body	Valve Housing	Housing for Valve Mount	9.62	1	0.382	9.24			9.62	68
34	Engine & Drivetrain	00015	AA	Throttle Body	Throttle Valve	Throtte Valve AT Power	8.01	1	0.198	7.81			8.01	70
35	Engine & Drivetrain	00016	AA	Throttle Body	Valve Actuator	Actuator for Valve	2.17	1	0.034	2.14			2.17	71
36	Engine & Drivetrain	00017	AA	Throttle Body	Restrictor	Intake Restrictor	4.45	1	0.863	3.59			4.45	73
37	Engine & Drivetrain	00018	AA	Throttle Body	Throttle Body Flange	Flange for Throttle Body	5.01	1	0.377	4.63			5.01	75
38	Engine & Drivetrain	00019	AA	Throttle Body	Torsion Spring	Spring for Throttle	1.00	1	1				1.00	77
39	Engine & Drivetrain	00020	AA	Throttle Body	Tension Spring	Spring for Throttle	1.00	1	1				1.00	78
40	Engine & Drivetrain	00021	AA	Throttle Body	Throttle cap end	End Cap at Throttle	2.99	1	0.084	2.91			2.99	79
41	Engine & Drivetrain	A0007	BA		Intake Manifold	Student Made Intake Manifold	29.28	1		27.75	1.2	0.33	29.28	81
42	Engine & Drivetrain	00022	BA	Intake Manifold	Plenum	Student Made Intake Plenum	178.45	1	138	39.88		0.573	178.45	83
43	Engine & Drivetrain	00023	BA	Intake Manifold	Plenum Bellmouth	Aluminum Bellmouth	61.04	1	9.646	51.06		0.33	61.04	85
44	Engine & Drivetrain	00024	BA	Intake Manifold	Intake Runner	Student Made Intake Runner	14.91	1	2.562	12.35			14.91	89
45	Engine & Drivetrain	00025	AA	Intake Manifold	Intake Manifold	Rubber Intake Manifold	7.14	1	0.33	0.14		6.67	7.14	91
46	Engine & Drivetrain	00026	BA	Intake Manifold	Intake Runner Holder	Metal Holder for Intake Runner	4.35	1	0.349	3.67		0.33	4.35	93
47	Engine & Drivetrain	00027	AA	Intake Manifold	Intake runner Spring	Spring for Intake Runner	3.00	1	3				3.00	95
48	Engine & Drivetrain	00028	BA	Intake Manifold	Plenum Holder	Holder for Plenum	2.30	1	0.148	2.15			2.30	96
49	Engine & Drivetrain	A0008	BA		Engine Mount	Student Made Engine Mounting	15.11	1		10.35	4.76		15.11	98
50	Engine & Drivetrain	00029	AA	Engine Mount	Front Engine Mount	Adapter from Engine and Chassis	7.46	2	0.863	6.6			14.93	99
51	Engine & Drivetrain	00030	BA	Engine Mount	Rear Engine Mounting - RH	Engine Mounting Right Hand	13.46	1	2.791	10.67			13.46	102
52	Engine & Drivetrain	00031	BA	Engine Mount	Rear Engine Mounting - LH	Engine Mounting Left Hand	13.46	1	2.791	10.67			13.46	105
53	Engine & Drivetrain	00032	BA	Engine Mount	Bushing, Student Built	Rubber Bhusing	7.98	6	0.066	7.91			47.86	108
54	Engine & Drivetrain	A0009	AA		Fuel Injector	Gasoline Fuel Injector	10.74	1	10.1	0.64			10.74	109
55	Engine & Drivetrain	A0010	BA		Fuel Tank	Fuel Tank Assembly	34.31	1		32.56	0.08	1.67	34.31	110
56	Engine & Drivetrain	00033	BA	Fuel Tank	Fuel Tank Body	Main Body of Fuel Tank	18.43	1	8.179	10.25			18.43	113
57	Engine & Drivetrain	00034	AA	Fuel Tank	Fuel Tank Sparator	Fuel Tank Sparator	4.09	1	0.337	3.75			4.09	116
58	Engine & Drivetrain	00035	AA	Fuel Tank	Drain Plug	Drain Plug for Fuel Tank	7.33	1	1.517	5.81			7.33	118

Line Num.	Area of Commodity	Asm/Prt #	Rev. Lvl.	Asm	Component	Description	Unit Cost	Quantity	Material Cost	Process Cost	Fastener Cost	Tooling Cost	Total Cost	Details Page Number
59	Engine & Drivetrain	00036	AA	Fuel Tank	Filler Neck	Tube Filler Neck	6.27	1	2.04	4.23			6.27	120
60	Engine & Drivetrain	00037	AA	Fuel Tank	Filler Neck Bung	Bung for Fuel Tank Cap	3.86	1	1.571	2.29			3.86	123
61	Engine & Drivetrain	00038	AA	Fuel Tank	Fuel Tank Cap	Student Purchase Fuel Tank Cap	12.62	1	4.2	8.42			12.62	124
62	Engine & Drivetrain	00039	AA	Fuel Tank	Fuel Check Valve	Student Purchase Check Valve	9.80	1	9.8				9.80	126
63	Engine & Drivetrain	00040	AA	Fuel Tank	Sight Glass	Transparant Hose	7.00	1	7				7.00	128
64	Engine & Drivetrain	00041	AA	Fuel Tank	Sight Glass Adapter	Adapter for Sight Glass	5.70	1	0.039	5.33		0.33	5.70	130
65	Engine & Drivetrain	00042	AA	Fuel Tank	Fuel Tank Mounting	Mounting for Fuel Tank	6.39	1	3.74	2.65			6.39	132
66	Engine & Drivetrain	00043		Fuel Tank	Fuel Pump Hose Adapter	Fuel Pump Hose Adapter on Fuel Tank	7.95	1	0.04	7.58		0.33	7.95	135
67	Engine & Drivetrain	A0011	AA		Belly Pan	Aluminum Belly Pan	7.72	1	0.943	6.45		0.33	7.72	137
68	Engine & Drivetrain	A0012	AA		Fuel Pump	Student Purchase Fuel Pump	41.78	1	35	6.52	0.26		41.78	140
69	Engine & Drivetrain	A0013	AA		Fuel Pressure Regulator	Student Purchase Fuel Pressure Regulator	17.35	1	15	2.32	0.0254		17.35	142
70	Engine & Drivetrain	A0014	AA		Fuel Filter	Student Purchase Fuel Filter	8.00	1	8				8.00	144
71	Engine & Drivetrain	A0015	AA		Fuel Lines	Complete Fuel Line Assembly	21.39	1		21.39			21.39	146
72	Engine & Drivetrain	00044	AA	Fuel Lines	Flexible Hose	All Flexible Hose in Fuel Line	49.31	1	48.64	0.67			49.31	148
73	Engine & Drivetrain	00045	AA	Fuel Lines	Fitting	All Fitting in Fuel Line	164.74	1	164.74				164.74	149
74	Engine & Drivetrain	A0016	AA		Fuel Rail	Student Made Fuel Rail	5.99	1	0.721	5.13	0.14		5.99	151
75	Engine & Drivetrain	A0017	BA		Radiator	Radiator Assembly	2.57	1		2.4		0.17	2.57	154
76	Engine & Drivetrain	00046	BA	Radiator	Engine Radiator	Radiator	-	1	13.043	23.65		0.33	0.00	157
77	Engine & Drivetrain	00047	BA	Radiator	Shroud	Aluminum Shroud	56.65	1	6.214	49.77		0.67	56.65	160
78	Engine & Drivetrain	A0018	AA		Coolant	Engine Coolant	12.00	1	0.0004	12			12.00	162
79	Engine & Drivetrain	A0019	AA		Cooling Additional Bottle	Cooling Additional Bottle	2.23	1		1.81	0.42		2.23	163
80	Engine & Drivetrain	00048	AA	Cooling Additional Bottle	Cooling Additional Bottle	Cooling Additional Bottle	45.02	1	2.213	41.81		1	45.02	165
81	Engine & Drivetrain	00049	AA	Cooling Additional Bottle	Cooling Additional Bottle Clamp	Clamp for Bottle	5.38	1	2.426	2.95			5.38	168
82	Engine & Drivetrain	A0020	BA		Coolant Overflow Bottle	Coolant Overflow Bottle Assy	12.37	1		9.74	2.63		12.37	170
83	Engine & Drivetrain	00050	AA	Coolant Overflow Bottles	Overflow Bottle	Main Bottle	15.14	1	1.455	13.02		0.667	15.14	172
84	Engine & Drivetrain	00051	AA	Coolant Overflow Bottles	Flexible Hose	Hose for Bottle	6.84	1	6.84				6.84	175
85	Engine & Drivetrain	00052	BA	Coolant Overflow Bottles	Overflow Bottle Clamp	Clamp for Overflow Bottle	2.24	2	0.036	2.2			4.47	176
86	Engine & Drivetrain	A0021	AA		Coolant Line	Coolant Line Assembly	10.00	1		6	4		10.00	178
87	Engine & Drivetrain	00053	AA	Coolant Lines	Y Connector	Aluminum Y Connector	14.42	1	0.944	12.98		0.5	14.42	179
88	Engine & Drivetrain	00054	AA	Coolant Lines	Cooling Hose	Hose for Cooling Line	5.33	1	4.57	0.76			5.33	182
89	Engine & Drivetrain	A0022	AA		Radiator Fan	Electric Fan for Radiator	30.12	1	30		0.12		30.12	184
90	Engine & Drivetrain	A0023	AA		Chain	Drivetrain Chain	46.71	1	46.4	0.31			46.71	186
91	Engine & Drivetrain	A0024	AA		Half-Axle - RH	Drivetrain Wheel Axle Right Hand	52.32	1	12.256	39.94	0.12		52.32	188
92	Engine & Drivetrain	A0025	AA		Half-Axle - LH	Drivetrain Wheel Axle Left Hand	47.90	1	12.256	35.52	0.12		47.90	191
93	Engine & Drivetrain	A0026	AA		Differential Bearing Carrier - LH	Aluminum Bearing Carier Assy Left Hand	8.35	1		7.51	0.84		8.35	194
94	Engine & Drivetrain	00055	AA	Differential Bearing Carrier - LH	Differential Bearing Carrier Mount - LH	Student Build Bearing Carrier Mount Left Hand	16.39	1	2.216	14.17			16.39	196
95	Engine & Drivetrain	00056	AA	Differential Bearing Carrier - LH	Differential Bearing Carrier Cap - LH	Bearing Carrier Cap Left Hand	18.49	1	2.632	15.86			18.49	199
96	Engine & Drivetrain	00057	AA	Differential Bearing Carrier - LH	Differential Adjuster and Bearing Housing - LH	Chain Tension Adjuster	25.78	1	2.993	22.79			25.78	202
97	Engine & Drivetrain	A0027	AA		Differential Bearing Carrier - RH	Aluminum Bearing Carier Assy Right Hand	8.35	1		7.51	0.84		8.35	205
98	Engine & Drivetrain	00058	AA	Differential Bearing Carrier - RH	Differential Bearing Carrier Mount - RH	Student Build Bearing Carrier Mount Right Hand	16.39	1	2.216	14.17			16.39	207
99	Engine & Drivetrain	00059	AA	Differential Bearing Carrier - RH	Differential Bearing Carrier Cap - RH	Bearing Carrier Cap Righ Hand	18.49	1	2.632	15.86			18.49	210
100	Engine & Drivetrain	00060	AA	Differential Bearing Carrier - RH	Differential Adjuster and Bearing Housing - RH	Chain Tension Adjuster	25.78	1	2.993	22.79			25.78	213
101	Engine & Drivetrain	A0028	AA		Sprocket	Drivetrain Sprocket	12.84	1		11.04	1.8		12.84	216
102	Engine & Drivetrain	00061	AA	Sprocket	Front Sprocket	Front Engine Sprocket	15.15	1	2.48	12.67			15.15	217
103	Engine & Drivetrain	00062	AA	Sprocket	Rear Sprocket	Aluminum Rear Sprocket	25.51	1	3.986	21.52			25.51	220
104	Engine & Drivetrain	00063	AA	Sprocket	Rear Sprocket Adapter	Adapter for Rear Sprocket	37.07	1	9.921	27.15			37.07	223
105	Engine & Drivetrain	A0029	AA		Differential	Drexler Differential Assy	21.63	1		19.5	2.13		21.63	226
106	Engine & Drivetrain	00064	AA	Differential	Differential Internal	Limited Slip Differential	110.00	1	110				110.00	229
107	Engine & Drivetrain	00065	AA	Differential	Differential End Cap -LH	End Cap Housing Differential Left Hand	27.29	1	5.53	21.76			27.29	230
108	Engine & Drivetrain	00066	AA	Differential	Differential End Cap - RH	End Cap Housing Differential Right Hand	28.09	1	5.376	22.71			28.09	232
109	Engine & Drivetrain	00067	AA	Differential	Differential Housing	Drexler Differential Housing	35.38	1	6.363	29.02			35.38	234
110	Engine & Drivetrain	A0030	AA		CV Joint - LH	Complete CV Joint Assembly Left Hand	2.01	1		1.57	0.44		2.01	236
111	Engine & Drivetrain	00068	AA	CV Joint	CV Joint, Tripod - LH	Tripod Joint Type for Drivetrain	45.00	1	45				45.00	237
112	Engine & Drivetrain	00069	AA	CV Joint	CV Joint, Housing - LH	Student Made Housing	106.10	1	15.577	90.52			106.10	239
113	Engine & Drivetrain	00070	AA	CV Joint	CV Joint Boot - LH	Boot for CV Joint	5.00	1	5				5.00	242
114	Engine & Drivetrain	A0031	AA		CV Joint - RH	Complete CV Joint Assembly Right Hand	2.01	1		1.57	0.44		2.01	245
115	Engine & Drivetrain	00071	AA	CV Joint	CV Joint, Tripod - RH	Tripod Joint Type for Drivetrain	45.00	1	45				45.00	246
116	Engine & Drivetrain	00072	AA	CV Joint	CV Joint, Housing - RH	Student Made Housing	90.10	1	12.745	77.35			90.10	248
117	Engine & Drivetrain	00073	AA	CV Joint	CV Joint Boot -RH	Boot for CV Joint	5.00	1	5				5.00	251
118	Engine & Drivetrain	A0032	BA		Scatter Shield	Student Made Scatter Shield	20.84	1	2.852	10.5	0.49	7	20.84	254
119	Engine & Drivetrain	A0033	AA		Engine Oil	Oil for Engine	9.50	1	1.5	8			9.50	258
120	Engine & Drivetrain	A0034	AA		Differential Oil	Oil for Differential	0.29	1	0.045	0.24			0.29	259
121	Engine & Drivetrain	A0035	BA		Oil Catch Tank	Engine oil catch tank	11.79	1		9.74	2.05		11.79	260
122	Engine & Drivetrain	00074	AA	Oil Catch Tank	Oil Catch Tank Body	Aluminum Oil Catch Tank	15.27	1	1.455	13.15		0.667	15.27	262
123	Engine & Drivetrain	00075	AA	Oil Catch Tank	Oil Catch Tank Hose	Hose for Catch Tank	4.58	1	4.583				4.58	265
124	Engine & Drivetrain	00076	BA	Oil Catch Tank	Oil Catch Tank Clamp	Clamp for Catch Tank	1.31	2	0.105	1.2			2.61	266

Line Num.	Area of Commodity	Asm/Prt #	Rev. Lvl.	Asm	Component	Description	Unit Cost	Quantity	Material Cost	Process Cost	Fastener Cost	Tooling Cost	Total Cost	Details Page Number
125	Engine & Drivetrain	A0036	AA		Differential Bearing Carrier Stabilizer	Differential Bearing Carrier Stabilizer Assy	15.85	1	0.1	15.2178	0.2	0.33	15.85	268
126	Engine & Drivetrain	00077		Differential Bearing Carrier Stabilizer	Differential Bearing Carrier Stabilizer Shaft	Stabilizer for Differential Bearing Carrier	0.56	1	0.114	0.45			0.56	270
127	Engine & Drivetrain	00078		Differential Bearing Carrier Stabilizer	Bolt Adapter	Adapter for bolt	2.83	2	0.052	2.78			5.66	272
128	Engine & Drivetrain	A0037	AA		Throttle Cable	Pull Cable for Throttle	48.83	1	45	3.75	0.08		48.83	274
	Engine & Drivetrain				Area Total				2216.55	1487.00	42.08	24.55	3804.06	
129	Frame & Body	A0001	AA		Impact Attenuator	Impact Attenuator Assembly	5.36	1		2.4	2.29	0.67	5.36	275
130	Frame & Body	00001	AA	Impact Attenuator	Plate Structural Impact Attenuator	Impact Attenuator Made by Student	68.59	1	7.363	60.56		0.67	68.59	278
131	Frame & Body	00002	AA	Impact Attenuator	Anti-Intrusion Plate	Aluminum Anti-Intrusion Plate	10.94	1	9.043	1.9			10.94	280
132	Frame & Body	A0002	BA		Brake Pedal	Brake Pedal Assembly	24.06	1		22.5	1.23	0.33	24.06	282
133	Frame & Body	00003	AA	Brake Pedal	Brake Pedal Lever	Lever for Brake	28.42	1	9.67	17.99	0.26	0.5	28.42	285
134	Frame & Body	00004	AA	Brake Pedal	Brake Pedal Mounting	Mount for Brake Pedal	10.08	1	4.2	5.55		0.33	10.08	288
135	Frame & Body	00005	AA	Brake Pedal	Female Rod End Clevis	Clevis to Brake Master Plunyer	3.78	2	3.78				7.56	291
136	Frame & Body	00006	AA	Brake Pedal	Brake Reservoir Mounting	Mounting for reservoir	5.93	1	0.403	5.36		0.17	5.93	293
137	Frame & Body	00007	AA	Brake Pedal	Master Cylinder Mounting	Mounting for Master Cylinder	18.61	1	3.414	14.37		0.83	18.61	296
138	Frame & Body	00008	BA	Brake Pedal	Brake Over Travel Mounting	Mounting for Brake over travel switch	3.47	1	0.501	2.97			3.47	299
139	Frame & Body	00009	AA	Brake Pedal	Brake Pedal Lever Bearing	Bearing for Brake Pedal Pivot	3.89	2	3.89				7.78	301
140	Frame & Body	00010	AA	Brake Pedal	Spacer (2 mm)	2 mm Spacer for brake pedal	1.74	2	0.035	1.7			3.47	302
141	Frame & Body	A0003	AB		Throttle Pedal	Throttle Pedal Assembly	14.81	1	1	12.25	1.56		14.81	304
142	Frame & Body	00011	AB	Throttle Pedal	Throttle Pedal Lever	Lever for Throttle	18.10	1	1.523	16.08		0.5	18.10	307
143	Frame & Body	00012	AA	Throttle Pedal	Throttle Pedal Mounting	Mount for Throttle Pedal	6.60	1	0.238	5.86		0.5	6.60	310
144	Frame & Body	00013	AA	Throttle Pedal	Pedal Bushing	Steel Bushing at Pedal Lever	0.38	2	0.03	0.35			0.76	313
145	Frame & Body	00014	AA	Throttle Pedal	Throttle Pedal Lever Bearing	Bearing for Throttle Pedal Lever	3.89	2	3.89				7.78	315
146	Frame & Body	00015	AA	Throttle Pedal	Throttle Cable Mounting	Mounting for Throttle Cable	7.16	1	0.473	6.19		0.5	7.16	316
147	Frame & Body	00016	AA	Throttle Pedal	Throttle Cable Lever	Lever for Throttle Cable	3.07	1	1.11	1.96			3.07	318
148	Frame & Body	00017	AA	Throttle Pedal	Connecting Rod	Aluminum Connecting Rod	1.25	1	0.053	1.2			1.25	320
149	Frame & Body	00018	AA	Throttle Pedal	Spacer (2 mm)	2 mm Spacer for throttle pedal	1.74	2	0.035	1.7			3.47	322
150	Frame & Body	A0004	AA		Clutch Pedal	Clutch Pedal Assembly	12.64	1		10.62	2.02		12.64	324
151	Frame & Body	00019	AA	Clutch Pedal	Clutch Pedal Lever	Lever for Clutch	18.50	1	1.625	16.2		0.67	18.50	327
152	Frame & Body	00020	AA	Clutch Pedal	Spacer (2 mm)	2 mm Spacer for clutch pedal	2.41	2	0.035	1.7		0.67	4.81	330
153	Frame & Body	00021	AA	Clutch Pedal	Clutch Pedal Clevis	Clevis for Clutch Master Cylinder Plunyer	0.81	1	0.46	0.35			0.81	332
154	Frame & Body	00022	AA	Clutch Pedal	Clutch Pedal Lever Mounting	Mounting for Pedal Lever	10.03	1	4.2	5.5		0.33	10.03	335
155	Frame & Body	00023	AA	Clutch Pedal	Clutch Master Cylinder Mounting	Mounting for Clutch Master Cylinder	20.17	1	9.345	10.32		0.5	20.17	338
156	Frame & Body	00024			Clutch Pedal Lever Bearing	Bearing for Clutch Pedal Lever	3.89	2	3.89				7.78	341
157	Frame & Body	A0005	AA		Clutch Master Cylinder	Clutch Master Cylinder Assy	4.32	1		3.63	0.69		4.32	342
158	Frame & Body	00025	AA	Clutch Master Cylinder	Clutch Master Cylinder	Student Purchase Clutch Mater Cylinder	60.00	1	60				60.00	343
159	Frame & Body	00026	AA	Clutch Master Cylinder	Clutch Slave Cylinder	Slave Cylinder for Clutch	45.00	1	45				45.00	346
160	Frame & Body	A0006	AB		Clutch line	Clutch Line Assembly	22.19	1	13.818	8.29	0.08		22.19	347
161	Frame & Body	A0007	BA		Manual Shifter	Manual Shifter all asembly	8.46	1		8.37	0.09		8.46	348
162	Frame & Body	00027	BA	Manual Shifter	Shifter Lever	manual shifter lever assembly	19.71	1	10.47	8.91		0.33	19.71	349
163	Frame & Body	00028	AA	Manual Shifter	Shifter Cable	cable shifter	30.00	1	30				30.00	351
164	Frame & Body	00029	AA	Manual Shifter	Shifter Solenoid Actuator	Actuator for Solenoid Shifter	25.00	1	25				25.00	352
165	Frame & Body	00030	AA	Manual Shifter	Rod End Cable Shifter	Rod End for Cable Shifter	3.22	1	3.22				3.22	353
166	Frame & Body	00031	BA	Manual Shifter	Shifter Manual Stick Actuator	Actuaor For Manual Stick	16.37	1	9.663	6.38		0.33	16.37	354
167	Frame & Body	A0008	AA		Frame	Tube Frame Assy	148.92	1		124.54	5.21	19.17	148.92	356
168	Frame & Body	00032	AA	Frame	Tube Frame	Student Made Tube steel Frame	483.04	1	67.88	385.49		29.67	483.04	359
169	Frame & Body	00033	AA	Frame	Front A-Arm Upper Bracket	Bracket for Front A-Arm Upper	3.72	4	0.28	3.44			14.88	361
170	Frame & Body	00034	AA	Frame	Front A-Arm Lower Bracket	Bracket for Front A-Arm Lower	3.88	4	0.32	3.56			15.52	363
171	Frame & Body	00035	AA	Frame	Rear A-Arm Steel Upper Bracket	Bracket for Rear A-Arm Upper	4.75	2	0.247	4.5			9.49	365
172	Frame & Body	00036	AA	Frame	Rear A-Arm Aluminum Upper Bracket	Bracket for Rear A-Arm Upper	7.12	2	0.851	6.27			14.24	367
173	Frame & Body	00037	AA	Frame	Rear A-Arm Steel Lower Bracket	Bracket for Rear A-Arm Lower	7.14	2	2.607	4.53			14.27	369
174	Frame & Body	00038	AA	Frame	Rear A-Arm Aluminum Lower Bracket	Bracket for Rear A-Arm Lower	7.12	2	0.851	6.27			14.24	371
175	Frame & Body	00039	AA	Frame	Front Bellcrank Bracket	Bracket for Front Bellcrank	2.28	4	0.071	2.21			9.12	373
176	Frame & Body	00040	AB	Frame	Front Suspension Mounting	Mounting for Front Suspension	3.60	4	0.085	3.51			14.38	375
177	Frame & Body	00041	AA	Frame	Rear Suspension Mounting	Mounting for Rear Suspension	4.34	2	0.134	4.21			8.69	377
178	Frame & Body	00042	AA	Frame	Pedal Box Hole Adjuster	Plate for Adjusting Pedal Box	13.08	2	0.679	12.4			26.16	379
179	Frame & Body	00043	AA	Frame	Gear Box Mounting	Plate for Adjusting Gear Box	2.69	2	0.252	2.44			5.38	381
180	Frame & Body	00044	AA	Frame	Steering Shaft Bearing Housing	Steering Shaft Bearing Housing on Frame	6.12	1	0.697	5.42			6.12	383
181	Frame & Body	00045	AA	Frame	Front Seat Belt Mounting	Mounting for Seat Belt	3.77	2		1.23	2.37	0.17	7.54	385
182	Frame & Body	00046	AA	Frame	Middle Seat Belt Mounting	Mounting for Seat Belt	3.77	2		1.23	2.37	0.17	7.54	386
183	Frame & Body	00047	AA	Frame	Rear Seat Belt Mounting	Mounting for Seat Belt	3.77	2		1.23	2.37	0.17	7.54	387
184	Frame & Body	00048	BA	Frame	Battery Seat	Seat for Battery	14.12	1	1.098	12.3	0.05	0.67	14.12	388
185	Frame & Body	00049	BA	Frame	Radiator Mounting	Mounting for Radiator	8.10	4	0.14	7.96			32.40	391
186	Frame & Body	00050	AB	Frame	Muffler Mounting	Mounting for muffler	1.47	2	0.018	1.45			2.94	394
187	Frame & Body	00051	AB	Frame	Head Rest Mounting	Mounting for Head Rest	1.76	2	0.108	1.65			3.52	396
188	Frame & Body	00052	AA	Frame	Pressure Regulator Mounting	Mounting for Pressure Regulator	2.07	1	0.063	2.01			2.07	398
189	Frame & Body	00053	AA	Frame	Shifter Solenoid Mounting	Mounting for Shifter Solenoid	2.43	1	0.118	2.31			2.43	400

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190	Frame & Body	00054	AA	Frame	Fuel Tank Mounting	Mounting for Fuel Tank	4.84	4	0.16	4.01		0.67	19.36	402
191	Frame & Body	00055	AA	Frame	Impact Attenuator Mounting	Mounting for Impact Attenuator	1.24	4	0.091	1.15			4.96	404
192	Frame & Body	00056	AA	Frame	Rear Bulkhead	Aluminum Rear Bulkhead	159.08	1	38.831	120.25			159.08	406
193	Frame & Body	00057	AA	Frame	Jacking Point	Student Made Jacking Point	0.97	1	0.594	0.38			0.97	408
194	Frame & Body	00058	AA	Frame	Jack Member	Member for Jacking Point	5.74	2	0.934	4.81			11.49	410
195	Frame & Body	00059	AA	Frame	Jacking Member Bracket	Bracket for Jack Member	4.93	4	0.526	4.4			19.70	412
196	Frame & Body	00060	AA	Frame	Firewall Bracket	Bracket for firewall	10.93	1	0.233	10.7			10.93	414
197	Frame & Body	00061	BA	Frame	Manual Shifter Mounting	Mounting for manual shifter	3.73	1	0.267	2.79		0.67	3.73	416
198	Frame & Body	00062	AA	Frame	Main switch mounting	Mounting for power switch	8.57	1	0.063	8.51			8.57	418
199	Frame & Body	00063	AA	Frame	Anti Roll Bar Mounting	Mounting for Anti Roll Bar	3.02	4	0.082	2.77		0.17	12.09	420
200	Frame & Body	00064	AA	Frame	Rear Bellcrank Bearing	Bearing for Rear Bellcrank	5.82	4	5.82				23.28	422
201	Frame & Body	00065	AA	Frame	Upper Seat Mounting	Mounting for Seat	1.01	2	0.056	0.95			2.01	423
202	Frame & Body	00066	BA	Frame	Lower Seat Mounting	Mounting for Seat	0.97	2	0.108	0.86			1.94	425
203	Frame & Body	00067	BA	Frame	Front Mounting Engine Adapter	Steel Adapter for Front Mounting Engine	5.08	2	0.503	4.58			10.17	427
204	Frame & Body	00068	BA	Frame	Bottom Engine Mounting	Mounting for Bottom Side Engine	6.54	2	0.024	6.19		0.33	13.09	429
205	Frame & Body	00069	AA	Frame	Oil Catchtank Mounting	Mounting for Oil Catchtank	2.42	2	0.062	2.36			4.84	431
206	Frame & Body	00070	AA	Frame	Cooling Additional Bottle Mounting	Mounting for Cooling Additional Bottle	1.76	1	0.045	1.71			1.76	433
207	Frame & Body	00071	AA	Frame	Overflow Bottle Mounting	Mounting for Overflow Bottle	2.42	1	0.063	2.36			2.42	435
208	Frame & Body	00072	BA	Frame	Dashboard Mounting	Mounting for Dashboard	2.52	1	0.128	2.39			2.52	437
209	Frame & Body	00073	AA	Frame	Resonator Mounting	Mounting for Resonator	0.80	1	0.018	0.78			0.80	439
210	Frame & Body	00074	AA	Frame	Diffuser Mounting	Mounting for Front, Middle and Rear Diffuser	17.46	1	0.141	17.32			17.46	441
211	Frame & Body	00075	AA	Frame	Front Side Body Mounting	Mounting for Body	1.54	1	0.043	1.5			1.54	443
212	Frame & Body	00076	AA	Frame	Inner Side Body Mounting	Mounting for Body	8.42	1	0.215	8.2			8.42	445
213	Frame & Body	00077	AA	Frame	Battery Seat Bracket	Bracket for Battery Seat	2.06	1	0.076	1.98			2.06	447
214	Frame & Body	00078	BA	Frame	Fuel Tank Mounting Support	Support for Fuel Tank Mounting	1.39	1	0.12	1.27			1.39	449
215	Frame & Body	00079	AA	Frame	Regulator Mounting	Mounting for Regulator	2.40	1	0.038	2.36			2.40	451
216	Frame & Body	00080	AA	Frame	Ignition Coil Mounting	Mounting for Ignition Coil	2.41	1	0.051	2.36			2.41	453
217	Frame & Body	00081	AA	Frame	Rear Bulkhead Adapter	Adapter for Rear Bulkhead	3.98	4	0.33	3.65			15.92	455
218	Frame & Body	00082	BA	Frame	Plenum Holder Mounting	Mounting for Plenum Holder	0.97	1	0.169	0.8			0.97	457
219	Frame & Body	00083	AA	Frame	Capacitor Bank Bracket	Bracket for Capacitor Bank	2.37	1	0.052	2.32			2.37	459
220	Frame & Body	A0009	BA		Body	Body Assembly	43.62	1		43.06	0.56		43.62	461
221	Frame & Body	00084	AA	Body	Front Side Body	Carbon Fiber Front Side Body	632.44	1	404.276	221.13		7.03	632.44	463
222	Frame & Body	00085	BA	Body	Front Side Body Cap	Cap for Pedal Box Setting	51.98	1	33.06	18.4		0.516	51.98	465
223	Frame & Body	00086	BA	Body	Side Body - RH	Carbon Fiber Right Side Body	269.92	1	138.344	128.98	0.2	2.394	269.92	467
224	Frame & Body	00087	AA	Body	Side Body - LH	Carbon Fiber Left Side Body	221.93	1	137.9	81.64		2.394	221.93	469
225	Frame & Body	00088	AA	Body	Inner Side Body - RH	Carbon Fiber Inner Right Side Body	137.90	1	87.127	49.26		1.512	137.90	471
226	Frame & Body	00089	AA	Body	Inner Side Body- LH	Carbon Fiber Inner Left Side Body	137.90	1	87.127	49.26		1.512	137.90	473
227	Frame & Body	00090	BA	Body	Elbow Body Mount	Steel Elbow Body Mount	12.14	8	0.243	11.53	0.2	0.17	97.14	475
228	Frame & Body	A0010	BA		Floor Pan	All Floor Pan	14.89	1		13.74	1.15		14.89	478
229	Frame & Body	00091	BA	Floor Pan	Pedals Floor Pan	Floor Pan for Pedal Box	5.24	1	1.354	3.81	0.08		5.24	479
230	Frame & Body	00092	BA	Floor Pan	Electric floor pan	Acrilic Floor Pan	1.44	1	0.873	0.57			1.44	481
231	Frame & Body	A0011	AA		Undertray	Undertray Assembly	19.53	1		18.6275	0.9		19.53	484
232	Frame & Body	00093	AA	Undertray	Diffuser	Student Made Diffuser	813.01	1	529	277.88		6.13	813.01	487
233	Frame & Body	00094	AA	Undertray	Pull Cable	Pull Cable for diffuser	24.00	1	24				24.00	489
234	Frame & Body	00095	AA		Bottom Cap	Cap for Looking Oil Leakage	85.24	1	64.766	14.35		6.125	85.24	490
	Frame & Body				Area Total				1950.22	2280.57	32.19	92.69	4355.67	
235	Electrical	A0001	AA		Main Wire Harness	Main Vehicle Harness	1,866.55	1	1831.9	33.65	1		1866.55	492
236	Electrical	A0002	AA		Kill Switch	Harness For Kill Switch	67.98	1	60.25	7.73			67.98	495
237	Electrical	A0003	BA		Dashboard Panel	Wiring for Dashboard Assembly	208.75	1	183	25.55	0.2		208.75	497
238	Electrical	A0004	AB		Brake Light	Brake Light Harness	22.62	1	14.2	8.34	0.08		22.62	499
239	Electrical	A0005	BA		Battery	Battery Assembly	143.12	1	140	3	0.12		143.12	501
240	Electrical	A0006	BA		Starter System	Starter System Harness	42.24	1	35.8	6.32	0.12		42.24	504
241	Electrical	A0007	AB		Rectifier	Rectifier Assembly	30.15	1	23	7.07	0.08		30.15	506
	Instruments & Wiring				Area Total				2265.15	84.59	1.52	0.00	2381.41	
242	Miscellaneous, Fit & Finish	A0001	AA		Seat	Student Made Driver Seat	432.31	1	272.727	157.353	0.34	1.89	432.31	508
243	Miscellaneous, Fit & Finish	A0002	AA		Paint - Frame	All Paint in Frame	44.38	1	29.1	15.28			44.38	511
244	Miscellaneous, Fit & Finish	A0003	AA		Paint - Body	All Paint in Body	47.97	1	17.36	30.61			47.97	512
245	Miscellaneous, Fit & Finish	A0004	BA		Fire Wall	Aluminum Firewall	49.46	1	12.684	36.02	0.76		49.46	513
246	Miscellaneous, Fit & Finish	A0005	BA		Dashboard	Acrylic Dashboard	6.13	1	1.155	4.71	0.26		6.13	515
247	Miscellaneous, Fit & Finish	A0006	AA		Roll Hoop Padding	roll hoop padding	5.34	2	4.55	0.12	0.67		10.68	517
248	Miscellaneous, Fit & Finish	A0007	BA		Heat Shield	student made heat shield	47.86	1	34.135	13.12	0.6		47.86	519
249	Miscellaneous, Fit & Finish	A0008	AA		Headrest	Student Made Headrest	48.11	1	28.37	19.453	0.29		48.11	521
250	Miscellaneous, Fit & Finish	A0009	AA		Seat Belt	Student Purchased Seat Belt	45.38	1	45	0.375			45.38	522
	Miscellaneous, Fit & Finish				Area Total				404.63	276.79	3.59	1.89	732.27	
251	Steering System	A0001	AA		Steering Wheel	Steering Wheel Assembly	3.16	1		2.95	0.21		3.16	523
252	Steering System	00001	AA	Steering Wheel	Steering Wheel Frame	Carbon Fiber Steering wheel Frame	136.58	1	82	54.58			136.58	526

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253	Steering System	00002	AA	Steering Wheel	Steering Wheel Hand-Grip	Rubber for Steering Wheel	3.37	1	0.315	3.05			3.37	529
254	Steering System	A0002	AA		Steering Wheel Quick Release	Quick Release for Steering	23.55	1	1	20.46	2.09		23.55	531
255	Steering System	00003	AA	Steering Wheel Quick Release	Quick Release Female	Female Part on Quick Release	30.57	1	5.236	25.33			30.57	534
256	Steering System	00004	AA	Steering Wheel Quick Release	Quick Release Male	Male Part on Quick Release	53.95	1	7.502	46.45			53.95	537
257	Steering System	00005	AA	Steering Wheel Quick Release	Quick Release Adapter	Adapter For Quick Release	7.00	1	1.006	5.99			7.00	540
258	Steering System	00006	AA	Steering Wheel Quick Release	p	Adapter in Steering Shaft	15.97	1	3.371	12.6			15.97	543
259	Steering System	A0003	AA		Steering Shaft	Steering Shaft Assembly	10.14	1	0.3	9.51		0.33	10.14	546
260	Steering System	00007	AA	Steering Shaft	Steering Column & Shaft	Student Made Steering Shaft	0.72	1	0.573	0.15			0.72	548
261	Steering System	00008	AA	Steering Shaft	Steering Shaft Adapter to Pinion	Steering Shaft Adadpter to Pinion	3.79	1	0.056	3.73			3.79	550
262	Steering System	00009	AA	Steering Shaft	Steering Shaft Adadpter to UJ	Steering Shaft Adadpter to UJ	4.37	1	0.074	4.3			4.37	552
263	Steering System	00010	AA	Steering Shaft	Universal Joint	U-Joint for Steering	20.70	1	20	0.7			20.70	554
264	Steering System	00011	AA	Steering Shaft	Steering Shaft Cover	Cover for steering shaft	0.25	1	0.25				0.25	556
265	Steering System	A0004	AA		Steering Gear Box	Miltera Steering Gear Box	16.02	1		15.1	0.92		16.02	557
266	Steering System	00012	AA	Steering Gear Box	Steering Rack	Miltera Steering Rack	6.03	1	0.476	5.55			6.03	560
267	Steering System	00013	AA	Steering Gear Box	Steering Pinion	Miltera Steering Pinion	5.81	1	0.263	5.55			5.81	562
268	Steering System	00014	AA	Steering Gear Box	Steering Rack Housing	Miltera Steering Housing	28.70	1	3.547	25.15			28.70	564
269	Steering System	00015	AA	Steering Gear Box	Input Shaft	Input Shaft for Gear Box	4.89	1	0.255	4.63			4.89	567
270	Steering System	00016	AA	Steering Gear Box	Clevis	Clevis to Rod End	5.60	2	2.042	3.56			11.20	569
271	Steering System	00017	AA	Steering Gear Box	Steering Gear Box Bearing	Bearing	5.09	1	5.09				5.09	571
272	Steering System	00018	AA	Steering Gear Box	Steering Gear Box Mount	Mounting for Steering Gear Box	5.62	2	0.312	5.31			11.24	572
273	Steering System	00019	AA	Steering Gear Box	Rack Support Saddle	Saddle for supporting rack	4.32	1	0.637	3.68			4.32	575
274	Steering System	A0005	AA		Steering Linkage	Linkage Assembly	9.10	2	0.2	8.08	0.49	0.33	18.20	577
275	Steering System	00020	AA	Steering Linkage	Tie Rods	Steering Tie Rod	0.69	2	0.537	0.15			1.37	579
276	Steering System	00021	AA	Steering Linkage	Male Rod End	Rod End for Tie Rod	6.44	4	6.44				25.76	581
277	Steering System	00022	AA	Steering Linkage	Rod End Adapter	Adapter For Rod End	7.71	4	4.5	3.21			30.84	583
278	Steering System	00023	AA	Steering Linkage	Rod End Spacer	Spacer for Rod End	1.32	8	0.004	1.32			10.59	586
279	Steering System	A0006	AA		Steering Gearbox Cover	Cover for Steering Gearbox	10.52	1	1.164	9.16	0.2		10.52	588
	Steering System				Area Total				181.93	307.06	4.20	0.99	504.70	
280	Suspension	A0001	AA		Dampers and springs	Ohlins TTX 25 MK Ⅱ Damper Assembly	7.57	4	2.833	4.2	0.54		30.29	590
281	Suspension	00001	AA	Dampers and springs	Suspension Damper	Student Purchase Damper	305.00	4	305				1220.00	593
282	Suspension	00002	AA	Dampers and springs	Spring	Student Purchase Suspension Spring	25.00	4	25				100.00	595
283	Suspension	00003	AA	Dampers and springs	Rod End Spacer (2 mm)	2 mm Spacer for Rod End	1.74	4	0.035	1.7			6.94	597
284	Suspension	00004	AA	Dampers and springs	Rod End Spacer (6 mm)	6 mm Spacer for Rod End	1.80	8	0.049	1.75			14.39	599
285	Suspension	00005	AA	Dampers and springs	Rod End Spacer (7 mm)	7 mm Spacer for Rod End	1.81	4	0.052	1.76			7.25	601
286	Suspension	A0002	AA		Front Pull Rod	Front Pull Rod Assembly	12.85	2	0.091	11.91	0.85		25.70	603
287	Suspension	00006	AA	Front Pull Rod	Pull rod stick	Steel Pipe Stick for Pull Rod	0.41	2	0.204	0.21			0.83	605
288	Suspension	00007	AA	Front Pull Rod	Male Rod End	Male Rod End, Zinc Alloy	3.78	4	3.78				15.12	607
289	Suspension	00008	AA	Front Pull Rod	Rod End Adapter	Steel Adapter for Rod End	2.65	4	0.052	2.6			10.61	609
290	Suspension	00009	AA	Front Pull Rod	Rod End Spacer (2 mm)	2 mm Spacer for Rod End	1.74	4	0.035	1.7			6.94	612
291	Suspension	00010	AA	Front Pull Rod	Rod End Spacer (4 mm)	4 mm Spacer for Rod End	1.76	4	0.042	1.72			7.05	614
292	Suspension	A0003	AA		Rear Push Rod	Rear Push Rod Assembly	13.23	2	0.109	12.27	0.85		26.46	616
293	Suspension	00011	AA	Rear Push Rod	Pushrod stick	Steel Pipe Stick for Push Rod	0.46	2	0.247	0.21			0.91	618
294	Suspension	00012	AA	Rear Push Rod	Male Rod End	Male Rod End, Zinc Alloy	3.78	4	3.78				15.12	620
295	Suspension	00013	AA	Rear Push Rod	Rod End Adapter	Steel Adapter for Rod End	2.65	4	0.052	2.6			10.61	622
296	Suspension	00014	AA	Rear Push Rod	Rod End Spacer (2 mm)	2 mm Spacer for Rod End	1.74	4	0.035	1.7			6.94	625
297	Suspension	00015	AA	Rear Push Rod	Rod End Spacer (2,5 mm)	2,5 mm Spacer for Rod End	1.74	4	0.035	1.7			6.94	627
298	Suspension	A0004	AA		Upper Front A-Arm - RH	Upper Front A-Arm Right Hand Assembly	20.82	1	0.287	18.83	1.2	0.5	20.82	629
299	Suspension	00016	AA	Upper Front A-Arm - RH	Upper Front A-Arm - RH	Upper Front A-Arm Right Hand	7.91	1	0.66	6.92		0.33	7.91	632
300	Suspension	00017	AA	Upper Front A-Arm - RH	Spherical Bearing Housing	Student Made Spherical Bearing Housing	2.87	1	0.196	2.67			2.87	635
301	Suspension	00018	AA	Upper Front A-Arm - RH	Spherical Bearing	Spherical Bearing	6.92	1	6.92				6.92	637
302	Suspension	00019	AA	Upper Front A-Arm - RH	Male Rod Ends	Male Rod End, Zinc Alloy	3.78	2	3.78				7.56	640
303	Suspension	00020	AA	Upper Front A-Arm - RH	Rod End Adapter	Steel Adapter for Rod End	2.65	2	0.052	2.6			5.30	642
304	Suspension	00021	AA	Upper Front A-Arm - RH	Rod End Spacers (5,5 mm)	5,5 mm Spacer for Rod End	1.79	2	0.045	1.74			3.57	645
305	Suspension	00022	AA	Upper Front A-Arm - RH	Rod End Spacers (9 mm)	9 mm Spacer for Rod End	1.85	2	0.059	1.79			3.70	647
306	Suspension	00023	AA	Upper Front A-Arm - RH	Rod End Spacers (15 mm)	15 mm Spacer for Rod End	1.94	2	0.08	1.86			3.88	649
307	Suspension	A0005	AA		Upper Front A-Arm - LH	Upper Front A-Arm Left Hand Assembly	20.82	1	0.287	18.83	1.2	0.5	20.82	651
308	Suspension	00024	AA	Upper Front A-Arm - LH	Upper Front A-Arm - LH	Upper Front A-Arm Left Hand	7.91	1	0.66	6.92		0.33	7.91	654
309	Suspension	00025	AA	Upper Front A-Arm - LH	Spherical Bearing Housing	Student Made Spherical Bearing Housing	2.87	1	0.196	2.67			2.87	657
310	Suspension	00026	AA	Upper Front A-Arm - LH	Spherical Bearing	Spherical Bearing	6.92	1	6.92				6.92	659
311	Suspension	00027	AA	Upper Front A-Arm - LH	Male Rod Ends	Male Rod End, Zinc Alloy	3.78	2	3.78				7.56	662
312	Suspension	00028	AA	Upper Front A-Arm - LH	Rod End Adapter	Steel Adapter for Rod End	2.65	2	0.052	2.6			5.30	664
313	Suspension	00029	AA	Upper Front A-Arm - LH	Rod End Spacers (5,5 mm)	5,5 mm Spacer for Rod End	1.79	2	0.045	1.74			3.57	667
314	Suspension	00030	AA	Upper Front A-Arm - LH	Rod End Spacers (9 mm)	9 mm Spacer for Rod End	1.85	2	0.059	1.79			3.70	669
315	Suspension	00031	AA	Upper Front A-Arm - LH	Rod End Spacers (15 mm)	15 mm Spacer for Rod End	1.94	2	0.08	1.86			3.88	671
316	Suspension	A0006	AA		Lower Front A-Arm - RH	Lower Front A-Arm Right Hand Assembly	21.89	1	0.322	19.53	1.2	0.833	21.89	673
317	Suspension	00032	AA	Lower Front A-Arm - RH	Lower Front A-Arm - RH	Lower Front A-Arm Right Hand	0.93	1	0.722	0.21			0.93	676

Line Num.	Area of Commodity	Asm/Prt #	Rev. Lvl.	Asm	Component	Description	Unit Cost	Quantity	Material Cost	Process Cost	Fastener Cost	Tooling Cost	Total Cost	Details Page Number
318	Suspension	00033	AA	Lower Front A-Arm - RH	Spherical Bearing Housing	Student Made Spherical Bearing Housing	2.87	1	0.196	2.67			2.87	679
319	Suspension	00034	AA	Lower Front A-Arm - RH	Spherical Bearing	Spherical Bearing	6.92	1	6.92				6.92	681
320	Suspension	00035	AA	Lower Front A-Arm - RH	Male Rod Ends	Male Rod End, Zinc Alloy	3.78	2	3.78				7.56	684
321	Suspension	00036	AA	Lower Front A-Arm - RH	Rod End Adapter	Steel Adapter for Rod End	2.65	2	0.052	2.6			5.30	686
322	Suspension	00037	AA	Lower Front A-Arm - RH	Rod End Spacers (5,5 mm)	5,5 mm Spacer for Rod End	1.79	2	0.045	1.74			3.57	689
323	Suspension	00038	AA	Lower Front A-Arm - RH	Rod End Spacers (9,5 mm)	9,5 mm Spacer for Rod End	1.86	2	0.059	1.80			3.72	691
324	Suspension	00039	AA	Lower Front A-Arm - RH	Rod End Spacers (14,5 mm)	14,5 mm Spacer for Rod End	1.91	2	0.059	1.85			3.82	693
325	Suspension	A0007	AA		Lower Front A-Arm - LH	Lower Front A-Arm Left Hand Assembly	21.89	1	0.322	19.53	1.2	0.833	21.89	695
326	Suspension	00040	AA	Lower Front A-Arm - LH	Lower Front A-Arm - LH	Lower Front A-Arm Left Hand	0.93	1	0.722	0.21			0.93	698
327	Suspension	00041	AA	Lower Front A-Arm - LH	Spherical Bearing Housing	Student Made Spherical Bearing Housing	2.87	1	0.196	2.67			2.87	700
328	Suspension	00042	AA	Lower Front A-Arm - LH	Spherical Bearing	Spherical Bearing	6.92	1	6.92				6.92	702
329	Suspension	00043	AA	Lower Front A-Arm - LH	Male Rod Ends	Male Rod End, Zinc Alloy	3.78	2	3.78				7.56	705
330	Suspension	00044	AA	Lower Front A-Arm - LH	Rod End Adapter	Steel Adapter for Rod End	2.65	2	0.052	2.6			5.30	707
331	Suspension	00045	AA	Lower Front A-Arm - LH	Rod End Spacers (5,5 mm)	5,5 mm Spacer for Rod End	1.79	2	0.045	1.74			3.57	710
332	Suspension	00046	AA	Lower Front A-Arm - LH	Rod End Spacers (9,5 mm)	9,5 mm Spacer for Rod End	1.86	2	0.059	1.8			3.72	712
333	Suspension	00047	AA	Lower Front A-Arm - LH	Rod End Spacers (14,5 mm)	14,5 mm Spacer for Rod End	1.91	2	0.059	1.85			3.82	714
334	Suspension	A0008	AA		Upper Rear A-Arms - RH	Upper Rear A-Arm Right Hand Assembly	19.86	1	0.265	18.39	1.2	0.833	19.86	718
335	Suspension	00048	AA	Upper Rear A-Arms - RH	Upper Rear A-Arm - RH	Upper Rear A-Arm Right Hand	0.82	1	0.581	0.24			0.82	719
336	Suspension	00049	AA	Upper Rear A-Arms - RH	Spherical Bearing Housing	Student Made Spherical Bearing Housing	2.87	1	0.196	2.67			2.87	722
337	Suspension	00050	AA	Upper Rear A-Arms - RH	Spherical Bearing	Spherical Bearing	6.92	1	6.92				6.92	724
338	Suspension	00051	AA	Upper Rear A-Arms - RH	Male Rod Ends	Male Rod End, Zinc Alloy	3.78	2	3.78				7.56	727
339	Suspension	00052	AA	Upper Rear A-Arms - RH	Rod End Adapter	Steel Adapter for Rod End	2.65	2	0.052	2.6			5.30	729
340	Suspension	00053	AA	Upper Rear A-Arms - RH	Rod End Spacers (5 mm)	5 mm Spacer for Rod End	1.79	1	0.045	1.74			1.79	732
341	Suspension	00054	AA	Upper Rear A-Arms - RH	Rod End Spacers (5,5 mm)	5,5 mm Spacer for Rod End	1.79	2	0.045	1.74			3.57	734
342	Suspension	00055	AA	Upper Rear A-Arms - RH	Rod End Spacers (10mm)	10 mm Spacer for Rod End	1.86	1	0.059	1.8			1.86	736
343	Suspension	00056	AA	Upper Rear A-Arms - RH	Rod End Spacers (13 mm)	13 mm Spacer for Rod End	1.89	1	0.059	1.83			1.89	738
344	Suspension	00057	AA	Upper Rear A-Arms - RH	Rod End Spacers (14 mm)	14 mm Spacer for Rod End	1.90	1	0.059	1.84			1.90	740
345	Suspension	A0009	AA		Upper Rear A-Arms - LH	Upper Rear A-Arm Left Hand Assembly	19.86	1	0.265	18.39	1.2	0.833	19.86	742
346	Suspension	00058	AA	Upper Rear A-Arms - LH	Upper Rear A-Arm - LH	Upper Rear A-Arm Left Hand	0.82	1	0.581	0.24			0.82	745
347	Suspension	00059	AA	Upper Rear A-Arms - LH	Spherical Bearing Housing	Student Made Spherical Bearing Housing	2.87	1	0.196	2.67			2.87	748
348	Suspension	00060	AA	Upper Rear A-Arms - LH	Spherical Bearing	Spherical Bearing	6.92	1	6.92				6.92	750
349	Suspension	00061	AA	Upper Rear A-Arms - LH	Male Rod Ends	Male Rod End, Zinc Alloy	3.78	2	3.78				7.56	753
350	Suspension	00062	AA	Upper Rear A-Arms - LH	Rod End Adapter	Steel Adapter for Rod End	2.83	2	0.052	2.78			5.66	755
351	Suspension	00063	AA	Upper Rear A-Arms - LH	Rod End Spacers (5 mm)	5 mm Spacer for Rod End	1.79	1	0.045	1.74			1.79	758
352	Suspension	00064	AA	Upper Rear A-Arms - LH	Rod End Spacers (5,5 mm)	5,5 mm Spacer for Rod End	1.79	2	0.045	1.74			3.57	760
353	Suspension	00065	AA	Upper Rear A-Arms - LH	Rod End Spacers (10mm)	10 mm Spacer for Rod End	1.86	1	0.059	1.8			1.86	762
354	Suspension	00066	AA	Upper Rear A-Arms - LH	Rod End Spacers (13 mm)	13 mm Spacer for Rod End	1.89	1	0.059	1.83			1.89	764
355	Suspension	00067	AA	Upper Rear A-Arms - LH	Rod End Spacers (14 mm)	14 mm Spacer for Rod End	1.90	1	0.059	1.84			1.90	766
356	Suspension	A0010	AA		Lower Rear A-Arms - RH	Lower Rear A-Arm Right Hand Assembly	22.91	1	0.387	20.8276	1.2	0.5	22.91	768
357	Suspension	00068	AA	Lower Rear A-Arms - RH	Lower Rear A-Arm - RH	Lower Rear A-Arm Right Hand	11.43	1	0.817	10.28		0.33	11.43	771
358	Suspension	00069	AA	Lower Rear A-Arms - RH	Spherical Bearing Housing	Student Made Spherical Bearing Housing	2.87	1	0.196	2.67			2.87	774
359	Suspension	00070	AA	Lower Rear A-Arms - RH	Spherical Bearing	Spherical Bearing	6.92	1	6.92				6.92	776
360	Suspension	00071	AA	Lower Rear A-Arms - RH	Male Rod Ends	Male Rod End, Zinc Alloy	3.78	2	3.78				7.56	779
361	Suspension	00072	AA	Lower Rear A-Arms - RH	Rod End Adapter	Steel Adapter for Rod End	2.65	2	0.052	2.6			5.30	781
362	Suspension	00073	AA	Lower Rear A-Arms - RH	Rod End Spacers (5 mm)	5 mm Spacer for Rod End	1.79	1	0.045	1.74			1.79	784
363	Suspension	00074	AA	Lower Rear A-Arms - RH	Rod End Spacers (5,5 mm)	5,5 mm Spacer for Rod End	1.79	1	0.045	1.74			1.79	786
364	Suspension	00075	AA	Lower Rear A-Arms - RH	Rod End Spacers (9 mm)	9 mm Spacer for Rod End	1.85	2	0.059	1.79			3.70	788
365	Suspension	00076	AA	Lower Rear A-Arms - RH	Rod End Spacers (19 mm)	19 mm Spacer for Rod End	1.97	1	0.094	1.88			1.97	790
366	Suspension	A0011	AA		Lower Rear A-Arms - LH	Lower Rear A-Arm Left Hand Assembly	22.91	1	0.387	20.8276	1.2	0.5	22.91	792
367	Suspension	00077	AA	Lower Rear A-Arms - LH	Lower Rear A-Arm - LH	Lower Rear A-Arm left hand	11.43	1	0.817	10.28		0.33	11.43	795
368	Suspension	00078	AA	Lower Rear A-Arms - LH	Spherical Bearing Housing	Student Made Spherical Bearing Housing	2.87	1	0.196	2.67			2.87	798
369	Suspension	00079	AA	Lower Rear A-Arms - LH	Spherical Bearing	Spherical Bearing	6.92	1	6.92				6.92	800
370	Suspension	00080	AA	Lower Rear A-Arms - LH	Male Rod Ends	Male Rod End, Zinc Alloy	3.78	2	3.78				7.56	803
371	Suspension	00081	AA	Lower Rear A-Arms - LH	Rod End Adapter	Steel Adapter for Rod End	2.65	2	0.052	2.6			5.30	805
372	Suspension	00082	AA	Lower Rear A-Arms - LH	Rod End Spacers (5 mm)	5 mm Spacer for Rod End	2.19	1	0.45	1.74			2.19	808
373	Suspension	00083	AA	Lower Rear A-Arms - LH	Rod End Spacers (5,5 mm)	5,5 mm Spacer for Rod End	2.19	2	0.45	1.74			4.38	810
374	Suspension	00084	AA	Lower Rear A-Arms - LH	Rod End Spacers (9 mm)	9 mm Spacer for Rod End	1.85	2	0.059	1.79			3.70	812
375	Suspension	00085	AA	Lower Rear A-Arms - LH	Rod End Spacers (19 mm)	19 mm Spacer for Rod End	1.97	1	0.094	1.88			1.97	814
376	Suspension	A0012	AA		Rear Holder-Arms - RH	Rear Holder A-Arm Right Hand Assemly	10.51	1	0.077	9.62	0.48	0.33	10.51	816
377	Suspension	00086	AA	Rear Holder-Arms - RH	Rear Holder-Arms - RH	Rear Holder A-Arm Rihgt Hand	0.38	1	0.168	0.21			0.38	819
378	Suspension	00087	AA	Rear Holder-Arms - RH	Rod End Adapter	Steel Adapter for Rod End	2.65	2	0.052	2.6			5.30	821
379	Suspension	00088	AA	Rear Holder-Arms - RH	Male Rod Ends	Male Rod End, Zinc Alloy	3.78	2	3.78				7.56	824
380	Suspension	00089	AA	Rear Holder-Arms - RH	Rod End Spacers (5,5 mm)	5,5 mm Spacer for Rod End	1.79	2	0.045	1.74			3.57	826
381	Suspension	A0013	AA		Rear Holder A-Arms - LH	Rear Holder A-Arm Left Hand Assembly	10.51	1	0.077	9.62	0.48	0.33	10.51	828
382	Suspension	00090	AA	Rear Holder-Arms - LH	Rear Holder A-Arms - LH	Rear Holder A-Arm Left Hand	0.38	1	0.168	0.21			0.38	831
383	Suspension	00091	AA	Rear Holder-Arms - LH	Rod End Adapter	Steel Adapter for Rod End	2.65	2	0.052	2.6			5.30	833

Line Num.	Area of Commodity	Asm/Prt #	Rev. Lvl.	Asm	Component	Description	Unit Cost	Quantity	Material Cost	Process Cost	Fastener Cost	Tooling Cost	Total Cost	Details Page Number
384	Suspension	00092	AA	Rear Holder-Arms - LH	Male Rod Ends	Male Rod End, Zinc Alloy	3.78	2	3.78				7.56	836
385	Suspension	00093	AA	Rear Holder-Arms - LH	Rod End Spacers (5,5 mm)	5,5 mm Spacer for Rod End	1.79	2	0.045	1.74			3.57	838
386	Suspension	A0014	AA		Front Bellcrank	Student Made Front Bell Crank	17.60	2	9.308	7.52	0.77		35.20	840
387	Suspension	00094	AA	Front Bell Crank	Front Bellcrank Plate	Aluminum Bellcrank Plate	8.37	4	1.185	7.18			33.46	843
388	Suspension	00095	AA	Front Bell Crank	Front Bellcrank Pivot	Aluminum Bearing Housing for Bellcrank	9.24	2	0.672	8.57			18.48	846
389	Suspension	00096	AA	Front Bell Crank	Front Bellcrank Spacer (2 mm)	2 mm Spacer for Bellcrank	1.30	8	0.004	1.3			10.43	849
390	Suspension	A0015	AA		Rear Bellcrank	Student Made Rear Bell Crank	3.41	2		3.02	0.39		6.82	851
391	Suspension	00097	AA	Rear Bell Crank	Rear Bellcrank Plate	Aluminum Rear Bellcrank Plate	5.94	4	0.651	5.29			23.76	854
392	Suspension	00098	AA	Rear Bell Crank	Rear Bellcrank Spacer	Spacer for Bellcrak	1.32	8	0.004	1.32			10.59	857
393	Suspension	A0016	BA		Front Upright - RH	Front Upright Right Hand Assembly	6.88	1		6.26	0.62		6.88	859
394	Suspension	00099	AA	Front Upright - RH	Front Upright - RH	Front Upright Right Hand	70.10	1	16.421	53.68			70.10	862
395	Suspension	00100	BA	Front Upright - RH	Front Knuckle Arm - RH	Front Right Hand Knuckle Arm	4.95	1	0.397	4.38		0.17	4.95	865
396	Suspension	00101	AA	Front Upright - RH	Front Top Bracket - RH	Front Top A-Arm Bracket Right Hand	8.10	1	1.267	6.83			8.10	867
397	Suspension	00102	AB	Front Upright - RH	Adjuster Shim	Camber Adjuster	1.04	1	0.093	0.95			1.04	870
398	Suspension	A0017	BA		Front Upright - LH	Front Upright Left Hand Assembly	6.88	1		6.26	0.62		6.88	873
399	Suspension	00103	AA	Front Upright - LH	Front Upright - LH	Front Upright Left Hand	70.10	1	16.421	53.68			70.10	876
400	Suspension	00104	BA	Front Upright - LH	Front Knuckle Arm - LH	Front Left Hand Knuckle Arm	4.95	1	0.397	4.38		0.17	4.95	879
401	Suspension	00105	AA	Front Upright - LH	Front Top Bracket - LH	Front Top A-Arm Bracket Left Hand	8.10	1	1.267	6.83			8.10	881
402	Suspension	00106	AB	Front Upright - LH	Adjuster Shim	Camber Adjuster	1.04	1	0.093	0.95			1.04	883
403	Suspension	A0018	AB		Rear Upright - RH	Rear Upright Right Hand Assembly	6.78	1		6.26	0.52		6.78	886
404	Suspension	00107	AA	Rear Upright - RH	Rear Upright - RH	Rear Upright Right Hand	90.41	1	21.051	69.36			90.41	889
405	Suspension	00108	AA	Rear Upright - RH	Rear Top Bracket - RH	Rear Top A-Arm Bracket Right Hand	8.10	1	1.267	6.83			8.10	892
406	Suspension	00109	AB	Rear Upright - RH	Adjuster Shim	Camber Adjuster	1.04	1	0.093	0.95			1.04	895
407	Suspension	A0019	AB		Rear Upright - LH	Rear Upright Left Hand Assembly	6.78	1		6.26	0.52		6.78	898
408	Suspension	00110	AA	Rear Upright - LH	Rear Upright - LH	Rear Upright Left Hand	90.41	1	21.051	69.36			90.41	901
409	Suspension	00111	AA	Rear Upright - LH	Rear Top Bracket - LH	Rear Top A-Arm Bracket Left Hand	8.10	1	1.267	6.83			8.10	904
410	Suspension	00112	AB	Rear Upright - LH	Adjuster Shim	Camber Adjuster	1.04	1	0.093	0.95			1.04	907
	Suspension & Shocks				Area Total				1619.36	936.90	20.72	5.99	2582.96	
411	Wheels & Tires	A0001	AA		Wheels and tires	Wheel and Tires Assembly	9.02	4		7.42	1.6		36.08	910
412	Wheels & Tires	00001	AA	Wheels and tires	Wheels	Student Purchase Aluminum Wheel	57.50	4	57.5				230.00	912
413	Wheels & Tires	00002	AA	Wheels and tires	Tires	Hoosier Slick Tire	85.00	4	85				340.00	914
414	Wheels & Tires	00003	AA	Wheels and tires	Valve Stems	Valve Stem	1.00	4	1				4.00	915
415	Wheels & Tires	00004	AA	Wheels and tires	Wheel Weights	Ballancer Wheel Weights	4.00	4	4				16.00	916
416	Wheels & Tires	A0002	AB		Rear Hub - RH	Rear Wheel Hub Right Hand Assembly	6.56	1		3.3	3.26		6.56	917
417	Wheels & Tires	00005	AA	Rear Hub - RH	Rear Wheel Hub - RH	Rear Wheel Hub Right Hand	277.79	1	201.711	76.08			277.79	920
418	Wheels & Tires	00006	AA	Rear Hub - RH	Wheel Bearing	Rear Wheel Bearing	28.55	2	28.55				57.10	923
419	Wheels & Tires	00007	AA	Rear Hub - RH	Custom Wheel Hub Nut	Student Made Wheel Hub Nut	30.05	1	2.604	27.45			30.05	924
420	Wheels & Tires	00008	AA	Rear Hub - RH	Rear Wheel Bearing Boss	Aluminum Boss for Rear Wheel Bearing	3.63	1	0.283	3.35			3.63	927
421	Wheels & Tires	A0003	AB		Rear Hub - LH	Rear Wheel Hub Left Hand Assembly	6.56	1		3.3	3.26		6.56	930
422	Wheels & Tires	00009	AA	Rear Hub - LH	Rear Wheel Hub - LH	Rear Wheel Hub Left Hand	277.79	1	201.711	76.08			277.79	933
423	Wheels & Tires	00010	AA	Rear Hub - LH	Wheel Bearing	Rear Wheel Bearing	28.55	2	28.55				57.10	936
424	Wheels & Tires	00011	AA	Rear Hub - LH	Custom Wheel Hub Nut	Student Made Wheel Hub Nut	30.05	1	2.604	27.45			30.05	937
425	Wheels & Tires	00012	AA		Rear Wheel Bearing Boss	Aluminum Boss for Rear Wheel Bearing	3.63	1	0.283	3.35			3.63	940
426	Wheels & Tires	A0004	AB		Front Hub - RH	Front Wheel Hub Right Hand Assembly	6.56	1		3.3	3.26		6.56	943
427	Wheels & Tires	00013	AA	Front Hub - RH	Front Wheel Hub - RH	Front Wheel Hub Right Hand	260.66	1	187.506	73.15			260.66	946
428	Wheels & Tires	00014	AA	Front Hub - RH	Wheel Bearing	Front Wheel Bearing	28.55	2	28.55				57.10	949
429	Wheels & Tires	00015	AA	Front Hub - RH	Custom Wheel Hub Nut	Student Made Wheel Hub Nut	30.05	1	2.604	27.45			30.05	950
430	Wheels & Tires	00016	AA	Front Hub - RH	Front Wheel Bearing Boss	Aluminum Boss for Front Wheel Bearing	3.48	1	0.208	3.27			3.48	953
431	Wheels & Tires	A0005	AB		Front Hub - LH	Front Wheel Hub Left Hand Assembly	6.56	1		3.3	3.26		6.56	956
432	Wheels & Tires	00017	AA	Front Hub - LH	Front Wheel Hub - LH	Front Wheel Hub Left Hand	260.66	1	187.506	73.15			260.66	959
433	Wheels & Tires	00018	AA	Front Hub - LH	Wheel Bearing	Front Wheel Bearing	28.55	2	28.55				57.10	962
434	Wheels & Tires	00019	AA	Front Hub - LH	Custom Wheel Hub Nut	Student Made Wheel Hub Nut	30.05	1	2.604	27.45			30.05	963
435	Wheels & Tires	00020	AA	Front Hub - LH	Front Wheel Bearing Boss	Aluminum Boss for Front Wheel Bearing	3.48	1	0.208	3.27			3.48	966
	Wheels & Tires				Area Total				1608.02	461.11	19.44	0.00	2092.05	
									10,573.78	**6,012.87**	**135.65**	**126.11**	**16,971.81**	

b. In the Cost event, the business logic case will be used to determine that the cost target was met for the same design solution and how Cost was integrated into the overall concept and the iterative design process.
c. In the Business Presentation event, the business logic case will be used to assess whether the business presentation is appropriate for the market and business strategy that the team has identified
d. For some Formula Student/FSAE Events, if the event is oversubscribed, then the entry selection process may include assessment of the quality of the Business Logic Case supplied.

S3.3 All teams must submit a Business Logic Case report in accordance with the general format applicable for the year of competition "FSAE Business Logic Case 201X". The report must be submitted on the template. Refer to the applicable competition website to acquire the template.

This report must be submitted by the deadline which will generally be **~ 6-9 months before the competition.** Refer to the deadlines posted on the website for each specific competition.

ARTICLE 4: COST AND MANUFACTURING EVENT

*Important Notice: *For 2016 Formula SAE Competitions in United States, Cost Report Submission process may be changed. Please refer to the website for additional announcements and information.*

Note: Additional information about the Cost and Manufacturing Event including Cost Tables and other information can be obtained from the www.fsaeonline.com website which is also linked off the Formula SAE Rules and Important Documents page on the FSAE Website.

S4.1 Event Objective

The objectives of the Cost and Manufacturing Event are:

a. To teach the participants that cost and budget are significant factors that must be considered in any engineering exercise.
b. For teams to make trade off decisions between content and cost based on the performance advantage of each part and assembly.
c. To gain experience with creating and maintaining a Bill of Material (BOM).
d. For the participants to learn and understand the principles of Design for Manufacture and Assembly, lean manufacturing and Minimum Constraint Design.

S4.2 Rules Objective

The objectives of the Cost and Manufacturing Event rules are:

a. To provide a logical, simple and time efficient rule set enabling students to achieve the event's objectives.
b. To improve fairness by providing consistent pricing guidelines independent of team geographical location by using standardized Cost Tables.
c. To require the minimal burden of supporting documentation such as receipts or catalog pages. However, in order to convey design information to cost judges engineering documentation (drawings, process descriptions, etc.) are required.

S4.3 Event Requirements

This event is comprised of three (3) parts

S4.3.1 Part 1 “Cost Report”
The preparation and submission of a report (the “Cost Report”), which is to be sent to the Cost Judges prior to the competition. See S4.1.

S4.3.2 Part 2 “Discussion”
A discussion at the Competition with the Cost Judges around the team’s vehicle. This evaluates not only the cost of the car, but also the team’s ability to prepare accurate engineering and manufacturing cost estimates.

S4.3.3 Part 3 “Real Case”
A “real case” scenario where students will have to respond to a challenge related to cost or manufacturing of the student vehicle.

S4.4 Formula SAE Michigan & Formula SAE Lincoln Reports
Teams that are entering more than one North American competition may submit one (1) Cost Report covering all the competitions entered providing that (a) the report properly identifies the competition names and car numbers and (b) any addenda necessary to cover changes or modifications made to the vehicle between events is properly completed and submitted.

S4.5 Public Cost Reports
By submitting a cost report to the competition’s organizing body for judging you and your team agree that your cost report can be reproduced and distributed by the competition organization, in both complete and edited versions, in any medium or format anywhere in the world.

NOTE: Beginning with the 2013 competition season it is the plan of the FSAE Rules Committee and the competition organizers to publish all cost reports, in as-submitted format, to the FSAE website. It is the intent of this move to make the cost event more transparent and improve the educational experience of the students by providing the full range of cost reports for teams to review. Cost reports for a given competition season will not be published before the end of the calendar year. Support materials, such as technical drawings, will not be released.

S4.6 Definitions
The following definitions will apply throughout the Cost Event rules:

S4.6.1 Adjusted Cost – The final cost for the vehicle including penalties

S4.6.2 Amended Cost – The cost of the vehicle after modification by the competition addendum

S4.6.3 Bill of Material – A hierarchical list of all parts of the vehicle. A BOM lists every item that is on the vehicle but also shows the relationships between these items, for example showing the parts that make up an assembly. A Costed Bill of Material (CBOM) is a standard BOM that includes cost information including cost of purchased parts, raw materials and processes that go into manufacturing the vehicle.

S4.6.4 Category - Each table has numerous entries which describe a classification of entry.
For example there are several types of hose clamps, and all have various costs. The category of hose clamp may be worm drive, constant tension, etc.

S4.6.5 Cost – The cost for each item from the materials table is simply the quantity multiplied by the unit cost.

S4.6.6 Cost Report – All materials, including electronic and hard copy, submitted for judging

S4.6.7 Cost Score – Refers to the total number of points out of 100 earned in the Cost Event

S4.6.8 Cost Tables – All tables that list costs for objects and processes

S4.6.9 Design for Manufacture and Assembly (DFMA) – The process where parts are designed for ease of manufacture and assembly, resulting in lower cost.

S4.6.10 Fasteners Table – A Cost Table that consists of not only traditional fasteners such as bolts, nuts and rivets but also adhesives, hose clamps and retaining rings.

S4.6.11 Fixed Cost – Costs associated with production that is independent of volume produced. Fixed cost items, such as tooling, are converted to variable costs when included in the Cost Report.

S4.6.12 Initial Cost – The cost of the vehicle submitted for initial judging in the Cost Report.

S4.6.13 Lean Manufacture – A methodology for producing goods that emphasizes the elimination of waste and improvement in process flow with the goal of optimizing the cost and quality of goods.

S4.6.14 Materials Table – Lists the costs for raw materials used to manufacture parts built by the teams and also of finished parts purchased by the teams.

S4.6.15 Minimum Constraint Design (MCD) – A design methodology emphasizing elimination of redundant constraints in the attachment of parts. Each part requires constraint in six degrees of freedom and additional constraints can make assembly difficult, force tight tolerances and increase the cost of manufactured goods.

S4.6.16 Parameters – Used to create an equation describing the cost of an object as a function of some characteristic of that object. For example the cost of steel is proportional to the mass (or volume) of steel. In this case steel has been parameterized by mass. Rubber hose could be parameterized by diameter. The equations can be linear or non-linear and both 1st and 2nd order equations are used as necessary to build the Cost Tables.

S4.6.17 Process Multipliers - Modify the standard costs of different operations to account for material and geometric differences in the part.

S4.6.18 Purchased Parts – Also called bought parts; these items are listed in the Cost Tables in a near as-installed condition. For example wheels, engines and turbochargers are purchased parts. In some cases purchased parts may still require additional processing before they can be assembled to the car. Wheels, for example, do not include the machined features for mounting to the hub. Purchased parts do not include fasteners unless specifically noted in the Cost Tables.

S4.6.19 Quantity – The amount of the item

S4.6.20 Raw Materials – Materials used for manufacturing parts, such as aluminum, steel and rubber hose.

S4.6.21 Tools – Tools refer to hand or power tools used to assemble the vehicle. The costs of these tools **are not included** in the Cost Report. The effect of the tools used for assembly are captured in the process tables for labor as different costs are given based on the tools used for assembly.

S4.6.22 Tooling - Is the production tooling associated with processes that are specific to the part geometry. The costs of tooling **must be included** in the Cost Report. For example the dies to stamp out a chassis bracket are tooling. The press used to stamp the bracket is not, and is considered production equipment which is not part of the Cost Event.

S4.6.23 Unit – Is the measurement system used to define the quantity of a parameter.
For example millimeters and kilograms are units. The hose clamp diameter unit is mm. When calculating the cost of the clamp the unit of measurement used by the team must match the Unit specified in the tables. For example a US team mistakenly calculates the hose clamp cost by using the expression with a diameter of 1, because their radiator hose is 1 inch in diameter. They should have used 25.4mm for the diameter and their cost is wrong because of it. For the penalties associated with this type of error see S4.19

S4.6.24 Unit Cost – Is the cost for something assuming a numerical value of one (1) of the unit used to measure the item. The cost is the quantity of an item multiplied by the unit cost.

S4.6.25 Variable Cost – Is a cost associated with production that is proportional to the vehicle volume produced. All costs submitted with the Cost Report will be variable costs.

S4.7 General Requirements

S4.7.1 The Cost Report must:

a. Use the standardized Cost Tables. The tables are designed to reflect a hypothetical car built for production at the annual volume of 1000 units per year.
b. List and cost every part on the prototype vehicle. This includes any equipment fitted on the vehicle at any time during the competition. The only exceptions are that, per S4.23 "Cost Report Exempt Items" of the Rules, the cost of any finish, on-board fire suppression system, rain tires, video or radio system, does not need to be included in the Cost Report.
c. Be based on the estimated costs of materials, fabrication, purchased parts, and assembly of the car. The costs shall be calculated as defined in these rules.
d. Be based on the actual manufacturing technique used on the prototype, e.g. cast parts on the prototype must be cost as cast, and fabricated parts as fabricated, etc.
e. Include tooling (e.g. welding jigs, molds, patterns and dies) for processes requiring it.
f. Exclude R & D and capital expenditures (e.g. plant, machinery, hand tools and power tools).

NOTE: There is no maximum cost. Receipts are not required for any items.

S4.7.2 The Cost Tables have been designed to:

a. Be verifiable at the event. Differentiating between different types of materials (for example different alloys of steel) is not possible so no differentiation is made in the table cost.
b. Minimize influence on safety equipment content. For example driver harnesses are cost independent of the style chosen.
c. Higher costs of some goods must reflect actually higher value of those goods. However, the costs must still allow for team innovation and vehicle content, with some reduction in cost score.

S4.8 Scoring

The points for the Cost and Manufacturing Event will be broken down as follows:

40x[(Pmax)/(Pyour)-1] [(Pmax)/Pmin)-1]	40 Points	Lowest cost - each of the participating schools will be ranked by total adjusted cost from the BOM and given 0-40 points based on the formula on the left.

	40 Points	Accuracy, Clarity & Event Day/Visual Inspection - The cars will be reviewed for part content, manufacturing feasibility and accuracy of the cost information. Supporting documentation will be assessed based on its quality, accuracy and thoroughness. The range for the score is 0-40 points.
	20 Points	Event Day/Manufacturing Processes - The teams must be prepared to discuss in detail the "real case" scenario distributed prior to the competition. The materials will include more specifics about the goal and scoring of the scenario. The range for the score is 0-20 points.
Total	100 Points	

Where:

Pyour is the adjusted cost of your car (with penalties) in dollars.
Pmin is the adjusted cost of the lowest cost car in dollars.
Pmax is the cost of the highest cost car in dollars.

S4.9 Cost Report

S4.9.1 The Cost Report consists of a full vehicle BOM with cost data derived from the Cost Tables and supporting documentation. The Cost Report must be submitted in two (2) forms:

a. Electronic Version – The upload of the electronic cost report has to be done in these steps:
   i. Upload of the vehicle BOM as Microsoft Excel ® file (.xls or .xlsx)
   ii. Upload of the supporting material as one separate PDF file (.pdf)

   The electronic version of the two files must be identified as follows:

   Carnumber_schoolname_competitioncode_CR_BOM.xls using the assigned car number, the complete school name and the competition code.
   Example: 087_University of FSAE_FSAEM_CR_BOM.xls

   Carnumber_schoolname_competitioncode_CR_Supplement.pdf using the assigned car number, the complete school name and the competition code for the BOM.
   Example: 087_University of FSAE_FSAEM_CR_Supplement.pdf

   Competition Codes are listed in Rule A2.6

b. Hard Copy – The hard copy Cost Report must be in a ring binder with 8.5" x 11" or A4 pages including both the BOM and supporting documentation (Annex).

c. A complete submission includes all portions of the electronic cost report and the hard copy. The electronic version of the Cost Report must be submitted via fsaeonline.com. The hard copy must be mailed to the address posted on sae.org. The hard copy must also include a copy of the electronic files on a memory stick or CD.

NOTE: Some competitions may waive the hard copy requirement. If so, the waiver will be published on the SAE website. Also note that the electronic submission has been broken into multiple parts to enable the BOM to be posted per rule S4.5 without posting the supporting documentation.

S4.9.2 Cost Report Identification

The cover of the Cost Report must include the following:
(a) university name, (b) competition name, and (c) vehicle number.

NOTE: Teams that are submitting a single Cost Report covering more than one North American competition must identify their report as follows:
University Name (full name)
Formula SAE Michigan, Car # XXX and Formula SAE Lincoln, Car #YYY

S4.9.3 The Cost Report must consist of the following:

- A Cover sheet
- A Table of Contents
- A Cost Summary page listing each section's cost, and the total vehicle cost
- Eight commodity report sections with the parts placed in the sections as specified in Appendix S-3.
- Tabs for each section

S4.10 Bill of Materials (BOM)

The BOM is a parts list for every vehicle part. It also shows the relationships between the items.

S4.10.1 The following terminology will be used when referring to the BOM.

- The overall vehicle is broken down into eight (8) systems which are defined in Appendix S-3.
- Systems are made up of Assemblies.
- Assemblies are made up of Parts.
- Parts consist of materials, processes and fasteners.
- Tooling is associated with each process that requires production tooling.

S4.10.2 An example BOM structure is shown below:

- Engine & Drivetrain…… System
  - Engine…….. Assembly
  - Differential…… Assembly
    - Housing……..…… Part
      - Aluminum……..… Material
      - Needle Bearing……...…… Material
      - Sand cast……..…… Process
        - Die & Core Package #4…..… Tooling
      - Machining-Turn……..... Process
      - Weld……..…… Process
      - M6x1.25 Grade 8.8…… Fastener
    - Internals……..…… Part
    - End Cap……..…… Part

The BOM must follow the format given above. There must be no other BOM levels added or any removed. Deviations from the structure published will be penalized per Section S4.18.

S4.10.3 All assemblies, parts and fasteners in the BOM must use a standard numbering convention explained in Appendix S-2.

S4.11 The Cost Tables

S4.11.1 All costs in the Cost Report come from the standardized Cost Tables. These tables have been compiled to represent the cost of parts and processes that a manufacturing company could be expected to pay for manufacturing a vehicle at 1000 units per year. Generally, the tabulated value represents ½ of the Manufacturer's Suggested Retail Price (MSRP) for finished parts. Raw materials, commodities

and fasteners also intended to represent the production volume of a company rather than the purchase price of the University teams.

S4.11.2 Requests to alter the cost of goods in the tables because of changing world markets or individual team purchase price will not be approved. The tables are intended to provide a fair, unchanging (within a given competition year) cost for parts and to reduce regional variations in price that may help or hurt certain teams. All teams must use the costs given in the tables. If a team wishes to use any parts, processes or materials not included in the tables an "Add Item Request" must be submitted as per Section S4.14.

S4.11.3 The tables represent cost based on specific parameters. For example the cost of steel is given per unit of volume (or mass). Likewise, engine costs are listed by displacement and specific power output.

S4.11.4 The following Cost Tables are used

- Materials
- Processes
- Process Multipliers
- Fasteners
- Tooling

Engine cost includes transmission (whether integral or not by design), components used to transmit power between engine and transmission and all components necessary to run including spark plugs, coils, wires, oil filter, etc. with the exception of the air induction and fuel system components. Any driveline component downstream of the transmission output gear/shaft is not included. Cost includes engine as received by manufacturer but not custom parts such as drysump pans, PCV changes, etc. Fully internal engine changes are free. If covers or other parts are removed disassembly labor must be included in labor cost.

S4.11.5 In general, most items have a cost expressed as a function of one parameter. In cases where more than one parameter is necessary additional categories are listed. For example the power output of the engine has three Categories and for each Category a different expression calculates the cost as a function of the engine displacement, which is the Parameter. The Unit would be cubic centimeters in this case.

S4.11.6 Process Multipliers are used to modify the standard costs of different operations to account for material and geometric differences in the part. For every process included in the Cost Report the list of process multipliers must be checked to determine if any apply, and if they do their effect on the cost must be included.

S4.11.7 When adding items from tables to the BOM the comments section should be reviewed thoroughly to understand what is included in the table entry. For example is the spring included in the damper cost? Do the spark plugs come with the engine or are they a separate line item? In cases where the explanation is not clear please contact the Rules Committee for clarification.

S4.12 Cost Models & Costing Methodology

The cost models are the underlying methodology and equations that relate the final cost of a part or process to the different operations and goods used in that part. The detailed explanation of the Cost Models and Costing Methodology is included in Appendix S-1 and should be referenced for understanding the use of the Cost Tables.

S4.13 Make Versus Buy

Every part on an individual car can be classified as “made” or “bought”. This designation does not necessarily refer to whether a team actually purchased or fabricated a part but is a reflection of how the part must be cost from the Cost Tables.

a. Made (or manufactured) parts must be cost as if the company manufacturing the vehicle was going to make the part internally. That is by purchasing raw materials and processing them into a finished product.
b. Bought parts must be cost as if the company manufacturing the vehicle was going to outsource the fabrication of that part. These parts would be received by the vehicle manufacturer in a relatively finished state (see the particular table entry comments field for specific information).

S4.13.1 The Cost Tables have been constructed as a tradeoff between complexity for the organizers and fairness for the teams. The make versus buy designation enables certain parts to be simplified to a relatively few number of entries. For example some teams may purchase axles but the majority of teams manufacture them. Axles are designated “make” parts so teams that purchase axles **must** cost them as if they had made them starting with the raw materials, in this case probably steel tubing. Made parts can be distinguished because they do not appear explicitly in the Cost Tables or appear with a “cost as made” option.

S4.13.2 If a team genuinely makes a part listed on the table as a bought part they may alternatively cost it as a made part **if and only if** a place holder entry is listed in the tables enabling them to do so. For example, in the category of dampers a “student built” entry is included. This line item must be included in the BOM (it has zero cost). Then they must proceed to cost the damper they actually designed and built.

S4.13.3 A table summary of options is given below:

	How Team Actually Acquired the Part	
How Table Lists Part	Team Made	Team Bought
Table Lists Part as "Made", or Part is not Listed in the Tables	Cost as "Made"	Cost as "Made"
Table Lists Part as "Bought"	Team made option NOT in table cost as "Bought". If team made option in table team can choose either "Bought" or "Made"	Cost as "Bought"

S4.13.4 For example a snap ring does not have a “team made” entry in the Cost Tables. A team who made their own would still have to use the table cost based on diameter, even if they could cost it less expensively by buying steel and processing it.

S4.13.5 Any part which is normally purchased that is optionally shown as a made part must have supporting documentation submitted to prove team manufacture. This might include engineering drawings, pictures of machining, etc. Teams found costing bought parts as made parts will be penalized appropriately.

S4.14 Add Item Request

S4.14.1 The costs tables are intended to include all materials, processes and fasteners needed by the teams to accurately reflect the content, manufacture and assembly of their vehicle. However, it will be necessary to add items to the tables to suit individual team requirements. To do this an "Add Item Request" must be submitted to the Rules Committee. After review the item will be added to the tables with the next table update with a cost appropriate to the overall Cost Table framework and spirit of the competition.

The tables will be updated throughout the competition year as required.

S4.14.2 The form should be completely filled out and contains the necessary instructions. Some supporting documentation will be required such as receipts or website links. The Add Item request is the only time receipts will be needed for the Cost Event.

NOTE: Since all teams work off the same tables once a team requests an item be added to the tables all teams will see the addition. Any team using the newly added item will use the same cost. The identity of the school that made the request will not be published.

S4.15 Report Submission and Deadline

a. The Cost Report must be submitted in the designated format for each event.
b. For some events, a printed copy of the report must also be submitted and must be on 8 1/2 inch x 11 inch or A4 size paper, using a 10-point font size or larger.
c. Submission Address and Deadline – The submission requirements, address and deadline will be published in the appendix or released on the website of the specific competition.

S4.16 Late Submission of Cost Report

It is imperative that the cost judges have the Cost Reports in enough time for proper evaluation. Teams that submit reports late will be penalized 10 points per day late, with a maximum penalty of 80 points. Teams that do not submit a Cost Report will receive negative 100 points for the Cost & Manufacturing Analysis score. Penalties will be applied based on official upload date and time for electronic submission and by post mark for printed submissions.

S4.17 Addenda

S4.17.1 An addendum that reflects any changes or corrections made after the submission of the Cost Report must be submitted at Registration when the Team registers on-site at the Event. It will not be accepted at any other time or place. The addendum document must follow the template format specified in Appendix C-5. No other format will be accepted.

S4.17.2 Addenda apply only to the competition at which they are submitted. A separate addendum is permitted for every competition a vehicle attends.

S4.17.3 Any items added to the Cost Report through addenda will be cost at 1.25 times the table cost. Any items removed through addenda will only be credited 0.75 times the table cost.

NOTE: Late changes to designs impact costs in the real world. Contracts need to be altered, commodity costs can change, cancellation fees may be incurred and information needs to be transmitted to suppliers. The scaling factors for the addenda capture this as well as encourage teams to submit full and accurate information with the initial Cost Report.

S4.18 Cost Report Judging and Penalties Process

S4.18.1 The following procedure will be used in determining penalties:

a. Penalty A will be calculated first using procedure S4.19
b. Penalty B will then be calculated using alternative procedure S4.20
c. The greater of the two penalties will be applied against the cost score
    i. Penalty A expressed in points will be deducted from the Accuracy score
    ii. Penalty B expressed in dollars will be added to the Adjusted Cost of the vehicle
d. If no additional points remain to be deducted from the Accuracy score the penalty will be applied using method B against the Adjusted Cost

S4.18.2 If the alternative penalty is used because no additional accuracy points remain then the highest of the A type penalties will be converted to B type penalties. In effect, the order the penalties are calculated and applied against the team does not matter.

S4.18.3 Any error that results in a team over reporting a cost in their Cost Report will not be further penalized. For example, when the Cost Report is prepared the thickness of the brake rotors has not yet been determined. The team conservatively costs the rotors as 10mm thick. The final thickness is 8mm and no change is made in the addendum. The team rotor price is higher than necessary but no penalty is applied.

NOTE: The penalty system is intended to reward accuracy and minimize workload at the competition for students and judges. In most cases a standard point deduction will be made to the accuracy score.

NOTE: Any instance where a team's score benefits by an intentional or unintentional error on the part of the students will be corrected on a case by case basis.

S4.19 Penalty Method A- Fixed Point Deductions

S4.19.1 From the Bill of Material, the cost judges will determine if all parts and processes have been included in the analysis. In the case of any omission or error the judges will add a penalty proportional to the BOM level of the error. The following standard points deductions will apply:

- Missing/inaccurate material, process, fastener……...…… 1 pt.
- Missing/inaccurate part…….. 3 pt.
- Missing/inaccurate assembly……. 5 pt.

NOTE: Each of the penalties listed above supersedes the previous penalty. If a 5 point deduction is given for a missing assembly the missing parts are ignored for Method A. Method B would include the cost of the missing parts in the calculation.

S4.19.2 Differences other than those listed above will be deducted at the discretion of the cost judges. Examples of errors leading to points deductions:

- Five M6 fasteners listed, six used – 1 pt.
- Three kilograms of steel listed, 4.4 used – 1 pt.
- Bearing carrier face machined, mill operation not included – 1 pt.
- Installation labor for steering wheel missing – 1 pt.
- Upright cost as cast but actual part billet machined – 3 pt.
- Pneumatic shifter not included on BOM – 5 pt.

The penalties above will be deducted from the points awarded for Accuracy of the Cost Report.

S4.20 Penalty Method B – Adjusted Cost Deductions

The alternative penalty will be calculated using the following equation:

Penalty = 2 x (Table Cost – Team Reported Cost)

The table cost will be calculated from the standard Cost Tables. The penalty calculation will result in a dollar value equal to twice the difference between the team cost and the correct cost for all items in error.

This penalty, if applied, will be made to the Adjusted Cost of the vehicle.

NOTE: The table costs of all items in error are included in the calculation. A missing assembly would include the price of all parts, materials, processes and fasteners making up the assembly.

S4.21 Penalty Calculation Example

For example the pneumatic shifter was inadvertently left off the Cost Report. As this is an assembly the standard error is 5 points. The cost of all air shifter parts and processes from the Cost Tables is $500. This means the total penalty cost is $1000. To see which is greater, 5 points or $1000, the dollar penalty needs to be converted to points by reference to the Cost Points formula:

$$\text{Points} = \frac{40x[(Pmax)/(Pyour)-1]}{[(Pmax)/Pmin)-1]}$$

Substitute the cost of the vehicle (Pyour) with $15,000 while the minimum vehicle cost (Pmin) was $10,000. The maximum vehicle cost (Pmax) was $50,000. Calculating the points equivalent for this dollar amount yields 2.5 points. This is less than the standard penalty. In this case the 5 points would be deducted from the Accuracy score.

If the team had made many small errors and had no more accuracy points available then the $1000 would be added to the team's adjusted cost.

S4.22 Discussion at the Competition

S4.22.1 At this discussion, the Cost Judges will:

a. Review whether the specification of the vehicle in the Cost Report accurately reflects the vehicle brought to the Competition
b. Review the manufacturing feasibility of the vehicle
c. Assess penalties for missing or incorrect information in the Cost Report compared to the vehicle presented at inspection.

S4.22.2 The team must present their vehicle at the designated time to the Cost Judges for review of the Cost Report. Teams that miss their cost appointment will potentially lose all cost points for that day. The schedule for these appointments will be in the registration packets and/or posted on the website.

S4.23 Cost Report Exempt Items

S4.23.1 Finishes

The car will be considered to be shipped as primed or gel coated and a cost recorded. Any finishes (paint, polish, etc.) that are only used to beautify need not be costed. Preservative finishes intended to protect the appearance or function of a part for an extended period of time must be costed (labor and material included).

S4.23.2 Fire Extinguisher and Suppression System

Hand held fire extinguishers are not allowed on the vehicle (See Rule T14.14 "Fire Extinguishers"), but if the car has an on-board fire suppression system, it is not required to be costed.

S4.23.3 Tires and Wheels
Only one set of tires and wheels needs to be included in the Cost Report. The tires and wheels that are declared as dry tires per rule T6.4 "Tires" must be the tires included in the Cost Report, and must be the tires on the car during the Cost Event judging. Other tires that will be potentially used at the competition (i.e. rain tires) do not need to be included in the Cost Report.

S4.23.4 Transponders, Video and Radio Systems
Transponders, video and radio systems, need not be included in the Cost Report.

S4.23.5 Data Acquisition Systems
Data acquisition systems must be included in the Cost Report. This includes display screens, control modules and all sensors.

Systems that are "stand-alone" data acquisition systems (e.g., a device that passively logs CAN data) are to be included at $0. Systems offering additional functionality have to have this functionality (e.g., a driver display) included, whether it is used or not.

Stand-alone systems must be removable without compromising any vehicle functionality aside from the logging capability. This capability may be audited by the judges at any time prior to the announcement of the Cost Event Results. Sensors and wiring must be included in the Cost Report using the Cost Table prices.

S4.24 Exchange Rates & Unit Systems
The currency of the Cost Report will be referred to as dollars. Since all items have a cost from the Cost Tables the actual currency unit is irrelevant.

S4.24.1 All Cost Tables are presented using metric units. The tables do not differentiate between parts designed in metric and US systems of measure. For example a ¼ bolt is simply input as a 6.35mm bolt. Tubing with a wall thickness of 0.035 inches is input as 0.889mm tubing. All sizes are assumed to be standard for the part being cost and no surcharge applies for any size, even if the size is non-standard. For example a team makes a custom 6.112mm bolt which took several hours of student time. However, this bolt is chosen from the Cost Tables and is less than one dollar. The assumption is in high volume production these bolts would be purchased in bulk.

S4.24.2 The comment section for each material, process or fastener may, at the student's discretion, refer to the specific part by actual local designation. For example a 6.35mm bolt is cost but the comments would say "¼ inch A-arm bolt".

S4.24.3 Because the Cost Report reflects a production cost for 1000 units per year all material and commodity sizes are assumed to be available for the necessary volume without cost penalty.

ARTICLE 5: PRESENTATION EVENT

S5.1 Presentation Event Objective – Business Case
S5.1.1 The objective of the presentation event is to evaluate the team's ability to develop and deliver a comprehensive business case that will convince the executives of a corporation that the team's design best meets the demands of the amateur, weekend competition market, including Sports Car Club of America (SCCA) Solo, and that it can be profitably manufactured and marketed. (See also A1.2)

APPENDIX S – 1 COST MODEL AND COST METHODOLOGY

1 Cost Models & Costing Methodology

The cost models are the underlying methodology and equations that relate the final cost of a part to the different operations and goods used in that part. These descriptions are accurate at the time of the rules publications. The models may be expanded as necessary based on evolving requirements.

2 Raw materials

2.1 Raw materials refer to the material stocks used to produce parts from scratch, such as billet steel for machining or aluminum ingot for casting. Bar, sheet and tube stock are purchased using raw material costs. The raw material purchased must include machining allowance. Standard allowances are given in 4.1 and must be used

2.2 Gross weight will refer to the weight of the raw material, including all machining stock

2.3 Net weight will refer to the weight of the finish machined part

2.4 Material costs are based on part gross weight. For example a steel hub is machined from solid bar. The interior is removed by boring. The cost of the bar must include this interior material. Raw materials are normally cost by volume. A cost by weight is also given using an official density listed in the tables. Any parts that are weighed at competition to confirm cost will use the official density in calculating cost.

3 Assembly Labor

The assembly labor model is based on the following parameters:

3.1 Mass – The mass of the part influences the time it takes the operator to assemble the part to the assembly or vehicle. Light parts can be installed with one hand. Heavier parts require two hands and the heaviest parts need a lift assist apparatus. These factors are accounted for by selecting the appropriate entry from the process labor tables. The actual part mass must be equal to or less than the value selected. For example a 300g part would have an assembly labor category of 1 kg.

3.2 Interfaces – The more interfaces a part has with the surrounding parts the longer it takes to assemble. Parts designed for minimal constraint are the easiest and cheapest to assemble.

3.3 Fit type – The ease with which a part can be assembled is described by the fit. There are three categories of fits:

3.3.1 Loose – the part assembles with no force. Examples include a quick release steering wheel onto the steering shaft and a bracket bolted to a monocoque.

3.3.2 Line on line – the part is designed to have a close fit to the surrounding parts and some buildup of force is required to get the part started. Examples include a rod end inserted between two tabs in double shear and a splined axle shaft into the differential gear.

3.3.3 Interference – significant force is required to insert the part and mechanical assistance may be necessary. Examples include a rubber hose onto a barbed fitting and a ball bearing into a bore.

4 Machining

Costs for machining operations are based on the volume of material removed. The actual machine used, whether mill, lathe or otherwise, is the same unless a specific line item is included for that machine, such as gear hob.

NOTE: the machining model has been simplified from previous years. There are no longer rough and finish cuts nor near net shape processes.

4.1 All processes require a minimum of 1mm (0.040 inches) of machining stock to be removed from each surface of the part with machining.

4.7 The process multiplier for the material must also be used to calculate the total process cost of the operation. If a process multiplier is required it will be listed in the processes table in the column labeled 'Multiplier Type Used'. If the column is blank for a process none is required.

4.8 When costing the raw materials that go into making machined parts the machine stock must be included in the purchased material mass, even though this material is machined away to produce the final part. This represents the cost of the purchased material. For example, an upright bore is machined into a piece of billet aluminum. The interior material that is milled away must be included in the billet mass and hence cost. The same feature machined into a casting need only include 1mm of machine stock of the machined away material

4.9 Machining requires labor operations to account for the time it takes an operator to fixture the part onto the machine. Every machined part requires at least a 'Machining Setup, Install and Remove' operation. This is the time it takes to pick up the work piece, fixture on the machine, and remove it when the machining is complete. For a part that requires an intermediate change in position, such as to machine the back of the part which would not be accessible in a single fixturing setup, the labor step of 'Machining Setup, Change' is also required. For example, an upright that requires three different orientations on a mill to fully machine would require two of the 'Machining Setup, Change' and the 'Machining Setup, Install and Remove' labor operations.

4.10 In certain cases, it is possible to fixture a work piece of raw material and machine more than one part out of it. For example, a self-feeding lathe could machine 10 suspension inserts out of a single piece of bar stock. In this case the quantity of the 'Machining Setup, Install and Remove' may be set to 0.1. This represents the 10 parts that can be machined per setup. This assumption should clearly be noted in the Cost Report along with enough details for the Cost Judges to verify the part geometry is appropriate for the machine being used.

5 Tooling & Fixturing

Tooling is necessary when certain processes are used. These can be identified in the tables because the tooling required will be indicated. Sometimes several types of tooling are available for the same process. Each has a description and an associated process with which it can be used. If a process has more than one tooling type associated with it the team must use the tooling that is closest to the actual tooling used in their prototype vehicle construction. Most tooling costs are independent of part shape, the assumption being that tooling for smaller parts will be built with multiple cavities to create an optimal cost effectiveness.

5.1 After calculating the total tooling cost for a part the cost must be divided by the Production Volume Factor (PVF) before being included in the Cost Report. The PVF represents the ability of the tooling to produce parts in volume production.

Production Volume Factor (PVF)

All parts not otherwise listed: 3000

Composite Monocoque (composite tub): 120

The following equation is used to calculate the tooling cost to be included for each part:

$$\text{Part Tooling Cost} = \frac{\text{Table Tooling Cost}}{\text{PVF} * \text{Number of Parts Using Exact Tooling}}$$

The tooling cost should be included with the appropriate part on the BOM. Tooling is not a separate section.

5.2 For example a cast aluminum upright uses a 2-piece sand core package. Total table price is $5000 + $5000 = $10000. The team has designed the casting to be used for both the left and right hand rear corners. Calculating the Part Tooling Cost gives:

$$\text{Part Tooling Cost} = \frac{\$10000}{3000 * 2} = \$1.67 \text{ per upright}$$

The $1.67 must be included as a line item on the Costed Bill of Material for each Upright.

5.3 Another example is a team is manufacturing a composite monocoque. The tub is constructed by building the top and bottom separately and bonding it together. Both the top and bottom use a two piece composite tool and the cost of all four tools is $45000. The PVF for tub tooling is only 120 because of the amount of time required to construct each tub so the tub Part Tooling Cost is:

$$\text{Part Tooling Cost} = \frac{\$45000}{120 * 1} = \$375 \text{ per tub}$$

6 Fastener Installation

The cost to tighten or loosen fasteners is based on the tool (or motion) needed to turn it, the diameter, length and whether the fastener requires a secondary tool for reacting the torque (such as a wrench on a nut).

6.1 Hand – When no tool is necessary for tightening, such as quick release fasteners or hand tightened nuts, the hand should be selected. Loose operations are those accomplished by using the fingers of the hand. If the entire hand is moving to rotate the fastener the tight category should be used.

6.2 Screwdriver – A tool that can be held in the hand and turned with the wrist. Any type of bit can be fitted such as straight, Philips, Torx, etc.

6.3 Wrench – An open-ended or box wrench or similar tool requiring motion of the hand. After a turn the wrench may have to be removed and repositioned for the next turn.

6.4 Ratchet – A tool with internal clutch that allows the hand to be moved and returned to the starting position without removal of the tool. Compatible with any bolt head style such as 6-point hex, 12-point hex, Torx or other.

6.5 Power Tool – An electric, pneumatic or other power assisted tool for running down fasteners. To qualify for power tool use a fastener must meet the following requirements:

6.5.1 A socket of the size needed to drive the fastener must fit in the fully secured position

6.5.2 One power tool with minimum dimensions given in Appendix S-4 must fit onto the socket.

6.5.3 An extension may be used to fit the power tool but it may not exceed 0.35m in length.

6.6 Reaction Tool - In the case where the fastener is not being attached into the part but requires a nut or other separate threaded piece then a reaction tool will be required. This will appear as a separate line item and should appear whenever a nut is used on a bolt.

7 Composites

Composite manufacture is defined by following steps:

7.1 Laminate – Used to build the laminate one (1) ply at a time. A ply is a single layer of the laminate consisting of a single sheet of material, regardless of material or thickness. A ply may consist of woven carbon, unidirectional glass, adhesive film or honeycomb core, for example.

7.2 Curing Operations – Used to take a laminate and convert it to a finished composite structure. All curing operations include vacuum bagging, peel ply, breather cloth and other consumable materials and labor. Costs also include part removal from the mold.

7.2.1 Room temperature cure – used for room temperature curing resin systems.

7.2.2 Oven cure – used for higher temperature cure cycles for composites. Limited to one (1) atmosphere of external pressure.

7.2.3 Autoclave cure – used for high temperature and pressure composites curing.

7.3 Curing operations require tooling. Tooling must reflect the type of tooling actually used (composite, aluminum, steel, etc.).

7.4 If hybrid weaves are used the cost can reflect the ratio of the materials in the ply. For example a 50% carbon fiber, 50% glass woven ply may use the average cost of the carbon and glass materials. If the actual fiber ratio is not used then the cost of the ply must be the cost of the highest cost material present.

7.5 When costing composite materials the total mass of the part in the Cost Report must match the actual mass of the part as presented on the vehicle for Cost Judging. The composite material, whether carbon fiber or other must be the cost of both the fiber and resin together. This is true for both prepreg and dry fiber systems and is further stated in the Materials Table. The mass of each ply can be adjusted to make the finish part mass match the Cost Report. Parts can be weighed during judging and the Cost Report mass must be equal to or greater than the actual mass of the part, even including clear coat, paint and other finishes. **NOTE**: The paint mass is being included to avoid debates in Cost Judging about how much weight the paint (or clear coat) has added. The cost of the paint and paint application need not be included if it is solely for cosmetic purposes (see S4.23.1) but the mass of paint must be included in the composite cost.

8 Electronics and Wiring

The wiring harness is cost as a number of connectors of a certain style, each interconnected by a number of wires of a certain type. The electrical system is composed of three wiring types.

8.1 Signals - Inputs to the control system such as wheel speed, mass airflow or the position of a driver toggle switch.

8.2 Controls - Control system outputs. These can be digital signals, pulse width modulated or voltage outputs.

8.3 Power - Wires carrying current for vehicle distribution or actuators. These include vehicle power from the battery, engine starter, solenoids, motors etc.

8.4 Additionally, the following terms will be used for the Cost Tables:

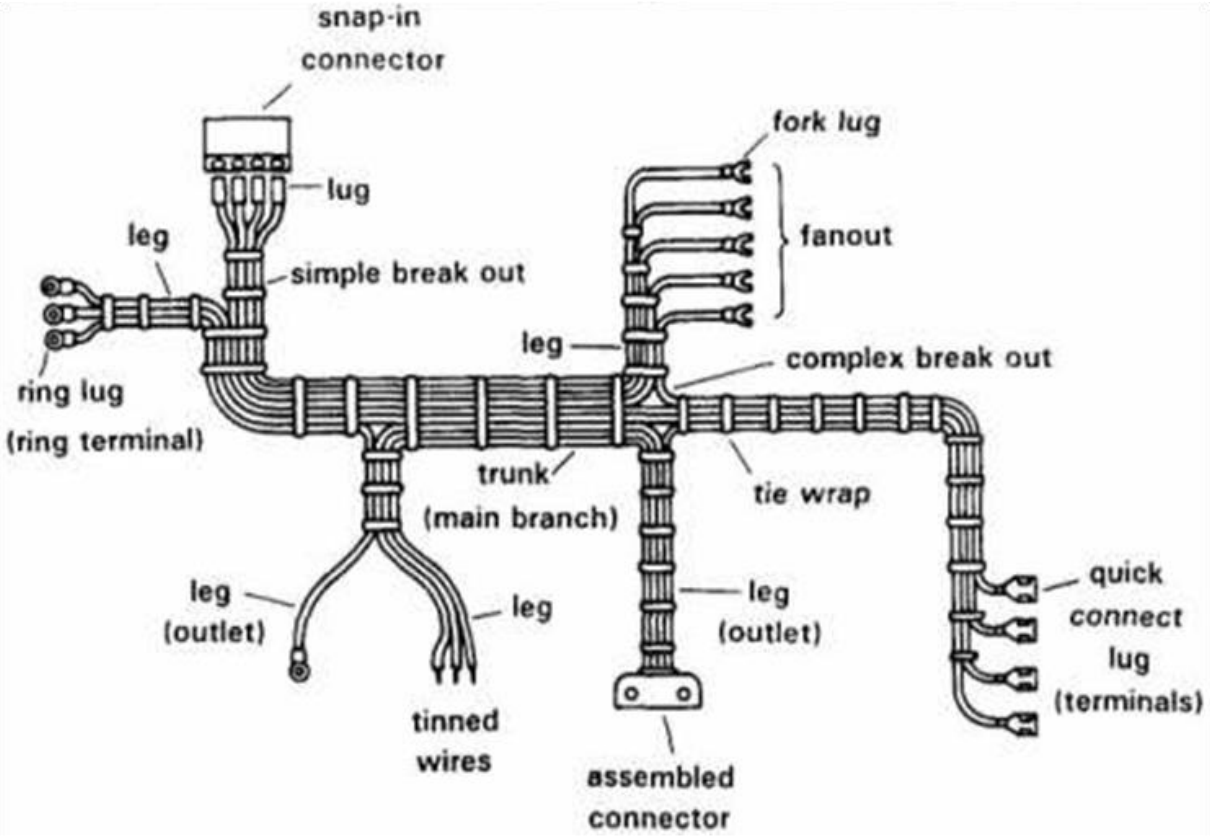

Figure E-1.1
From "Product Design for Manufacture & Assembly" by Geoffrey Boothroyd, 1994.

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APPENDIX S-2
STANDARD PART NUMBERING

1 All assemblies and parts in the BOM must have a part number using the following convention:

Competition Code – Date Code - Car Number – System Designation – Base Number – Suffix

1.1 Competition Code – A code for the competition entered. Refer to A2.6.

1.2 Date Code – Last two digits of the year of the event.

1.3 Car Number – A three (3) digit number assigned to the car for the specific event

1.4 System Designation – A two (2) letter code for the system under which the part is associated. These can be found in Appendix C-3.

1.5 Base Number – Five (5) digit numbers assigned at the student's discretion. For assemblies this becomes a four (4) digit number with preceding character of "A".

1.6 Suffix – Two character code showing part change history. These are provided for student use only so if desired all can be "AA".

1.6.1 First character refers to the part design revision level.

1.6.2 Second character refers to the part process revision level.

1.7 For example, a part entered into the chassis section for car number 27 competing at an event with code "FSAEM" that the students have decided is part one would be:

FSAEM – 08 – 027 – CH – 00001 – AA

1.8 The same part, after significant design changes would become:

FSAEM – 08 – 027 – CH – 00001 – BA

The differential assembly that the students have decided is the third assembly for the Engine & Drivetrain group would be:

FSAEM – 08 – 027 – EN – A0003 – AA

1.9 In the printed version of the Cost Report the competition code, date and car number fields of the part numbers do not need to be printed. They do need to be included in the digital files submitted. The event code and car numbers are for SAE use when the different digital files are combined into the master database.

2 All fasteners in the BOM must have a part number using the same convention as parts. All fasteners use system code "FS" even though they are included in the BOM under the part and assembly where they are used.

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APPENDIX C-3
ORGANIZED LIST OF SYSTEMS & ASSEMBLIES

The Cost Report must follow the organized list of systems and assemblies/parts outlined below. Any questions as to the correct location of the specific items **must be submitted to the rules committee by March 1 of the competition year.**

The two letter abbreviation after each system name is to be used in the part number.

1) Brake System - BR
Brake Fluid
Brake Master Cylinder
Fasteners
Brake Lines
Brake Discs
Brake Pads
Balance Bar
Calipers
Proportioning Valve

2) Engine and Drivetrain – EN
Air Filter
Axles
Carburetor
Chain / Belt
Coolant
Coolant Lines
CV Joints/U Joints
Differential
Differential Bearings
Differential Mounts
Engine
Engine Mounts
Engine/Diff Oil
Exhaust Manifold
Fuel Filter
Fuel Injectors
Fuel Lines/Rails
Fuel Pressure Reg.
Fuel Pump
Fuel Tank
Fuel Vent/Check Valve
Hose Clamps
Intake Manifold
Muffler
Oil Cooler
Overflow Bottles
Radiator
Radiator Fans
Restrictor
Shields
Sprocket/Pulleys

Throttle Body
Turbo/Super Charger

3) Frame & Body - FR

Aerodynamic Wing (if used)
Body Attachments
Body Material
Body Processing
Clutch
Floor Pan
Frame / Frame Tubes
Mounts Integral to Frame
Pedals
Shifter
Shifter Cable/Linkage
Throttle Controls
Tube End Preps
Tubes Cuts/Bends

4) Electrical – EL

Battery
Brake Light
Bulbs
Dash Panel
ECM/Engine Electronics
Fuses
Indicator Lights
Kill Switch
Oil Pressure Gage/Light
Relays
Solenoids
Starter Button
Tachometer
Water Temperature Gage
Wire Harness/Connectors

5) Miscellaneous, Finish and Assembly – MS

Driver's Harness
Fire Wall
Headrest / Restraints
Mirrors
Paint – Body
Paint – Frame
Seats
Shields

6) Steering System – ST

Steering Rack
Steering Shaft
Steering Wheel
Steering Wheel Quick Release
Tie Rods

7) Suspension System – SU

Bell Cranks
Front A/Arms or Equivalent
Front Uprights
Pushrods/Pullrods
Rear A/Arms or Equivalent
Rear Uprights
Rod Ends
Shocks Front
Springs
Suspension Mechanism

8) Wheels, Wheel Bearings and Tires - WT

Front Hubs
Lug Nuts
Rear Hubs
Tires
Valve Stems
Wheel Bearings
Wheel Studs
Wheel Weights
Wheels

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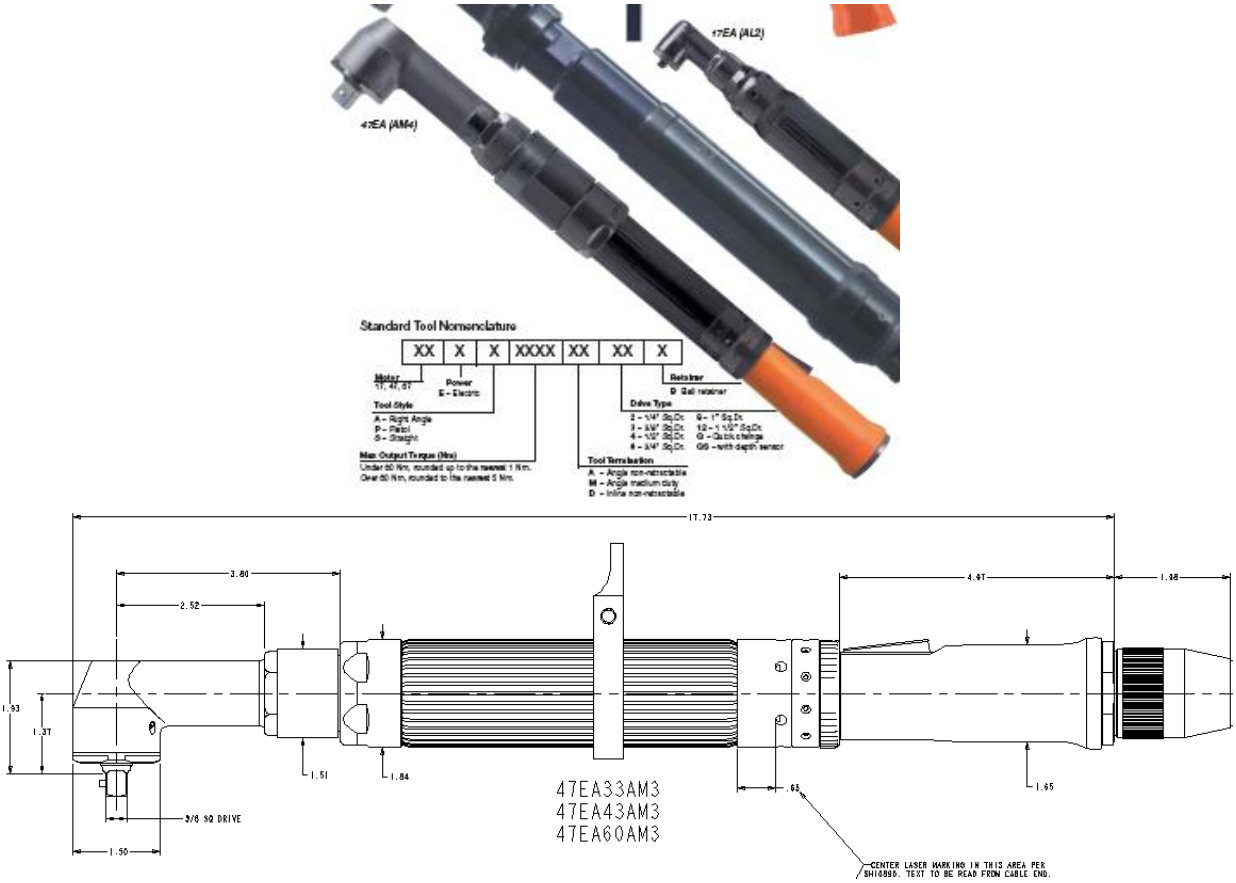
APPENDIX C-4
POWER TOOL PACKAGE ENVELOPES

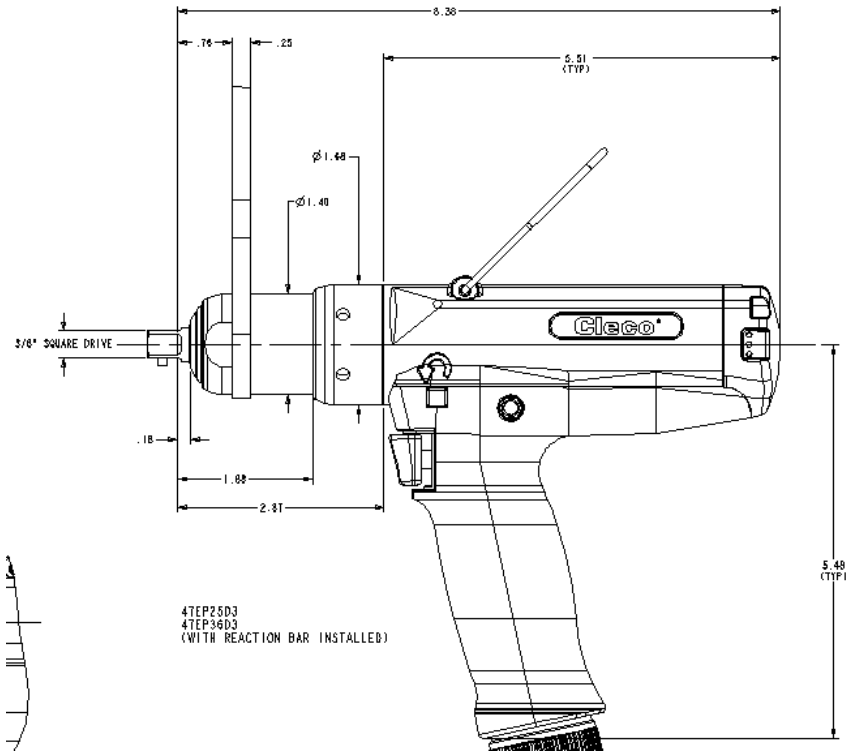
1 Any power tool may be used. There are no restrictions on size or shape. Teams should bring the actual power tool with them to the discussion at the Competition along with sockets and extensions, if applicable, and be prepared to prove to the judges the tool has access to each fastener that used the power tool cost.

2 Future years may use simplified versions of the following power tools shown below. These are included only for reference.

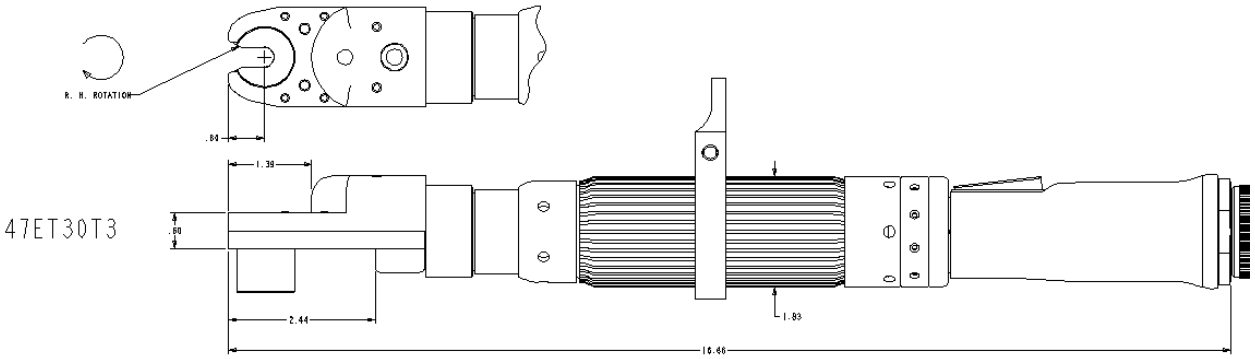
3 Right Angle Electric Power Tool:



4 Pistol Grip Electric Power Tool:



3 Nut Runner Electric Power Tool:



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Materials Table. Posted Version 19.0, 26-Jun-2014

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Added cost calculation Size1	Size2	Calc Value	Modified	Comments
	Bearing Ball, Steel	Any	Bearings	[C1]*[Size1]+[C2]	mm		0.003	0.05	0		0.05	5-May-09	[Size1]=Ball diameter (mm). Any steel materiAluminum This material is for a single steel sphere ball, not a complete bearing.
	Bearing, Ball, Angular Contact	Any	Bearings	[C1]*(([Size1]^2*[Size2]))^([C2])	mm	mm	0.1	0.5	0	0	$ -	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Not to be used for wheel bearings.
	Bearing, Ball, Deep Groove	Any	Bearings	[C1]*(([Size1]^2*[Size2]))^([C2])	mm	mm	0.1	0.5	0	0	$ -	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Not to be used for wheel bearings.
	Bearing, Ball, Radial	Any	Bearings	[C1]*(([Size1]^2*[Size2]))^([C2])	mm	mm	0.1	0.5	0	0	$ -	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Not to be used for wheel bearings.
	Bearing, Cylindrical Roller	Any	Bearings	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0045	3.6	0	0	$ 3.60	23-Feb-09	[Size1]=Outer Diameter (mm). [Size2]=Length of bearing (mm). Not for wheel bearing use.
	Bearing, Double Row, Ball, Angular Contact	Any	Bearings	[C1]*(([Size1]^2*[Size2]))^([C2])	mm	mm	0.1	0.5	0	0	$ -	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Not to be used for wheel bearings.
	Bearing, Double Row, Ball, Deep Groove	Any	Bearings	[C1]*(([Size1]^2*[Size2]))^([C2])	mm	mm	0.1	0.5	0	0	$ -	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Not to be used for wheel bearings.
	Bearing, Double Row, Ball, Radial	Any	Bearings	[C1]*(([Size1]^2*[Size2]))^([C2])	mm	mm	0.1	0.5	0	0	$ -	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Not to be used for wheel bearings.
	Bearing, Linear, Closed	Any	Bearings	[C1]*[Size1]^2*[Size2]+[C2]	mm	mm	0.00010	7.38	0	0	$ 7.38	10-Mar-09	[Size1]=Outer diameter (mm), [Size2]=Length (mm). Use with end-supported shafts.
	Bearing, Linear, Open	Any	Bearings	[C1]*[Size1]^2*[Size2]+[C2]	mm	mm	0.00012	13.1	0	0	$ 13.10	10-Mar-09	[Size1]=Outer diameter (mm), [Size2]=Length (mm). Use with continuously supported shafts or where access to shaft ends is not possible.
	Bearing, Needle	Any	Bearings	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0045	3.6	0	0	$ 3.60	23-Feb-09	[Size1]=Outer Diameter (mm). [Size2]=Length of bearing (mm). Any style of needle bearing. Not for wheel bearing use.
	Bearing, Spherical	Any	Bearings	[C1]*[Size1]^2+[C2]	mm		0.03	5.00	0		$ 5.00		[Size1]=bore size (diameter of hole in spherical bearing).
	Bearing, Tapered Needle	Any	Bearings	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0045	10.45	0	0	$ 10.45	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Cost includes outer ring, inner ring and roller assembly. Not to be used for wheel bearings.
	Bearing, Tapered Roller	Any	Bearings	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0045	10.45	0	0	$ 10.45	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Cost includes outer ring, inner ring and roller assembly. Not to be used for wheel bearings.
	Bearing, Thrust Needle Roller, Cage Assembly	Any	Bearings	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.02	0.15	0	0	$ 0.15	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Cost includes cage assembly but no washers. Not to be used for wheel bearings.
	Bearing, Thrust Needle Roller, Washers	Any	Bearings	[C1]*[Size1]^2*[Size2]+[C2]	mm	mm	0.0003	0.13	0	0	$ 0.13	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). For thrust bearings. Not to be used for wheel bearings.
	Bushing, Student Built	Student Built	Bearings	$ -	unit								Solid material (metal, plastic, etc.). No moving elements (ball, needle, etc.)
	Rod End, Aluminum	Any	Bearings	[C1]*[Size1]^2+[C2]	mm		0.05	3.80	0		$ 3.80		[Size1]=bore size (diameter of hole in spherical bearing). Includes male/female and left/right threads.
	Rod End, Industrial	Any	Bearings	[C1]*[Size1]^2+[C2]	mm		0.02	1.22	0		$ 1.22		[Size1]=bore size (diameter of hole in spherical bearing). Includes male/female and left/right threads. Not for Suspensions
	Rod End, Suspension	Any	Bearings	[C1]*[Size1]^2+[C2]	mm		0.05	5.00	0		$ 5.00		[Size1]=bore size (diameter of hole in spherical bearing). Includes male/female and left/right threads.

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Wheel Bearing, Ball, Angular Contact	Any	Bearings	[C1]*(([Size1]^2*[Size2]))^([C2])	mm	mm	0.4	0.5	0	0	$ -	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Higher load capacity bearings intended for wheel/hub applications.
	Wheel Bearing, Ball, Deep Groove	Any	Bearings	[C1]*(([Size1]^2*[Size2]))^([C2])	mm	mm	0.4	0.5	0	0	$ -	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Higher load capacity bearings intended for wheel/hub applications.
	Wheel Bearing, Ball, Radial	Any	Bearings	[C1]*(([Size1]^2*[Size2]))^([C2])	mm	mm	0.4	0.5	95	20	$ 169.94	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Higher load capacity bearings intended for wheel/hub applications.
	Wheel Bearing, Double Row, Ball, Angular Contact	Any	Bearings	[C1]*(([Size1]^2*[Size2]))^([C2])	mm	mm	0.4	0.5	0	0	$ -	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Higher load capacity bearings intended for wheel/hub applications.
	Wheel Bearing, Double Row, Ball, Deep Groove	Any	Bearings	[C1]*(([Size1]^2*[Size2]))^([C2])	mm	mm	0.4	0.5	0	0	$ -	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Higher load capacity bearings intended for wheel/hub applications.
	Wheel Bearing, Double Row, Ball, Radial	Any	Bearings	[C1]*(([Size1]^2*[Size2]))^([C2])	mm	mm	0.4	0.5	0	0	$ -	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Higher load capacity bearings intended for wheel/hub applications.
	Wheel Bearing, Tapered Needle	Any	Bearings	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.009	20.9	0	0	$ 20.90	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Higher load capacity bearings intended for wheel/hub applications.
	Wheel Bearing, Tapered Roller	Any	Bearings	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.009	20.9	0	0	$ 20.90	23-Feb-09	[Size1]=Outer diameter (mm), [Size2]=Thickness (mm). Higher load capacity bearings intended for wheel/hub applications.
	90-Degree Coupler, Tilton 72-560	Tilton	Brake System	$ 45.00	unit								
	90-Degree Coupler, Tilton 72-561	Tilton	Brake System	$ 47.50	unit							14-Mar-09	
	90-Degree Coupler, Tilton 72-562	Tilton	Brake System	$ 50.00	unit							14-Mar-09	
	ABS Kit, Bosch, M4 Kit 1	Bosch	Brake System	$ 3,534.00	unit							18-Apr-10	
	ABS Kit, Bosch, M4 Kit 2	Bosch	Brake System	$ 4,158.00	unit							18-Apr-10	
	ABS Kit and ESP Module, Bosch, ESP-9	Bosch	Brake System	$ 500.00	unit							24-Mar-16	ESP-9 module only. Does not include wiring or external sensors.
	Balance Bar Cable Adjuster, Racetech, Any BBAxx series	Racetech	Brake System	$45.00	unit							23-Mar-12	
	Balance Bar Cable Adjuster, Right Angle Drive, AP CP5500-10	AP	Brake System	$ 103.00	unit							18-Apr-10	
	Balance Bar Cable Adjuster, Sandtler, 128154	Sandtler	Brake System	$ 73.00	unit							23-May-10	
	Balance Bar, AP, CP5500-9	AP	Brake System	$ 270.00	unit								
	Balance Bar, AP, CP5520-4	AP	Brake System	$ 300.00	unit							8-Jun-09	
	Balance Bar, Brake, Student Built	Student Built	Brake System	$ -	unit								
	Balance Bar, OBP,OBPCB010	OBP	Brake System	$ 20.00	unit							29-Apr-15	
	Balance Bar, Sandtler, 128153	Sandtler	Brake System	$ 65.00	unit							23-May-10	
	Balance Bar, Sandtler, 128154	Sandtler	Brake System	$ 73.00	unit							23-May-10	
	Balance Bar, Tilton, 72-250	Tilton	Brake System	$ 30.00	unit								
	Balance Bar, Tilton, 72-260	Tilton	Brake System	$ 30.00	unit								
	Balance Bar, Tilton, 72-280	Tilton	Brake System	$ 312.50	unit								
	Balance Bar, Tilton, 72-281	Tilton	Brake System	$ 325.00	unit								
	Balance Bar, Tilton, 72-300	Any	Brake System	$ 32.00	unit							15-Mar-09	
	Balance Bar, Timms Autoteile, 013 901	Timms Autoteile	Brake System	$ 28.40	unit							3-May-09	
	Balance Bar, Wilwood, 340-4745	Wilwood	Brake System	$ 30.00	unit							3-Jun-13	
	Balance Bar, Wilwood, 340-4745	Wilwood	Brake System	$ 30.00	unit							13-Oct-14	
	Brake Caliper Piston, Student Built	Student Built	Brake System	$ 5.00	unit								
	Brake Caliper, Harrison, 121019P	Harrison	Brake System	$ 162.00	unit							27-Mar-09	
	Brake Caliper, AP, CP2577	AP	Brake System	$ 125.00	unit								
	Brake Caliper, AP, CP3696-6E0	AP	Brake System	$ 77.50	unit								
	Brake Caliper, AP, CP4226	AP	Brake System	$ 112.50	unit								
	Brake Caliper, AP, CP4227	AP	Brake System	$ 200.00	unit								

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Brake Caliper, AP, CP4488	AP	Brake System	$ 490.00	unit								
	Brake Caliper, AP, CP7003	AP	Brake System	$ 100.00	unit								
	Brake Caliper, AP, CP7853	AP	Brake System	$ 340.50	unit							23-May-10	
	Brake Caliper, Beringer, 2D1	Beringer	Brake System	$ 83.00	unit							7-May-11	
	Brake Caliper, Beringer, 4H02	Beringer	Brake System	$ 110.00	unit							7-May-11	
	Brake Caliper, Beringer, 4H12	Beringer	Brake System	$ 110.00	unit							7-May-11	
	Brake Caliper, Brembo, 20.5161.46/P32F	Brembo	Brake System	$ 50.00	unit								
	Brake Caliper, Brembo, 20.6001/P2-24	Brembo	Brake System	$ 350.00	unit							30-Mar-14	
	Brake Caliper, Brembo, 20.6101/GP4-24	Brembo	Brake System	$ 450.00	unit								
	Brake Caliper, Brembo, 20.6950.10	Brembo	Brake System	$ 70.00	unit							23-Feb-09	
	Brake Caliper, Brembo, 20.6950.11/P32G	Brembo	Brake System	$ 70.00	unit							6-Apr-09	
	Brake Caliper, Brembo, 20.6950.21/P32G	Brembo	Brake System	$ 70.00	unit								
	Brake Caliper, Brembo, 20.6951.12/P34G	Brembo	Brake System	$ 70.00	unit							24-Feb-09	
	Brake Caliper, Brembo, 20.6951.50/P34C	Brembo	Brake System	$ 70.00	unit								
	Brake Caliper, Brembo, 20.6960.10/P30G	Brembo	Brake System	$ 62.82	unit							2-Jun-14	
	Brake Caliper, Comet 650, Front		Brake System	$ 43.00	unit							1-Mar-09	
	Brake Caliper, Formula-Italy, MTC 350cc	Formula-Italy	Brake System	$ 52.00	unit							9-Mar-16	
	Brake Caliper, Harrison, 222004P	Harrison	Brake System	$ 94.00	unit							27-Mar-09	
	Brake Caliper, Harrison, 222005P	Harrison	Brake System	$ 94.00	unit							27-Mar-09	
	Brake Caliper, Honda, 45150-HP1-006	Honda/Nissin	Brake System	$ 55.00	unit								
	Brake Caliper, Honda, 45150-HN6-006	Honda/Nissin	Brake System	$ 30.00	unit								
	Brake Caliper, ISR, 22-028	ISR	Brake System	$ 65.00	unit								
	Brake Caliper, ISR, 22-034	ISR	Brake System	$ 240.00	unit							20-Apr-10	Same cost left and right calipers
	Brake Caliper, ISR, 22-036	ISR	Brake System	$ 77.50	unit							20-Mar-10	
	Brake Caliper, ISR, 22-048	ISR	Brake System	$ 96.00	unit								
	Brake Caliper, ISR, 22-049	ISR	Brake System	$ 97.00	unit							20-Mar-10	
	Brake Caliper, ISR, 22-050-OA	ISR	Brake System	$ 218.88	unit							28-May-15	
	Brake Caliper, Magura, 908.1	Magura	Brake System	$ 226.00	unit							20-Mar-10	
	Brake Caliper, Motorcycle, OEM (Any)	Any	Brake System	AIR	unit							24-Feb-09	
	Brake Caliper, NISSIN, 08-1CP-32-15	Nissin	Brake System	$ 82.00	unit								
	Brake Caliper, NISSIN, 08-2CP-25-08	Nissin	Brake System	$ 96.00	unit								
	Brake Caliper, NISSIN, 08-2CT-25-06	Nissin	Brake System	$ 109.00	unit								
	Brake Caliper, NISSIN, 08-2CT-38-07	Nissin	Brake System	$ 109.00	unit								
	Brake Caliper, Polaris, 1910825/1910826	Polaris	Brake System	$ 66.00	unit							1-Mar-09	Cost applies to either part number (similar part one left hand one right hand)
	Brake Caliper, Pretech, P400	Pretech	Brake System	$ 125.00	unit							28-May-15	Same price for left and right calipers.
	Brake Caliper, PVM, 2-Piston Monoblock Radial Mount	PVM	Brake System	$ 225.00	unit							19-Apr-09	
	Brake Caliper, PVM, 6-piston Monoblock Radial Mount	PVM	Brake System	$ 600.00	unit							19-Apr-09	
	Brake Caliper, PVM, Front 4-Piston Monoblock Radial Mount	PVM	Brake System	$ 385.00	unit							19-Apr-09	
	Brake Caliper, PVM, Rear 4-Piston Monoblock Radial Mount	PVM	Brake System	$ 225.00	unit							19-Apr-09	
	Brake Caliper, Red Devil,240 Sprint	Red Devil	Brake System	$ 147.50	unit							20-Mar-14	Same price for left and right calipers.
	Brake Caliper, Spiegler, S070	Spiegler	Brake System	$ 207.00	unit							23-May-10	Same price for left and right calipers.
	Brake Caliper, Spiegler, S108	Spiegler	Brake System	$ 257.00	unit							23-May-10	Same price for left and right calipers.
	Brake Caliper, Student Built	Student Built	Brake System	$ -	unit								
	Brake Caliper, Tokico, 45150-MEL-023	Tokico	Brake System	$ 75.00	unit							2-Mar-09	
	Brake Caliper, Wilwood, Billet Dynalite Side Inlet 120-5081	Wilwood	Brake System	$ 85.00	unit							18-Dec-14	
	Brake Caliper, Wilwood, Billet Dynalite Single	Wilwood	Brake System	$ 50.00	unit								
	Brake Caliper, Wilwood, Billet NDL	Wilwood	Brake System	$ 78.00	unit								
	Brake Caliper, Wilwood, Dynalite Single Floater	Wilwood	Brake System	$ 50.00	unit								
	Brake Caliper, Wilwood, DynaPro Radial	Wilwood	Brake System	$ 110.00	unit								
	Brake Caliper, Wilwood, DynaPro Single	Wilwood	Brake System	$53.00	unit							18-Apr-10	

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Brake Caliper, Wilwood, Forged Dynalite	Wilwood	Brake System	$ 68.00	unit								
	Brake Caliper, Wilwood, GP200	Wilwood	Brake System	$ 49.50	unit							4-Dec-13	
	Brake Caliper, Wilwood, GP310	Wilwood	Brake System	$ 105.00	unit								
	Brake Caliper, Wilwood, GP320	Wilwood	Brake System	$ 98.00	unit								
	Brake Caliper, Wilwood, Kart	Wilwood	Brake System	$ 58.00	unit								
	Brake Caliper, Wilwood, NDL	Wilwood	Brake System	$ 70.00	unit								
	Brake Caliper, Wilwood, PS-1	Wilwood	Brake System	$ 46.00	unit								
	Brake Caliper, Yamaha (YZF 450), 5TG-2580T-00-00	Yamaha	Brake System	$ 91.00	unit							20-Mar-10	
	Brake Hard Line, Any Material (All Cost as Made)	Any	Brake System	$ -	unit								
	Brake Light Pressure Switch Banjo Bolt	Any	Brake System	$ 8.00	unit							8-Mar-09	
	Brake Pad, Aluminum or MMC Rotor	Any	Brake System	$ 0.0004	mm^3								Volume of pad and backing plate to be included in calculation
	Brake Pad, Carbon Rotor	Any	Brake System	$ 0.0012	mm^3								Please submit Add Item Request
	Brake Pad, Iron or Steel Rotor	Any	Brake System	$ 0.0002	mm^3								Volume of pad and backing plate to be included in calculation.
	Brake Rotor (All Cost as Made)	Any	Brake System	$ -	unit								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Hydraulic Fluid Reservoir, Remote (Plastic)	Any	Brake System	$ 5.00	unit							22-Feb-09	Includes lid
	Master Cyilnder, ISR, 21-010-OE	ISR	Brake System	$ 81.00	unit							18-Apr-10	
	Master Cylinder, AP, CP2623	AP	Brake System	$ 81.50	unit								
	Master Cylinder, AP, CP3756	AP	Brake System	$ 97.00	unit							19-Apr-09	
	Master Cylinder, AP, CP4400	AP	Brake System	$ 117.50	unit								
	Master Cylinder, AP, CP4623	AP	Brake System	$ 68.50	unit							9-May-10	
	Master Cylinder, AP, CP5854	AP	Brake System	$ 203.50	unit								
	Master Cylinder, AP, CP5855	AP	Brake System	$ 260.00	unit								
	Master Cylinder, AP, CP6465	AP	Brake System	$ 203.50	unit								
	Master Cylinder, AP, CP7855	AP	Brake System	$ 174.50	unit							23-May-10	
	Master Cylinder, Beck Arnley, 072-9455	Beck Arnley	Brake System	$ 45.00	unit							1-Mar-10	
	Master Cylinder, Beringer MC12.7 x 22	Beringer	Brake System	$ 160.59								2-Jun-14	
	Master Cylinder, Brembo, 10.4776.10	Brembo	Brake System	$ 26.00	Unit								
	Master Cylinder, Brembo, 10.4776.20	Brembo	Brake System	$ 26.00	Unit							1-Jun-09	
	Master Cylinder, Brembo, 10.4776.65	Brembo	Brake System	$ 46.50	Unit								
	Master Cylinder, Brembo, XA3.G1.A2/L2	Brembo	Brake System	$ 317.00	unit							29-Mar-09	Front Pivot Fixing with Vertical Bearing
	Master Cylinder, Brembo, XA6.C2.3	Brembo	Brake System	$ 205.00	Unit							8-Jun-09	
	Master Cylinder, Bremob, 10.6815.16/97	Brembo	Brake System	$ 193.00	unit							29-Mar-09	Single Nut Fixing
	Master Cylinder, Bremob, 10.9243.54/96	Brembo	Brake System	$ 167.50	unit							29-Mar-09	Two Bolt Fixing
	Master Cylinder, Centric Parts, CE130.51017	Centric	Brake System	$ 51.00	unit							1-Mar-09	
	Master Cylinder, Girling	Girling	Brake System	$ 44.00	unit							3-Aug-09	
	Master Cylinder, Honda CBR600F4i, 43510MBW006	Honda	Brake System	$ 127.20	unit							18-Apr-10	
	Master Cylinder, Hyundai Mobis, 41610-2D100	Hyundai Mobis	Brake System	$ 28.00	unit							20-Mar-10	
	Master Cylinder, Magura, 10.5mm	Magura	Brake System	$ 55.00	unit							20-Mar-10	
	Master Cylinder, Magura, 770.1	Magura	Brake System	$ 222.50	unit							20-Mar-10	
	Master Cylinder, Magura, 770.50	Magura	Brake System	$ 222.50	unit							20-Mar-10	
	Master Cylinder, New Concept Products, G3	New Concept Products	Brake System	$ 32.50								26-Mar-09	
	Master Cylinder, NISSIN, 08-2RM-14-02	Nissin	Brake System	$ 55.00									
	Master Cylinder, NISSIN, 08-4RM-15-05	Nissin	Brake System	$ 57.00									
	Master cylinder, Nissin, 153-M00-125B	Nissin	Brake System	$ 55.00	unit							1-Mar-09	
	Master Cylinder, Student Made	Student Built	Brake System	$ -	unit								
	Master Cylinder, Suzuki OEM 69600-16G00	Suzuki	Brake System	$ 65.00	unit							23-May-10	
	Master Cylinder, Tilton, Model 73	Tilton	Brake System	$ 27.50	unit								
	Master Cylinder, Tilton, Model 74	Tilton	Brake System	$ 39.50	unit								
	Master Cylinder, Tilton, Model 75	Tilton	Brake System	$ 49.50	unit								
	Master Cylinder, Tilton, Model 76	Tilton	Brake System	$ 62.50	unit								

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Master Cylinder, Tilton, Model 77	Tilton	Brake System	$ 197.50	unit								
	Master Cylinder, Tonykart, BS5 0029.E0	Tonykart	Brake System	$ 130.00	unit							7-May-14	
	Master Cylinder, Tripmatic & Speed 18771	Tripmatic	Brake System	$ 30.50	unit							23-May-10	
	Master Cylinder, Wilwood, 260-10371	Wilwood	Brake System	$ 43.00	unit							1-Mar-10	
	Master Cylinder, Wilwood, 260-10373	Wilwood	Brake System	$ 43.00	unit							1-Mar-10	
	Master Cylinder, Wilwood, 260-1304	Wilwood	Brake System	$ 27.00	unit							1-Mar-10	
	Master Cylinder, Wilwood, 260-2636	Wilwood	Brake System	$ 27.00	unit							1-May-09	
	Master Cylinder, Wilwood, 260-4201	Wilwood	Brake System	$ 37.50	unit							15-Dec-15	
	Master Cylinder, Wilwood, 260-5520	Wilwood	Brake System	$ 39.40	unit							24-Feb-09	
	Master Cylinder, Wilwood, 260-6087	Wilwood	Brake System	$ 26.00	unit							20-Mar-10	
	Proportioning Valve, Hydraulic	Any	Brake System	$ 35.00	unit								
	Proportioning Valve, Tilton, 90-1000	Tilton	Brake System	$ 49.50	unit								
	Proportioning Valve, Tilton, 90-1003	Tilton	Brake System	$ 49.50	unit								
	Proportioning Valve, Tilton, 90-2000	Tilton	Brake System	$ 49.50	unit								
	Proportioning Valve, Tilton, 90-2003	Tilton	Brake System	$ 49.50	unit								
	Proportioning Valve, Wilwood, 260-10922	Wilwood	Brake System	$ 22.65	unit							31-Mar-16	
	Proportioning Valve, Wilwood, 260-11179	Wilwood	Brake System	$ 49.50	unit							8-Mar-16	
	Remote Brake Bias Adjuster, AP Racing, CP2905-8	AP	Brake System	$ 45.50	unit							26-Jun-14	
	Remote Brake Bias Adjuster, Tilton 72-408	Tilton	Brake System	$ 97.50	unit							14-Mar-09	
	Remote Brake Bias Adjuster, Tilton 72-501	Tilton	Brake System	$ 33.25	unit								
	Remote Brake Bias Adjuster, Wilwood, 340-4990	Wilwood	Brake System	$ 26.00	unit							4-Jun-13	
	Remote Brake Bias Adjuster, Wilwood, 340-4990	Wilwood	Brake System	$ 26.00	unit							14-Oct-14	
	Slave Cylinder, CNC, SERIES 305	CNC	Brake System	$ 35.00	unit							3-Aug-09	
	Chassis (All Cost as Made)	Any	Chassis	$ -	unit							26-Mar-10	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Hubs (All Cost as Made)	Any	Chassis	$ -	unit							26-Mar-10	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Monocoque (All Cost as Made)	Any	Chassis	$ -	unit							26-Mar-10	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Rockers (All Cost as Made)	Any	Chassis	$ -	unit							26-Mar-10	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Upright (All Cost as Made)	Any	Chassis	$ -	unit							26-Mar-10	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Adhesive Film	Any	Composite	$ -	m^2								Included in composite cost
	Aramid (Kevlar) Fiber, 1 Ply	Any	Composite	$ 150.00	kg								Density= 1420kg/m^3 Dry or Pre-Preg. Both include resin. Hand trimming allowed.
	Basalt Fiber, 1 Ply	Any	Composite	$ 110.00	kg							31-Mar-14	Density= 2200kg/m^3 Dry or Pre-Preg. Both include resin. Hand trimming allowed.
	Carbon Fiber Reinf Carbon	Any	Composite	$ 0.0092	mm^3							19-Apr-09	Note: actual cost is $0.0092 even though display shows $0.01 actual value is used in math.
	Carbon Fiber Reinf Silicon Carbide, Brake Pads	Any	Composite	$ 0.0012	mm^3							19-Apr-09	Note: actual cost is $0.0012 even though display shows $0.01 actual value is used in math.
	Carbon Fiber Reinf Silicon Carbide, Brake Rotors	Any	Composite	$ 0.0092	mm^3							19-Apr-09	Note: actual cost is $0.0092 even though display shows $0.01 actual value is used in math.
	Carbon Fiber, 1 Ply	Any	Composite	$ 200.00	kg								Density= 1580kg/m^3 Dry or Pre-Preg. Both include resin. Hand trimming allowed.
	Ceramic Matrix Composite, 1 Ply	Any	Composite	$ 500.00	kg							29-Mar-14	No official density due to density variability Includes resin(matrix). Hand trimming allowed.
	Flax Fiber, 1 Ply	Any	Composite	$ 110.00	kg							31-Mar-14	Density= 1400kg/m^3 Dry or Pre-Preg. Both include resin. Hand trimming allowed.
	Glass Fiber, 1 Ply	Any	Composite	$ 100.00	kg								Density= 2200kg/m^3 e.g. S-Glass. Dry or Pre-preg. Both include resin. Hand trimming allowed.
	Honeycomb, Aluminum	Any	Composite	$ 50.00	kg								No official density due to density variability, Any cell size and density. Hand trimming allowed.
	Honeycomb, Cardboard	Any	Composite	$ 10.00	kg							1-Mar-09	No official density due to density variability, Any cell size and density. Hand trimming allowed.

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Honeycomb, Nomex	Any	Composite	$ 125.00	kg								No official density due to density variability, Any cell size and density. Hand trimming allowed.
	Honeycomb, Plastic	Any	Composite	$ 20.00	kg							26-Mar-09	No official density due to density variability, Any cell size and density. Hand trimming allowed.
	Polypropylene, High Modulus	Any	Composite	$ 35.00	kg							20-Apr-10	Density= 900kg/m^3 Includes 'Tegris' and 'Innegra' fibers
	Structural Foam	Any	Composite	$ 125.00	kg								No official density due to density variability, Any cell size and density. Hand trimming allowed.
	Carbon Fiber Tubes, Purchased (All Cost as Made)	Any	Composites	$ -	unit							8-Mar-09	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Composite Panel Insert, Potted-in (NAS) Style, Torlon	Torlon	Composites	$ 2.00	unit							22-Apr-09	Any Size
	Composite Panel Insert, Press Fit, Torlon	Torlon	Composites	$ 2.00	unit							22-Apr-09	Any Size
	Composite Tubes, Purchased (All Cost as Made)	Any	Composites	$ -	unit							8-Mar-09	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Aim Evo 3 Pista Car	AIM	Control Module	$ 940.00								18-Jun-13	
	Aim Evo 3 Pro Car	AIM	Control Module	$ 1,200.00								18-Jun-13	
	Aim Evo 4 DataLogger Car	AIM	Control Module	$ 575.00								18-Jun-13	
	Aim MXL Pista Race Graphic Car	AIM	Control Module	$ 940.00								18-Jun-13	
	Aim MXL Pista Road Graphic Car	AIM	Control Module	$ 940.00								18-Jun-13	
	Aim MXL Pro05 Car	AIM	Control Module	$ 1,200.00								18-Jun-13	
	Aim MXL Strada Race Graphic Car	AIM	Control Module	$ 525.00								18-Jun-13	
	Aim MXL Strada Road Graphic Car	AIM	Control Module	$ 525.00								18-Jun-13	
	Aim SmartyCam GPS Standard	AIM	Control Module	$ 500.00								18-Jun-13	
	Aim SmartyCamGP Complete Car	AIM	Control Module	$ 500.00								18-Jun-13	
	Aim Solo DL GPS LapTimer For Car	AIM	Control Module	$ 300.00								18-Jun-13	
	Aim Solo GPS Lap Timer Kit 1 Car	AIM	Control Module	$ 180.00								18-Jun-13	
	Aim TG Lap Timer External Power	AIM	Control Module	$ 165.00								18-Jun-13	
	Aim TG Lap Timer Internal Power	AIM	Control Module	$ 165.00								18-Jun-13	
	Chassis Cntrl Module, +Active Differential	Student Built	Control Module	$ 125.00	unit							2-Mar-09	Includes circuit board and circuitry for processing necessary inputs (wheel speed, axle speed, etc) and differential control outputs. Required Chassis Control Module, Baseline Enclosure. Sensors and wiring harness not included.
	Chassis Control Module, +Active Suspension	Student Built	Control Module	$ 125.00	unit							2-Mar-09	Includes circuit board and circuitry necessary inputs (damper position, velocity, etc) and damper control outputs. Required Chassis Control Module, Baseline Enclosure. Sensors and wiring harness not included.
	Chassis Control Module, +Automatic Shifter	Student Built	Control Module	$ 5.00	unit							2-Mar-09	Includes circuit board and circuitry for processing sensor input from engine, output to shifter. Required Chassis Control Module, Baseline Enclosure. Sensors and wiring harness not included.
	Chassis Control Module, +Battery Charger	Student Built	Control Module	$ 10.00	unit							2-Mar-09	Includes circuit board and circuitry for processing battery health input from pack and charging outputs. Required Chassis Control Module, Baseline Enclosure. Sensors and wiring harness not included.
	Chassis Control Module, +Dashboard	Student Built	Control Module	$ 20.00	unit							2-Mar-09	Includes circuit board and circuitry for processing sensor inputs and dashbboard outputs. Required Chassis Control Module, Baseline. Sensors and wiring harness not included.
	Chassis Control Module, +Dashboard	Student Built	Control Module	$ 5.00	unit							2-Mar-09	Includes circuit board and circuitry for processing sensor input and output to one (1) engine actuator device. Include once per actuator in the chassis control module. Required Chassis Control Module, Baseline. Sensors and wiring harness not included.
	Chassis Control Module, +Electronic Brake Bias	Student Built	Control Module	$ 25.00	unit							23-Mar-12	

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Chassis Control Module, +Traction Control	Student Built	Control Module	$ 150.00	unit							2-Mar-09	Includes circuit board and circuitry for processing sensor input from engine, output to shifter. Required Chassis Control Module, Baseline Enclosure. Sensors and wiring harness not included.
	Chassis Control Module, Baseline Enclosure	Student Built	Control Module	$ 25.00	unit							2-Mar-09	Includes enclosure. This item must be included for all chassis control modules. Add functionality by adding additional line items.
	Controller, Active Differential	Any	Control Module	$ 200.00	unit								
	Controller, Active Suspension	Any	Control Module	$ 200.00	unit								
	Datalogger, 2D, Formula Student Data Logger	2D	Control Module	$ 1,020.00	unit							26-Jun-14	2D Debus & Diebold Meßsysteme GmbH
	Datalogger, Aim EVO4	AIM	Control Module	$ 700.00	unt							23-May-10	No screen data logger
	Datalogger, Aim MXL 2	AIM	Control Module	$ 1,000.00	unt							30-Mar-15	Dash display data logger
	Datalogger, Aim MXL Pista	AIM	Control Module	$ 1,000.00	unt							5-Jun-13	Dash display data logger
	Datalogger, Aim MXL Pista	AIM	Control Module	$ 1,000.00	unt							15-Oct-14	Dash display data logger
	Datalogger, Bosch, DDU 7	MoTeC	Control Module	$ 2,350.00	unit							28-Mar-15	Dash display with data logger
	Datalogger, Motec, ADL	MoTeC	Control Module	$ 1,490.00	unit							9-Mar-15	Dash display with data logger
	Datalogger, Motec, ADL2	MoTeC	Control Module	$ 1,490.00	unit							9-Mar-15	Dash display with data logger
	Datalogger, Motec, ADL3	MoTeC	Control Module	$ 1,490.00	unit							9-Mar-15	Dash display with data logger
	Datalogger, Motec, C125	MoTeC	Control Module	$ 1,555.00	unit							29-Mar-16	Dash display with data logger
	Datalogger, Motec, C185	MoTeC	Control Module	$ 2,695.00	unit							15-Dec-15	Dash display with data logger
	Datalogger, Motec, CDL3	MoTeC	Control Module	$ 1,200.00	unit							6-Jun-13	Dash display
	Datalogger, Motec, CDL3	MoTeC	Control Module	$ 1,200.00	unit							16-Oct-14	Dash display
	Datalogger, Murphy, Powerview 450	Murphy	Control Module	$ 450.00	unit							30-Mar-15	Dash display with data logger
	Datalogger, Race Technologies, DL1	Race Technologies	Control module	$ -	unit							13-Mar-15	No screen data logger
	Dashboard, Translogic Systems, Micro Dash	Tanslogic Systems	Control Module	$ 314.00	unit							26-Jun-14	Dash display
	ECU, AEM, Coil driver 30-2840	AEM	Control Module	$ 93.75	unit							20-Mar-14	
	ECU, AEM, EMS-4, 30-6905	AEM	Control Module	$ 472.00	unit							12-Jan-16	
	ECU, AEM Plug & Play, AVM-30-1052U	AEM	Control Module	$ 725.00	unit								
	ECU, AEM Plug & Play, Infinity-6, 30-7106	AEM	Control Module	$ 778.00	unit							26-Mar-14	
	ECU, AEM Plug & Play, Infinity-8, 30-7101	AEM	Control Module	$ 1,305.50	unit							3-Mar-14	
	ECU, AEM Plug & Play, Infinity-8h, 30-7108	AEM	Control Module	$ 717.00	unit							19-Feb-15	
	ECU, AEM Plug & Play, Infinity-10, 30-7100	AEM	Control Module	$ 1,500.00	unit							3-Mar-14	
	ECU, AEM Plug & Play, Infinity-12, 30-7102	AEM	Control Module	$ 1,777.75	unit							3-Mar-14	
	ECU, AEM Wire & Play	AEM	Control Module	$ 751.93	unit								
	ECU, Aeromotive, Fuel Pump Controller, 16306	Aeromotive	Control Module	$ 175.00	unit							31-Mar-14	Only controls fuel pump pressure
	ECU, Autronic, SM4	Autronic	Control Module	$ 1,150.00	unit							19-Apr-09	
	ECU, Bosch Motorsport, HPI Box 1.1	Bosch	Control Module	$ 1,200.00	unit							23-May-10	
	ECU, Bosch Motorsport, MS3 Sport	Bosch	Control Module	$ 952.00	unit							4-May-09	
	ECU, Bosch Motorsport, MS4.0 Sport	Bosch	Control Module	$ 1,100.00	unit							23-Apr-09	
	ECU, Bosch Motorsport, MS4.4 Sport, F01TA20068	Bosch	Control Module	$ 1,400.00	unit							3-Apr-09	
	ECU, DTA, S100 Pro	DTA	Control Module	$ 950.00	unit							20-Apr-10	
	ECU, DTA, S40 Pro	DTA	Control Module	$ 495.00	unit							20-Apr-10	
	ECU, DTA, S60 Pro	DTA	Control Module	$ 750.00	unit							20-Apr-10	
	ECU, DTA, S80 Pro	DTA	Control Module	$ 850.00	unit							20-Apr-10	
	ECU, Dynojet, Autotune (single channel), AT-200	Dynojet	Control Module	$ 140.00	unit							7-Jun-13	Requires Dynojet Powercommander
	ECU, Dynojet, Autotune (single channel), AT-200	Dynojet	Control Module	$ 140.00	unit							17-Oct-14	Requires Dynojet Powercommander
	ECU, Dynojet, LCD unit, LCD-100 &200	Dynojet	Control Module	$ 150.00	unit							8-Jun-13	Dash display, Requires Dynojet Powercommander
	ECU, Dynojet, LCD unit, LCD-100 &200	Dynojet	Control Module	$ 150.00	unit							18-Oct-14	Dash display, Requires Dynojet Powercommander
	ECU, Dynojet, Power Commander V USB	Dynojet	Control Module	$ 200.00	unit							9-Jun-13	Requires OEM ECU to also be included in cost
	ECU, Dynojet, Power Commander V USB	Dynojet	Control Module	$ 200.00	unit							19-Oct-14	Requires OEM ECU to also be included in cost
	ECU, Dynojet, Power Commander V-PTi USB	Dynojet	Control Module	$ 225.00	unit							10-Jun-13	Requires OEM ECU to also be included in cost. Pti version is for turbo applications
	ECU, Dynojet, Power Commander V-PTi USB	Dynojet	Control Module	$ 225.00	unit							20-Oct-14	Requires OEM ECU to also be included in cost. Pti version is for turbo applications
	ECU, Dynojet, Power Commender III USB	Dynojet	Control Module	$ 175.00	unit								Requires OEM ECU to also be included in cost
	ECU, Electromotive, TEC-GT	Electromotive	Control Module	$ 1,000.00	unit								

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	ECU, EngineLab, EL1140L	EngineLab	Control Module	$ 1,250.00	unit							1-Mar-10	
	ECU, FuelTech, FT400 EFI	FuelTech	Control Module	$ 750.00								16-Dec-14	
	ECU, FuelTech, FT500 EFI	FuelTech	Control Module	$ 1,050.00	unit							16-Dec-14	
	ECU, Haltech, E11v2	Haltech	Control Module	$ 966.00	unit								6,8 c seq
	ECU, Haltech, E6x	Haltech	Control Module	$ 590.00	unit								4,6,8 c
	ECU, Haltech, E8	Haltech	Control Module	$ 762.00	unit								4 c seq
	ECU, Haltech, Elite 1500	Haltech	Control Module	$ 775.00	unit							15-Dec-15	
	ECU, Haltech, Platinum Sport 2000 Long Flying Lead Kit	Haltech	Control Module	$ 850.00	unit								
	ECU, Haltech, PS1000	Haltech	Control Module	$ 536.00	unit							1-Jun-09	
	ECU, Life Racing, F88R	Life Racing	Control Module	$ 870.00	unit							25-Mar-14	
	ECU, Link, G4 Storm	Link	Control Module	$ 647.50	unit							27-Mar-09	
	ECU, Magneti Marelli, SRA-E	Magneti Marelli	Control Module	$ 870.00	unit							4-May-09	
	ECU, Magneti Marelli, SRA-EDL 4	Magneti Marelli	Control Module	$ 1,275.00	unit							4-May-09	
	ECU, Magneti Marelli, SRA-EDL 8	Magneti Marelli	Control Module	$ 1,275.00	unit							4-May-09	
	ECU, Magneti Marelli, SRT-E	Magneti Marelli	Control Module	$ 1,945.00	unit							4-May-09	
	ECU, Magneti Marelli, SRT-EDL 16	Magneti Marelli	Control Module	$ 2,345.00	unit							4-May-09	
	ECU, Magneti Marelli, SRT-EDL 32	Magneti Marelli	Control Module	$ 2,745.00	unit							4-May-09	
	ECU, McLaren MESL TAG-400	McLaren Electronic Systems	Control Module	$ 2,500.00	unit							23-May-10	
	ECU, Megasquirt	Megasquirt	Control Module	$ 400.00	unit								Assembled with case
	ECU, Microsquirt	Megasquirt	Control Module	$ 400.00	unit								Assembled with case
	ECU, MoTeC, IEX - Ignition Expander	MoTeC	Control Module	$ 150.00	unit							26-Apr-09	
	ECU, MoTeC, LTC - Lambda sensor controller	MoTeC	Control Module	$ 281.00	unit							26-Mar-15	
	ECU, MoTeC, LTCD - Lambda sensor controller	MoTeC	Control Module	$ 422.00	unit							26-Mar-15	
	ECU, MoTeC, M4	MoTeC	Control Module	$ 1,050.00	unit								
	ECU, MoTeC, M400	MoTeC	Control Module	$ 1,615.00	unit								
	ECU, MoTeC, M48	MoTeC	Control Module	$ 1,236.00	unit								
	ECU, MoTeC, M600	MoTeC	Control Module	$ 1,650.00	unit							20-Mar-10	
	ECU, MoTeC, M800	MoTeC	Control Module	$ 1,500.00	unit							27-Nov-10	
	ECU, MoTeC, M800	MoTeC	Control Module	$ 1,650.00	unit							8-Mar-09	
	ECU, MoTeC, M84	MoTeC	Control Module	$ 1,137.50	unit							22-Feb-14	
	ECU, MoTeC, SDL3, Backlighting	MoTeC	Control Module	$ 1,723.00	unit							3-Mar-14	Note: no data logging functionality included in price.
	ECU, MoTeC, SDL3, No Backlighting	MoTeC	Control Module	$ 1,485.00	unit							3-Mar-14	Note: no data logging functionality included in price.
	ECU, MoTeC, TCMUX - Traction Control Multiplexer	MoTeC	Control Module	$ 150.00	unit							26-Apr-09	
	ECU, Nira, i3+	Nira	Control Module	$ 786.00	unit							18-Apr-10	
	ECU, OEM Spark & Fuel	Any OEM	Control Module	$ 500.00	unit								
	ECU, OEM Spark Only	Any OEM	Control Module	$ 250.00	unit								
	ECU, OEM Spark, Fuel & Traction Control	Any OEM	Control Module	$ 750.00	unit								
	ECU, Ole Buhl Racing, EFI Euro4	Ole Buhl Racing	Control Module	$ 1,669.00	unit							26-Jun-14	
	ECU, Pectel, SQ-6 ECU		Control Module	$ 1,990.00									
	ECU, Performance Electronics, PE-ECU-1	Performance Electronics	Control Module	$ 500.00	unit								
	ECU, Performance Electronics, PE-ECU-3	Performance Electronics	Control Module	$ 535.00	unit							8-Feb-12	
	ECU, Simple Digital Systems, EM-4 D	Simple Digital Systems	Control Module	$ 486.50	unit								
	ECU, Simple Digital Systems, EM-4 E/MSD	Simple Digital Systems	Control Module	$ 582.50	unit								e.g. 1010, 1025 etc.
	ECU, Simple Digital Systems, EM-4 F	Simple Digital Systems	Control Module	$ 572.50	unit								e.g. 4130, Chrome Moly, etc.
	ECU, Sodemo Moteurs, EV11/4	Sodemo Moteurs	Control Module	$ 693.00	unit								
	ECU, SPDi, programmable spark module 910001	SPDi	Control Module	$ 240.00	unit							11-Jun-13	Controls ignition only
	ECU, SPDi, programmable spark module 910001	SPDi	Control Module	$ 240.00	unit							21-Oct-14	Controls ignition only
	ECU, Student Built, +Active Diff	Student Built	Control Module	$ 125.00	unit								In addition to cost of base student built ECU

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	ECU, Student Built, +Traction Control	Student Built	Control Module	$ 150.00	unit								In addition to cost of base student built ECU
	ECU, Student Built, Spark & Fuel	Student Built	Control Module	$ 375.00	unit								Housing, connector included
	ECU, Student Built, Spark Only	Student Built	Control Module	$ 190.00	unit								Housing, connector included
	ECU, Syvecs, S6 GP	Syvecs	Control Module	$ 1,000.00	unit							18-May-15	
	ECU, Trecs, Model II	Trecs	Control Module	$ 803.00	unit							18-Apr-10	
	ECU, Trikejt Plus	Trijekt	Control Module	$ 760.00	unit							9-May-10	
	ECU, VEMS, v3	Versatile Engine Management System	Control Module	$ 400.00	unit							18-Apr-10	
	ECU, Vortex Ignitions, ECU-2D	Vortex Ignitions	Control Module	$ 276.00	unit							13-Mar-15	
	M3 XG LOG Datalogger	AIM	Control Module	$ 590.00								18-Jun-13	
	Mychron 3 Basic	AIM	Control Module	$ 140.00								18-Jun-13	
	Mychron 4 Basic	AIM	Control Module	$ 140.00								18-Jun-13	
	Cable, Pull	Any	Controls	$ 15.00	m								Includes cable and housing and integral moutnings at both ends. Mounting hardware not included
	Cable, Push/Pull	Any	Controls	$ 30.00	m								Includes cable and housing and integral moutnings at both ends. Mounting hardware not included
	Damper, AFCO, 1650, Twin tube	AFCO	Damper	$ 95.00	unit							18-Dec-14	
	Damper, AFCO, 513SP, Mono tube	AFCO	Damper	$ 85.00	unit							18-Dec-14	
	Damper, AVO, 1.9" Alum Dbl Adj (DAAWA100/75)	AVO	Damper	$ 145.00	unit							23-May-10	
	Damper, Bilstein MDS Formula Student	Bilstein	Damper	$ 800.00	unit							18-May-15	
	Damper, Cane Creek Double Barrel	Cane Creek	Damper	$ 300.00	unit								
	Damper, Cane Creek Double Barrel Air (DBAir)	Cane Creek	Damper	$ 310.00	unit							12-Jun-13	
	Damper, Cane Creek Double Barrel Air (DBAir)	Cane Creek	Damper	$ 310.00	unit							22-Oct-14	
	Damper, DT Swiss, M212	DT Swiss	Damper	$ 178.00	unit							1-Jun-14	
	Damper, DT Swiss, X313	DT Swiss	Damper	$ 278.00	unit							31-May-16	
	Damper, DNM Burner RCP	DNM	Damper	$ 190.00	unit							26-Jun-14	
	Damper, Elka Stage-5 MTB	Elka	Damper	$ 225.00	unit							23-Feb-09	
	Damper, Fox DHX 5.0	Fox	Damper	$ 210.00	unit								
	Damper, Fox Van R	Fox	Damper	$ 125.00	unit								
	Damper, Fox Vanilla R	Fox	Damper	$ 190.00	unit								
	Damper, Hotbits 4WD DT1	Hotbits	Damper	$ 260.00	unit							7-May-14	
	Damper, Kind Shock, KS-504	Kind Shock	Damper	$ 78.00	unit							18-Apr-10	
	Damper, Koni 3012	Koni	Damper	$ 250.00	unit							1-Mar-09	
	Damper, Koni, Trax Spax DA, Double Adjustable	Koni	Damper	$ 181.00	unit							19-Apr-09	
	Damper, Koni, Trax Spax DA, Single Adjustable	Koni	Damper	$ 145.00	unit							19-Apr-09	
	Damper, KW GFw 3-Way Adjustable	KW	Damper	$ 375.00	unit							23-May-10	
	Damper, Manitou, Swinger 4 Way	Manitou	Damper	$ 100.00	unit							26-Mar-09	Damper cost without spring
	Damper, Marzocchi, Roco TST R	Marzocchi	Damper	$ 135.00	unit							1-Mar-09	Damper cost without spring
	Damper, Ohlins SD115	Ohlins	Damper	$ 189.00	unit							23-May-10	
	Damper, Ohlins ST44	Ohlins	Damper	$ 325.00	unit								
	Damper, Ohlins TTX 25	Ohlins	Damper	$ 305.00	unit							9-May-10	
	Damper, Ohlins TTX 36	Ohlins	Damper	$ 500.00	unit							23-May-10	
	Damper, Penske 7800-Non-Adjustable Quarter Midget	Penske	Damper	$ 117.50	unit							3-May-10	Non-adjustable Quarter Midget
	Damper, Penske 7800-Piggyback Dbl. Adj. (Kaz Tech.)	Penske/Kaz Tech	Damper	$ 337.50	unit							3-May-10	Piggyback, Double Adjustable
	Damper, Penske 7800-Piggyback Non-Adj.(Kaz Tech.)	Penske/Kaz Tech	Damper	$ 255.00	unit							3-Apr-11	Piggyback, Non-adjustable
	Damper, Penske 8100	Penske	Damper	$ 400.00	unit							23-Feb-09	
	Damper, Penske 8300	Penske	Damper	$ 412.50	unit								
	Damper, Penske 8760	Penske	Damper	$ 660.00	unit								
	Damper, Quantum, Zero, non-adjustable	Quantum racing	Damper	$ 140.00	unit							21-Oct-16	no external adjustment
	Damper, Quantum, One.Zero, single adjustable	Quantum racing	Damper	$ 195.00	unit							21-Oct-16	
	Damper, Quantum, Two.Zero, Two-way adjustable	Quantum racing	Damper	$ 325.00	unit							21-Oct-16	

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Damper, Risse Jupiter 5	Risse Racing	Damper	$ 175.00	unit								
	Damper, Risse Jupiter 5R	Risse Racing	Damper	$ 200.00	unit								
	Damper, Risse Jupiter 7R	Risse Racing	Damper	$ 300.00	unit								
	Damper, SRAM, Rock Shox, Vivid R2C	SRAM	Damper	$ 215.00	unit							13-Jun-13	
	Damper, SRAM, Rock Shox, Vivid R2C	SRAM	Damper	$ 215.00	unit							23-Oct-14	
	Damper, Tanner	Tanner	Damper	$ 85.00	unit								
	Damper, Team Built	Team	Damper	$ -	unit								
	Damper, Team Built, Reservoir Bladder	Any	Damper	$ 5.00	unit							26-Mar-09	
	Damper, X-Fusion Vektor DH 1.0	X-Fusion	Damper	$ 170.00	unt							24-May-10	
	Damper, ZF Sachs, ETX36/15x	ZF Sachs	Damper	$ 360.00	unit							23-Feb-09	
	Damper, ZF Sachs, Formula Student	ZF Sachs	Damper	$ 512.05	unit							19-May-14	
	Damper, ZF Sachs, RD 36-2	ZF Sachs	Damper	$ 370.00	unit							31-Mar-10	
	Axle (All Cost as Made)	Any	Drivetrain	$ -	unit							20-Mar-10	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Axle Snubber	Any	Drivetrain	$ 2.50	unit							19-Apr-09	For example Taylor Race Engineering plastic snubber
	Belt	Any	Drivetrain	$ 0.05	mm								
	Chain	Any	Drivetrain	$ 0.05	mm							20-Dec-14	Cost is for a single row chain. Multiple row chains should be cost as $.05/mm/chain row. Master link included in price of chain.
	Chain Guard (All Cost as Made)	Any	Drivetrain	$ -	unit							26-Mar-10	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Constant Velocity Joint, Boot	Any	Drivetrain	$ 5.00	unit								
	Constant Velocity Joint, Housing (All Cost as Made)	Any	Drivetrain	$ -	unit							7-May-11	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Constant Velocity Joint, Plug, Axial Locating	Any	Drivetrain	$ 2.50	unit							19-Apr-09	For example Taylor Race Engineering plastic snubber
	Constant Velocity Joint, Rzepa Plunging	Any	Drivetrain	$ 20.00	unit							7-May-11	6-Ball plunging, includes grease, does not inlucde housing which is cost as made
	Constant Velocity Joint, Rzeppa Fixed	Any	Drivetrain	$ 20.00	unit							7-May-11	6-Ball Non-plunging, includeas grease, does not inlucde housing which is cost as made
	Constant Velocity Joint, Stub-shaft (All Cost as Made)	Any	Drivetrain	$ -	unit							7-May-11	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Constant Velocity Joint, Tripod	Any	Drivetrain	$ 45.00	unit							7-May-11	3-Needle bearing plunging, includes grease, does not inlucde housing which is cost as made
	Differential Housing (All Cost as Made)	Any	Drivetrain	$ -	unit								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Differential Internals, Limited Slip, Cam & Pawl	Any	Drivetrain	$ 110.00	unit							1-Mar-09	
	Differential Internals, Limited Slip, Quaife	Quaife	Drivetrain	$ 165.00	unit							21-Apr-09	
	Differential Internals, Limited Slip, Salisbury or Powerflow or Clutch Style	Any	Drivetrain	$ 110.00	unit								
	Differential Internals, Limited Slip, Torsen T1	Torsen	Drivetrain	$ 165.00	unit								
	Differential Internals, Limited Slip, Torsen T2	Torsen	Drivetrain	$ 165.00	unit								
	Differential Internals, Open Gearset (Any)	Any	Drivetrain	$ 60.00	unit								
	Half Shaft (All Cost as Made)	Any	Drivetrain	$ -	unit								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Pulley (All Cost as Made)	Any	Drivetrain	$ -	unit								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Sprocket (All Cost as Made)	Any	Drivetrain	$ -	unit								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Universal Joint	Any	Drivetrain	$ 20.00	unit								
	Aim Evo 3 Pista Car	Aim	Electronics	$ 940.00	unit							25-Oct-14	
	Aim Evo 3 Pro Car	Aim	Electronics	$ 1,200.00	unit							26-Oct-14	
	Aim Evo 4 DataLogger Car	Aim	Electronics	$ 575.00	unit							22-Oct-14	
	Aim M3 XG LOG Datalogger	Aim	Electronics	$ 590.00	unit							13-Oct-14	
	Aim MXL Pista Race Graphic Car	Aim	Electronics	$ 940.00	unit							19-Oct-14	
	Aim MXL Pista Road Graphic Car	Aim	Electronics	$ 940.00	unit							20-Oct-14	
	Aim MXL Pro05 Car	Aim	Electronics	$ 1,200.00	unit							21-Oct-14	

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Aim MXL Strada Race Graphic Car	Aim	Electronics	$ 525.00	unit							17-Oct-14	
	Aim MXL Strada Road Graphic Car	Aim	Electronics	$ 525.00	unit							18-Oct-14	
	Aim SmartyCam GPS Standard	Aim	Electronics	$ 500.00	unit							23-Oct-14	
	Aim SmartyCamGP Complete Car	Aim	Electronics	$ 500.00	unit							24-Oct-14	
	Aim Solo DL GPS LapTimer For Car	Aim	Electronics	$ 300.00	unit							14-Oct-14	
	Aim Solo GPS Lap Timer Kit 1 Car	Aim	Electronics	$ 180.00	unit							13-Oct-14	
	Aim TG Lap Timer External Power	Aim	Electronics	$ 165.00	unit							15-Oct-14	
	Aim TG Lap Timer Internal Power	Aim	Electronics	$ 165.00	unit							16-Oct-14	
	Battery, Advanced Chemistry (NiMH, Li-Ion, etc.)	Any	Electronics	$ 65.00	kg								Not for use as an EV main battery.
	Battery, Lead Acid	Any	Electronics	$ 3.00	kg								
	Circuit Breaker, Thermal, Klixon 7277-2-20	Klixon	Electronics	$ 8.80	unit							19-Apr-09	
	Connector, Aerospace Quality	Any	Electronics	$ 1.00	pin(s)								
	Connector, Computer Type	Any	Electronics	$ 1.00	pin(s)								Seriel, Parallel, USB, Firewire, etc.
	Connector, High Power, > 2 Amps	Any	Electronics	$ 2.00	pin(s)								Vehicle power, starter, alternator, etc.
	Connector, OEM Quality	Any	Electronics	$ 0.50	pin(s)								
	Connector, Single Wire	Any	Electronics	$ 0.05	wire								Any style, any size, per wire end. Includes, ring, spade, bullet, etc.
	Dashpanel, Haltech, Racepak IQ3 Display	Haltech	Electronics	$ 383.00	unit							1-Mar-10	
	Dashpanel, Memotec, G-Dash	Memotec	Electronics	$ 204.75	unit							18-May-15	
	Dashpanel, Race Technology, Dash4Pro	Race Technologies	Electronics	$ 339.50	unit							13-Mar-15	
	Display, 7 Segment	Any	Electronics	$ 1.00	digit								Each digit can represent a single character alpha or numeric
	Display, LCD (for Student Built Elect. Only), Area	Any	Electronics	[C1]*[Size1]+[C2]	cm^2		1.25	0	0		0	2-Mar-09	[Size1]=Display surface area (cm^2). LCD Display when incorporated into or driven off student built electroincs. Not to be used in place of purchased displays that are part of data acquisition systems, engine controllers, etc.
	Display, LCD (for Student Built Elect. Only), Rect	Any	Electronics	[C1]*[Size1]*[Size2]+[C2]	cm	cm	1.25	0	0	0	$ -	25-Feb-09	LCD Display when incorporated into or driven off student built electroincs. Not to be used in place of purchased displays that are part of data acquisition systems, engine controllers, etc.
	Display, Matrix	Any	Electronics	$ 2.00	digit								Each digit can represent a single character alpha or numeric
	Fuse Box	Any	Electronics	$ 0.25	pin(s)								Use 2 x Number of Fuses and relays to calculate number of pins
	Fuse, Control	Any	Electronics	$ 0.50	unit								
	Fuse, Power	Any	Electronics	$ 1.00	unit								
	Fuse, Signal	Any	Electronics	$ 0.50	unit								
	Gauge, Analog	Any	Electronics	$ 5.00	unit								Any use such as RPM, pressure, temperature, etc. Includes driver (motor, etc) and needle.
	Gauge, Analog Housing	Any	Electronics	$ 8.00	unit								Used with Gauge, Analog when mounted not integrated into the instrument panel.
	Gauge, Digital Pro Shifter System, 6187	Autometer	Electronics	$ 85.00	unit								
	Gauge, Ecliptech, Shift-I shift light, SI-SGAR	Ecliptech	Electronics	$ 80.00	unit							20-Jan-16	multiple light shift light
	Heat Shrink Tubing	Any	Electronics	$ 0.50	m								
	Lamp, Brake with Housing	Any	Electronics	$ 4.00	unit								
	Lamp, Incandescent	Any	Electronics	$ 2.00	unit								
	Lamp, LED	Any	Electronics	$ 0.50	unit								
	Motor, 12 Volt, DC Brush	Any	Electronics	$ 20.00	unit								Used for general actuation. For more specefic motors please submit an Add Item RequeSteel
	Motor, 12 Volt, DC Brushless Servo	Any	Electronics	$ 40.00	unit								Used for general actuation. For more specefic motors please submit an Add Item RequeSteel
	Power Distribution Module, Cosworth, IPS32	Cosworth	Electronics	$2,000	unit							11-Nov-16	
	Power Distribution Module, Rowe Electronics, PDM60	Rowe Electronics	Electronics	$ 100.00	unit							8-Mar-16	
	Relay, Control	Any	Electronics	$ 2.00	unit								
	Relay, Power	Any	Electronics	$ 4.00	unit								
	Relay, Signal	Any	Electronics	$ 2.00	unit								
	Sensor to CAN Converter	Any	Electronics	$ 25.00	unit								Converts analog or digital sensor input to CAN output

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Servo, 12V	Any	Electronics	$ 25.00	unit							3-Mar-09	Radio Controlled Hobby style servo with built in gear reduction.
	Solenoid, 12 Volt	Any	Electronics	$ 7.50	unit								
	Speaker	Any	Electronics	$ 2.50	unit							12-Jun-11	Can be used for 'ready to drive sound' for electric
	Switch, Kill	Any	Electronics	$ 3.00	unit								
	Switch, Pushbutton	Any	Electronics	$ 1.00	unit								
	Switch, Rotary Multi-position Selector	Any	Electronics	$ 3.00									
	Switch, Toggle	Any	Electronics	$ 1.00	unit								
	Terminal Block, Wiring	Any	Electronics	$ 0.25	pin(s)								
	Wire Sleeving, Expandable	Any	Electronics	$ 1.00	m							18-Apr-10	
	Wire Sleeving, Split	Any	Electronics	$ 0.50	m								
	Wire, Control	Any	Electronics	$ 1.00	m								
	Wire, fusible link	Any	Electronics	$ 1.50	m							28-May-15	
	Wire, Power	Any	Electronics	$ 3.00	m								
	Wire, Signal	Any	Electronics	$ 1.00	m								
	Accusump	Canton Racing Products	Engine	([C1]*[Size1]+[C2])	L		14.3	82				23-May-10	Gage not included, include as separate material line item if used on vehicle.
	Air Filter	Any	Engine	$ 0.15	cm^2							17-Mar-09	Paper, foam and cotton (K&N type) elements
	Boost Control Solenoid Valve, MR561312	Mitsubishi Motors	Engine	$ 14.00	unit							18-Apr-10	
	Blow off valve	Any	Engine	$ 30.00	unit							30-Mar-15	Blow off valve unit only. Includes any integral fasteners but not mounting fasteners or external hoses etc.
	Carburetor	Any	Engine	$ 50.00	unit								
	Coolant Pump, External Electric	Any	Engine	$ 20.00									
	Cooling System Air Bleed Valve	Any	Engine	$ 6.50	unit								
	Dry Sump Pump, Aviad, 003-32000	Aviad	Engine	$ 250.00	unit							23-Mar-12	2 stage, non regulating
	Dry Sump Pump, Dailey Engineering, 04-00-2162	Dailey Engineering	Engine	$ 726.00	unit							26-Mar-09	
	Dry Sump Pump, Dailey Engineering, 04-99-2162	Dailey Engineering	Engine	$ 726.00								26-Mar-09	
	Dry Sump Pump, Dailey Engineering, 04-99-2162-2	Dailey Engineering	Engine	$ 726.00								26-Mar-09	
	Dry Sump Pump, Dailey Engineering, 04-99-2186	Dailey Engineering	Engine	$ 264.00								26-Mar-09	
	Dry Sump Pump, Dailey Engineering, 04-99-2204	Dailey Engineering	Engine	$ 429.00								26-Mar-09	
	Dry Sump Pump, Dailey Engineering, 04-99-2204-2	Dailey Engineering	Engine	$ 429.00								26-Mar-09	
	Dry Sump Pump, Dailey Engineering, 04-99-2264-2	Dailey Engineering	Engine	$ 726.00								26-Mar-09	
	Dry Sump Pump, Dailey Engineering, 04-99-2301-2	Dailey Engineering	Engine	$ 429.00								22-Mar-16	
	Dry Sump Pump, Pace, 2 Stage	Pace	Engine	$ 315.00	unit							26-Mar-09	Any 2 stage Pace pump
	Dry Sump Pump, Pace, 3 Stage	Pace	Engine	$ 380.00	unit							26-Mar-09	Any 3 stage Pace pump
	Dry Sump Pump, Pace, Single Stage	Pace	Engine	$ 215.00	unit							26-Mar-09	Any single stage Pace pump
	Dry Sump Pump, Student Made	Student Built	Engine	$ -	unit							22-Feb-09	
	Engine and Transmission, High Performance (5-10 HP/100 cc)	Any	Engine	$ 2.00	cc							26-Mar-09	Normal motorcycle engines with 2 valves per cylinder, etc. Engine cost includes tranmission (whether integral or not by design), components used to transmit power between engine and transmission and all components necessary to run including spark plugs, coils, wires, oil filter, etc. with the exception of the air induction and fuel system components. Any driveline component downstream of the transmission output gear/shaft is not included. Cost includes engine as received by manufacturer but not custom parts such as dry sump pans, PCV changes, etc. Fully Internal engine changes are free. If covers or other parts are removed disassembly labor must be included in labor cost.

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Engine and Transmission, Low Performance (<5 HP/100 cc)	Any	Engine	$ 1.20	cc							26-Mar-09	Industrial engines, etc. Engine cost includes tranmission (whether integral or not by design), components used to transmit power between engine and transmission and all components necessary to run including spark plugs, coils, wires, oil filter, etc. with the exception of the air induction and fuel system components. Any driveline component downstream of the transmission output gear/shaft is not included. Cost includes engine as received by manufacturer but not custom parts such as dry sump pans, PCV changes, etc. Fully Internal engine changes are free. If covers or other parts are removed disassembly labor must be included in labor cost.
	Engine and Transmission, Ultra High Performance (>10 HP/100 cc)	Any	Engine	$ 2.50	cc							26-Mar-09	New high tech engines, 3-5 valves per cylinder, etc. Engine cost includes tranmission (whether integral or not by design), components used to transmit power between engine and transmission and all components necessary to run including spark plugs, coils, wires, oil filter, etc. with the exception of the air induction and fuel system components. Any driveline component downstream of the transmission output gear/shaft is not included. Cost includes engine as received by manufacturer but not custom parts such as dry sump pans, PCV changes, etc. Fully Internal engine changes are free. If covers or other parts are removed disassembly labor must be included in labor cost.
	Exhaust Manifold (All Cost as Made)	Any	Engine	$ -	unit							26-Mar-10	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Exhaust Pipe, Flexible	Any	Engine	([C1]*[Size1]*[Size2]+[C2])			0.001	0				4-May-10	Flexible tubing used for exhaust systems. Also called convoluted or flex piping.
	Fuel Check Valve	Any	Engine	$ 8.00	unit								
	Fuel Filter	Any	Engine	$ 8.00	unit								
	Fuel Injector, Direct Injection	Any	Engine	$ 30.00	unit							27-May-10	Either fuel, gasoline or E85
	Fuel Injector, E85	Any	Engine	$ 13.00	unit								
	Fuel Injector, Gasoline	Any	Engine	$ 10.00	unit								
	Fuel Pressure Regulator, E85	Any	Engine	$ 19.50	unit			355					
	Fuel Pressure Regulator, Gasoline	Any	Engine	$ 15.00	unit			470					
	Fuel Pump, Carburetor, Gasoline or E85	Any	Engine	$ 20.00	unit								
	Fuel Pump, Direct Injection	Any	Engine	$ 120.00	unit							27-May-10	Either fuel, gasoline or E85
	Fuel Pump, Fuel Injected, E85	Any	Engine	$ 45.50	unit								Port fuel injection, not for direct injection use
	Fuel Pump, Fuel Injected, Gasoline	Any	Engine	$ 35.00	unit								Port fuel injection, not for direct injection use
	Fuel Rail (All Cost as Made)	Any	Engine	$ -	unit								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Fuel Tank (All Cost as Made)	Any	Engine	$ -	unit							26-Mar-10	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	~~Header Wrap~~	~~Any~~	~~Engine~~	~~$ 30.00~~	~~m^2~~							~~18-Apr-10~~	REMOVE
	Heat Exchanger Fan	Any	Engine	$ 30.00	unit								Includes motor and blades
	Heat Exchanger Fan, small <120mm diameter	Any	Engine	$ 10.00	unit							31-Mar-14	Includes motor and blades
	Heat Exchanger Fan Shroud (All Cost as Made)	Any	Engine	$ -	unit								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Heat Exchanger, Air-to-Air	Any	Engine	$ 0.0035	cm^3							26-Mar-09	Includes radiator, oil cooler and others. Volume based on length * width * height of core. Cost as made the end caps, filler knecks, etc.
	Heat Exchanger, Air-to-Liquid	Any	Engine	$ 0.0035	cm^3							26-Mar-09	Includes radiator, oil cooler and others. Volume based on length * width * height of core. Cost as made the end caps, filler knecks, etc.

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Heat Exchanger, Liquid-to-Liquid	Any	Engine	$ 0.0035	cm^3							26-Mar-09	Includes radiator, oil cooler and others. Volume based on length * width * height of core. Cost as made the end caps, filler knecks, etc.
	Intake (All Cost as Made)	Any	Engine	$ -	unit							26-Mar-10	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Muffler (All Cost as Made)	Any	Engine	$ -	unit								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Muffler Batting	Any	Engine	$ 0.003	cm^3								Cost based on total volume of muffler
	Oil Filter	Any	Engine	$ -	unit								Included in engine cost - Shown only for reference
	Overflow Bottle, Aluminum Drinking Bottle	Any	Engine	$ 10.00	unit								
	Overflow Bottle, JAX 1 Qt. Oil Breather Tank	Jax	Engine	$ 28.50	unit							3-Aug-09	
	Overflow Bottle, JAX, 1 Qt. Recirc. Catch Can	Jax	Engine	$ 12.00	unit							3-Aug-09	
	Overflow Bottle, Nalgene Bottle	Any	Engine	$ 5.00	unit								
	Overflow Bottle, Plastic Bottle	Any	Engine	$ 5.00	unit							10-Mar-09	
	Overflow Bottle, Plastic Drinking Bottle	Any	Engine	$ 5.00	unit								
	Overflow Bottle, Steel Oil Can	Any	Engine	$ 1.00	unit							18-Apr-10	
	Overflow Bottle, Student Built	Student Built	Engine	$ -	unit								
	Pump, Transmission Oil, Hope Technik, 006	Hope Technik	Engine	$ 105.00	unit							18-Apr-10	
	Spark Plug Coil	Any	Engine	$ -	unit								Included in engine cost - Shown only for reference
	Spark Plug Wire	Any	Engine	$ -	unit								Included in engine cost - Shown only for reference
	Supercharger	Any	Engine	$ 300.00	unit								Includes pulley and bypass valve (if fitted) but no plumbing.
	Throttle Body (All Cost as Made)	Any	Engine	$ -	unit								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Turbocharger	Any	Engine	$ 300.00	unit								Includes waste gate but no plumbing
	Chassis Control Module, + Battery Charger HV	Any	EV - Control Module	$ 600.00	kW							25-Apr-12	See tab "EV" for more information
	Chassis Control Module, + Battery Charger LV	Any	EV - Control Module	$ 100.00	pack							25-Apr-12	See tab "EV" for more information
	Chassis Control Module, + Battery Management System	Any	EV - Control Module	$ 20.00	channel							25-Apr-12	See tab "EV" for more information
	Chassis Control Module, + DCDC-Power (>1A) HV->LV	Any	EV - Control Module	$ 70.00	unit							25-Apr-12	See tab "EV" for more information
	Chassis Control Module, + HC-HV Fuse incl. Box	Any	EV - Control Module	$ 100.00	unit							25-Apr-12	See tab "EV" for more information
	Chassis Control Module, + HV Housing	Any	EV - Control Module	$ 25.00	unit							25-Apr-12	See tab "EV" for more information
	Chassis Control Module, + HV Insulation Relay	Any	EV - Control Module	$ 120.00	unit							25-Apr-12	See tab "EV" for more information
	Chassis Control Module, + HV Precharge	Any	EV - Control Module	$ 50.00	unit							25-Apr-12	See tab "EV" for more information
	Chassis Control Module, + Isolation Monitoring Device	Any	EV - Control Module	$ 300.00	unit							25-Apr-12	e.g. Bender ISO F1. See tab "EV" for more information
	Chassis Control Module, + Motor Controller AC	Any	EV - Control Module	$ 45.00	kW							25-Apr-12	See tab "EV" for more information
	Chassis Control Module, + Motor Controller DC	Any	EV - Control Module	$ 22.50	kW							25-Apr-12	See tab "EV" for more information
	Chassis Control Module, + Power Distribution Module	Any	EV - Control Module	$ 7.00	channel							25-Apr-12	See tab "EV" for more information
	Chassis Control Module, + TSAL	Any	EV - Control Module	$ 10.00	unit							25-Apr-12	See tab "EV" for more information
	Chassis Control Module, + TSAS, buzzer	Any	EV - Control Module	$ 5.00	unit							25-Apr-12	See tab "EV" for more information
	Chassis Control Module, + TSAS, melody	Any	EV - Control Module	$ 15.00	unit							25-Apr-12	See tab "EV" for more information
	ECU, Automotive	Any	EV - Control Module	$ 2,000.00	unit							25-Apr-12	i.e. TTC. See tab "EV" for more information
	ECU, Industrial	Any	EV - Control Module	$ 3,000.00	unit							25-Apr-12	i.e. Siemens, B&R. See tab "EV" for more information
	ECU, Rapid Prototyping	Any	EV - Control Module	$ 5,000.00	unit							25-Apr-12	i.e. dSpace, ETAS. See tab "EV" for more information
	ECU, student built	Student built	EV - Control Module	$ 500.00	unit							25-Apr-12	See tab "EV" for more information
	Battery, Tractive Lithium	Any	EV - Electronics	$ 600.00	kWh							25-Apr-12	See tab "EV" for more information
	Conduit incl. Nuts, Elbows etc.	Any	EV - Electronics	$ 1.00	m							25-Apr-12	See tab "EV" for more information
	Connector, HC-HV incl. Interlock	Any	EV - Electronics	$ 30.00	pin							25-Apr-12	See tab "EV" for more information
	Connector, HC-HV Lug Type	Any	EV - Electronics	$ 1.00	pin							25-Apr-12	See tab "EV" for more information
	Wiring HV (> 12 mm²)	Any	EV - Electronics	$ 15.00	m							25-Apr-12	See tab "EV" for more information
	Motor, Tractive AC	Any	EV - Tractive Drive	$ 100.00	kW							25-Apr-12	See tab "EV" for more information
	Motor, Tractive DC	Any	EV - Tractive Drive	$ 50.00	kW							25-Apr-12	See tab "EV" for more information
	Fluid, Coolant	Any	Fluid	$ 0.00	liter								Water or water wetter mixture. Free.
	Fluid, Oil	Any	Fluid	$ 0.75	liter								Engine oil, differential, hydraulic (brake/clutch), etc.

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Foam, Fuel Anti-Surge	Any	Fuel System	$ 1.00	liter							22-Feb-09	
	Fuel Check Valve, In-line, Aluminum Rollover	Any	Fuel System	$ 15.00	unit							18-Mar-09	
	Fuel Check Valve, In-line, Plastic Rollover	Any	Fuel System	$ 7.00	unit							1-Mar-09	
	Cable Tie Mount, Adhesive Backed	Any	Hardware	$ 0.15	unit							23-May-10	Adhesive mount for connecting cable ties, zip ties, etc. Normally is injection molded with a single loop for tie wrap connection.
	Coupling, Shaft, Helical Beam	Any	Hardware	([C1]*[Size1]+[C2])	mm		0.125	8	0		8	29-Mar-09	[Size1]=Coupling Outer Diameter (mm).
	Drawbolt Catch & Hook	Any	Hardware	$ 1.25	unit							18-Apr-10	
	Grommet, Elastomer	Any	Hardware	$ 0.05	unit								Any size, any material
	Locating Pin, Bullet-Nose Dowel, Steel	Any	Hardware	[C1]*[Size1]+[C2]	mm		0.032	1.12	0		1.12		[Size1]=Dowel diameter (mm)
	Locating Pin, Liner, Steel	Any	Hardware	[C1]*[Size1]+[C2]	mm		0.05	2.34	0		2.34		[Size1]=Hole diameter for dowel (mm)
	Mount, Vibration-Damping Sandwich	Any	Hardware	[C1]*[Size1]+[C2]	mm		0.27	0	0		0	29-Mar-09	[Size1]=Mount Outer Diameter (mm).
	Piano Hinge, Aluminum	Any	Hardware	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.04	1.16	0	0	$ 1.16	14-Mar-09	[Size1]=Hing pin diameter (mm), [Size2]=Open width (mm). Hinge cost does not include any holes.
	Woodruff Key	Any	Hardware	0.1	unit							17-Mar-09	Any size up to 6.35mm width
	Adhesive	Any	Misc.	$ -	unit								Included in process cost (brush apply, aerosol apply, etc.). Includes glue, thread locker, etc.
	Balance Bar Cable Adjuster, AP CP2905-8	AP	Misc.	$80.00								19-Apr-09	
	Balance Bar Cable Adjuster, Optimum Balance Prod	Optimum Balance Products	Misc.	$22.00	unit							22-Apr-09	
	Cable Adjuster	Any	Misc.	$1.00	unit							1-Mar-09	
	Cable end clevis	Any	Misc.	[C1]*[Size1]+[C2]	mm		0.5	1				2-Jun-15	Attaches to end of a cable or wire rope to allow fastening to a bracket. Can be attached with crimp or nut and ferrule. Does not include fastener to bracket
	Clevis	Any	Misc.	[C1]*[Size1]^2+[C2]	mm		0.01	0.61	0		$ 0.61	22-Feb-09	[Size1]=bore size (diameter of hole). Includes male/female and left/right threads.
	Edge protection	Any	Misc.	$ 3.00	m								Typical U-shape trim for edge protection. Any size, rubber or plastic outer surface, metal inner structure allowed.
	Filler Cap	Any	Misc.	$ 3.00	unit								Fuel, cooling system, etc.
	Gearbox Oil Temp. Control Valve, GearZmo	GearZmo	Misc.	$ 232.00	unit							22-Feb-09	
	Head Rest Padding	Any	Misc.	$ 0.005	cm^3								
	Heat Barrier	Any	Misc.	$ 50.00	m^2								Adhesive film (foil) or matting for reflecting heat.
	Mirror Lens	Any	Misc.	$ 0.15	cm^2								
	Mirror, Rear View, Housing (All Cost as Made)	Any	Misc.	$ -	in^2								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Paint	Any	Misc.	$ 10.00	m^2								
	Roll Hoop Padding	Any	Misc.	$ 0.05	cm								
	Seat (All Cost as Made)	Any	Misc.	$ -	unit								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Tape	Any	Misc.	$ -	unit							18-Apr-10	Included in process cost
	Throttle Linkage, Tilton, 72-790	Tilton	Misc.	$85.00	unit							1-Mar-09	
	Pedal Assembly, Optimum Balance Products OBP0181	Optimum Balance Products	Pedals	$110.00	unit							21-Apr-09	With bias bar adjustment. After 2015 competitions all pedals will be cost as made
	Pedal Assembly, Tilton, 72-680	Tilton	Pedals	$360.00	unit							1-Mar-09	After 2015 competitions all pedals will be cost as made
	Pedal, Wilwood, 340-1285	Wilwood	Pedals	$61.00	unit							18-Apr-10	After 2015 competitions all pedals will be cost as made
	Adapter, Hex Nipple, Brass	Any	Plumbing	[C1]*[Size1]+[C2]	mm		1.1	0.22	0		0.22	8-Mar-09	[Size1]=Pipe Size (mm)
	Adapter, Hex Nipple, Reducing, Brass	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm		0.02	2.23	0	0	$ 2.23	8-Mar-09	[Size1]=Inlet Pipe Size (mm). [Size2]=Outlet Pipe Size (mm)
	Adapter/L.P.///Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]+[C2]	mm		0.176	0.056	0		0.056	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Barb to Male Pipe/90 Deg./Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.048	1.995	0	0	$ 2.00	29-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Pipe Size (mm). Low Pressure.
	Adapter/L.P./Barb to Male Pipe/Elbow/Plastic	Any	Plumbing	$ 0.50								19-Apr-09	Up to 25.4mm diameter inlet and outlet size. Low Pressure.
	Adapter/L.P./Barb to Male Pipe/Straight/Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.032	1.33	0	0	$ 1.33	29-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Pipe Size (mm). Low Pressure.
	Adapter/L.P./Barb to Male Pipe/Straight/Plastic	Any	Plumbing	$ 0.50								19-Apr-09	Up to 25.4mm diameter inlet and outlet size. Low Pressure.

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Adapter/L.P./Bulkhead Male Connector//Steel/	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0155	5.82	0	0	$ 5.82	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Bulkhead Run Tee//Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.019	10.67	0	0	$ 10.67	11-Mar-09	[Size1]=Largest Hose Size (mm), [Size2]=2nd Largest Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm (use two largest sizes and ignore 3rd outlet). Low Pressure.
	Adapter/L.P./Bulkhead Run Tee//Steel/	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0155	15.24	0	0	$ 15.24	11-Mar-09	[Size1]=Largest Hose Size (mm), [Size2]=2nd Largest Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm (use two largest sizes and ignore 3rd outlet). Low Pressure.
	Adapter/L.P./Bulkhead Tee//Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.014	10.54	0	0	$ 10.54	11-Mar-09	[Size1]=Largest Hose Size (mm), [Size2]=2nd Largest Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm (use two largest sizes and ignore 3rd outlet). Low Pressure.
	Adapter/L.P./Bulkhead Tee//Steel/	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.015	12.91	0	0	$ 12.91	11-Mar-09	[Size1]=Largest Hose Size (mm), [Size2]=2nd Largest Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm (use two largest sizes and ignore 3rd outlet). Low Pressure.
	Adapter/L.P./Bulkhead Union//Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.008	3.3	0	0	$ 3.30	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Bulkhead Union//Steel/	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0072	5.47	0	0	$ 5.47	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Bulkhead Union/45 deg./Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.024	2.36	0	0	$ 2.36	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Bulkhead Union/45 deg./Steel/	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.024	2.36	0	0	$ 2.36	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Bulkhead Union/90 deg./Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.013	6.47	0	0	$ 6.47	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Bulkhead Union/90 deg./Steel/	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.01	12.15	0	0	$ 12.15	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Elbow/FeMale to Male Pipe/90 deg./Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.144	8.63	0	0	$ 8.63	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Female Flare Tee//Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.024	7.55	0	0	$ 7.55	11-Mar-09	[Size1]=Largest Hose Size (mm), [Size2]=2nd Largest Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm (use two largest sizes and ignore 3rd outlet). Low Pressure.
	Adapter/L.P./Female Flare Tee//Brass	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.01	3.02	0	0	$ 3.02	15-Mar-11	[Size1]=Largest Hose Size (mm), [Size2]=2nd Largest Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm (use two largest sizes and ignore 3rd outlet). Low Pressure.
	Adapter/L.P./Female Pipe Tee//Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.07	13.1	0	0	$ 13.10	11-Mar-09	[Size1]=Largest Hose Size (mm), [Size2]=2nd Largest Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm (use two largest sizes and ignore 3rd outlet). Low Pressure.
	Adapter/L.P./FemAle Pipe to Male Flare//Steel/	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.018	6.45	0	0	$ 6.45	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Male Branch Tee//Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.08	8.92	0	0	$ 8.92	11-Mar-09	[Size1]=Largest Hose Size (mm), [Size2]=2nd Largest Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm (use two largest sizes and ignore 3rd outlet). Low Pressure.
	Adapter/L.P./Male Flare to Pipe//Aluminum/Nickel-Plated	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.004	4.34	0	0	$ 4.34	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Male Flare to Pipe//Brass/	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0016	1.74	0	0	$ 1.74	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Male Flare to Pipe//Steel/	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0006	1.47	0	0	$ 1.47	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Male Flare to Pipe/45 deg./Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0002	11.55	0	0	$ 11.55	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Male Flare to Pipe/45 deg./Aluminum/Nickel-Plated	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0004	18.59	0	0	$ 18.59	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Male Flare to Pipe/45 deg./Steel/	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0006	6.78	0	0	$ 6.78	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Male Flare to Pipe/90 deg./Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0004	5.28	0	0	$ 5.28	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Adapter/L.P./Male Flare to Pipe/90 deg./Aluminum/Nickel-Plated	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0006	9	0	0	$ 9.00	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Male Flare to Pipe/90 deg./Brass/	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0002	2.11	0	0	$ 2.11	7-May-11	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Male Flare to Pipe/90 deg./Steel/	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0003	1.88	0	0	$ 1.88	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Male Pip Nipple//Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.035	3.5	0	0	$ 3.50	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Male Run Tee//Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.066	9.79	0	0	$ 9.79	11-Mar-09	[Size1]=Largest Hose Size (mm), [Size2]=2nd Largest Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm (use two largest sizes and ignore 3rd outlet). Low Pressure.
	Adapter/L.P./Male Run Tee//Steel/	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.069	10.98	0	0	$ 10.98	11-Mar-09	[Size1]=Largest Hose Size (mm), [Size2]=2nd Largest Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm (use two largest sizes and ignore 3rd outlet). Low Pressure.
	Adapter/L.P./Pipe Coupling//Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.067	3.93	0	0	$ 3.93	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Pipe to Pipe//Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.016	7.2	0	0	$ 7.20	11-Mar-09	[Size1]=Inlet Pipe Size (mm), [Size2]=Outlet Pipe Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure
	Adapter/L.P./Push-to-Connect to Male Pipe/Straight/Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.032	2	0	0	$ 2.00	29-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Pipe Size (mm). Low Pressure
	Adapter/L.P./Union Reducer//Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0063	1.75	9.5	15	$ 2.65	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Union Reducer//Brass	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0025	0.7	0	0	$ 0.70	15-Mar-11	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Union Tee//Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.012	7.13	0	0	$ 7.13	11-Mar-09	[Size1]=Largest Hose Size (mm), [Size2]=2nd Largest Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm (use two largest sizes and ignore 3rd outlet). Low Pressure.
	Adapter/L.P./Union Tee//Brass/	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.005	2.85	0	0	$ 2.85	7-May-11	[Size1]=Largest Hose Size (mm), [Size2]=2nd Largest Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm (use two largest sizes and ignore 3rd outlet). Low Pressure.
	Adapter/L.P./Union//Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0063	1.75	0	0	$ 1.75	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Union/90 deg./Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0124	9.33	0	0	$ 9.33	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Union/90 deg./Brass	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.005	3.73	0	0	$ 3.73	15-Mar-11	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Adapter/L.P./Union/FeMale Flare//Aluminum/Anodized	Any	Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.0089	4.2	0	0	$ 4.20	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Banjo Bolt, Aluminum	Any	Plumbing	[C1]*[Size1]+[C2]	mm		0.68	0	0		0	24-Mar-09	[Size1]=Thread Size (mm).
	Banjo Bolt, Steel	Any	Plumbing	[C1]*[Size1]+[C2]	mm		0.68	0	0		0	24-Mar-09	[Size1]=Thread Size (mm).
	Banjo Fitting, 45 Deg., Aluminum	Any	Plumbing	[C1]*[Size1]+[C2]	mm		1.25	1.875	0		1.875	24-Mar-09	[Size1]=Inlet Fitting Size (mm).
	Banjo Fitting, 45 Deg., Steel	Any	Plumbing	[C1]*[Size1]+[C2]	mm		2.625	0	0		0	24-Mar-09	[Size1]=Inlet Fitting Size (mm).
	Banjo Fitting, 90 Deg., Aluminum	Any	Plumbing	[C1]*[Size1]+[C2]	mm		1.5	2.25	0		2.25	24-Mar-09	[Size1]=Inlet Fitting Size (mm).
	Banjo Fitting, 90 Deg., Steel	Any	Plumbing	[C1]*[Size1]+[C2]	mm		3.15	0	0		0	24-Mar-09	[Size1]=Inlet Fitting Size (mm).
	Banjo Fitting, Aluminum	Any	Plumbing	[C1]*[Size1]+[C2]	mm		1	1.5	0		1.5	24-Mar-09	[Size1]=Inlet Fitting Size (mm).
	Banjo Fitting, Double, Aluminum	Any	Plumbing	[C1]*[Size1]+[C2]	mm		1.5	2.25	0		2.25	24-Mar-09	[Size1]=Largest Inlet Fitting Size (mm).
	Banjo Fitting, Double, Steel	Any	Plumbing	[C1]*[Size1]+[C2]	mm		3.15	0	0		0	24-Mar-09	[Size1]=Largest Inlet Fitting Size (mm).
	Banjo Fitting, Steel	Any	Plumbing	[C1]*[Size1]+[C2]	mm		2.1	0	0		0	24-Mar-09	[Size1]=Inlet Fitting Size (mm).
	Bleedscrew, Hydraulic (Brake, clutch, etc.)	Any	Plumbing	$ 1.00	unt								Any size, materiAluminum
	Break Coupling, Dry, Female, Goodridge	Goodridge	Plumbing	$ 64.00	unit							28-May-15	Sizes up to 8mm
	Break Coupling, Dry, Female, KC Engineering	KC Engineering	Plumbing	$ 85.00	unit							23-May-10	Sizes up to 8mm
	Break Coupling, Dry, Female, Staubli	Staubli	Plumbing	$ 85.00	unit							14-Mar-09	Sizes up to 8mm
	Break Coupling, Dry, Male, Goodridge	Goodridge	Plumbing	$ 72.50	unit							28-May-15	Sizes up to 8mm
	Break Coupling, Dry, Male, KC Engineering	KC Engineering	Plumbing	$ 73.50	unit							23-May-10	Sizes up to 8mm
	Break Coupling, Dry, Male, Staubli	Staubli	Plumbing	$ 73.50	unit							14-Mar-09	Sizes up to 8mm
	Check Valve, High Press, Adj, In-Line, Generant	Generant	Plumbing	$ 10.00	unit							19-Apr-09	
	Check Valve, Residuel Pressure	wilwood	Plumbing	$ 10.00	unit							31-Mar-16	

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Crush Washer	Any	Plumbing	[C1]*[Size1]+[C2]	mm		0.027	0.12	0		0.12	24-Mar-09	[Size1]=Inner Diameter (mm). Any material (steel, aluminum, copper, etc.)
	Drain Plug, Hex Head, Magnetic	Any	Plumbing	[C1]*[Size1]+[C2]	mm		0.093	0.05	0		0.05	8-Mar-09	[Size1]=Threaded Diameter (mm)
	Drain Plug, Square Head, Magnetic	Any	Plumbing	[C1]*[Size1]+[C2]	mm		0.093	0.05	0		0.05	8-Mar-09	[Size1]=Threaded Diameter (mm)
	Fitting, Fuel Pressure Gauge	Any	Plumbing	$ 3.00	unit							1-Mar-09	12.7mm Barb End (x2), 3.175mm NPT Female
	Fitting, JT2000, Quick Con. Plug to Flare, 45 Deg.	Jiffy-Tite	Plumbing	$ 14.50	unit							1-Mar-09	Jiffy-Tite 2000 Series. Sizes up to 12.7mm Flare
	Fitting, JT2000, Quick Con. Plug to Flare, 90 Deg.	Jiffy-Tite	Plumbing	$ 14.50	unit							1-Mar-09	Jiffy-Tite 2000 Series. Sizes up to 12.7mm Flare
	Fitting, JT2000, Quick Con. Plug to Flare, Str.	Jiffy-Tite	Plumbing	$ 11.50	unit							1-Mar-09	Jiffy-Tite 2000 Series. Sizes up to 12.7mm Flare
	Fitting, JT2000, Quick Con. Socket to Flare, 45 Deg.	Jiffy-Tite	Plumbing	$ 16.00	unit							1-Mar-09	Jiffy-Tite 2000 Series. Sizes up to 12.7mm Flare
	Fitting, JT2000, Quick Con. Socket to Flare, 90 Deg.	Jiffy-Tite	Plumbing	$ 18.50	unit							1-Mar-09	Jiffy-Tite 2000 Series. Sizes up to 12.7mm Flare
	Fitting, JT2000, Quick Con. Socket to Flare, Straight	Jiffy-Tite	Plumbing	$ 17.50	unit							1-Mar-09	Jiffy-Tite 2000 Series. Sizes up to 12.7mm Flare
	Fitting, Push-to-Connect, Plastic, Elbow 90°	Any	Plumbing	[C1]*[Size1]+[C2]	mm		0.25	0.4	0		0.4	25-Mar-09	[Size1]=Tube Outer Diameter, Largest end (mm).
	Fitting, Push-to-Connect, Plastic, Straight	Any	Plumbing	[C1]*[Size1]+[C2]	mm		0.25	0.4	0		0.4	25-Mar-09	[Size1]=Tube Outer Diameter, Largest end (mm).
	Fitting, Push-to-Connect, Plastic, Tee	Any	Plumbing	[C1]*[Size1]+[C2]	mm		0.2	0.95	0		0.95	8-Mar-09	[Size1]=Tube Outer Diameter (mm)
	Fitting, Push-to-Connect, Plastic, Wye	Any	Plumbing	[C1]*[Size1]+[C2]	mm		0.2	0.95	0		0.95	8-Mar-09	[Size1]=Tube Outer Diameter (mm)
	Fitting, Weld-in, Male, Aluminum		Plumbing	[C1]*EXP([C2]*[Size1])	mm		1.3	0.044	0		$ 1.30	18-Mar-09	[Size1]=Flare Size (mm). For cost as made oil reservoir tanks, etc.
	Fitting, Wiggins, Clamshell Assembly	Any	Plumbing	[C1]*[Size1]+[C2]	mm		0.5	16	0		16	14-Mar-09	[Size1]=Tube Outer Diameter (mm)
	Fitting, Wiggins, Coupling Assembly	Any	Plumbing	[C1]*[Size1]+[C2]	mm		1.6	8	0		8	14-Mar-09	[Size1]=Tube Outer Diameter (mm)
	Fitting, Wiggins, Weld Ferrule	Any	Plumbing	[C1]*[Size1]+[C2]	mm		0.32	4.5	0		4.5	14-Mar-09	[Size1]=Tube Outer Diameter (mm)
	Fitting/H.P./Elbow/45 deg./Steel/		Plumbing	[C1]*[Size1]+[C2]	mm		0.9	7.3	0		7.3	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. High Pressure.
	Fitting/H.P./Elbow/90 deg./Steel/		Plumbing	[C1]*[Size1]+[C2]	mm		0.6	9.5	0		9.5	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. High Pressure.
	Fitting/H.P./MAluminume Flare//Brass/		Plumbing	[C1]*[Size1]+[C2]	mm		0	11	0		11	15-Mar-11	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. High Pressure.
	Fitting/H.P./MAluminume Inverted Flare//Brass/		Plumbing	[C1]*[Size1]+[C2]	mm		1.04	-0.41	0		-0.41	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. High Pressure.
	Fitting/H.P./MAluminume Inverted Flare//Steel/		Plumbing	[C1]*[Size1]+[C2]	mm		0.43	6.8	0		6.8	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. High Pressure.
	Fitting/H.P./MAluminume Inverted Flare/45 deg./Steel/		Plumbing	[C1]*[Size1]+[C2]	mm		0	12	0		12	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. High Pressure.
	Fitting/H.P./MAluminume Inverted Flare/90 deg./Steel/		Plumbing	[C1]*[Size1]+[C2]	mm		0	15	0		15	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. High Pressure.
	Fitting/H.P./MAluminume Pipe//Brass/		Plumbing	[C1]*[Size1]+[C2]	mm		0.67	-2.1	0		-2.1	15-Mar-11	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. High Pressure.
	Fitting/H.P./MAluminume Pipe//Steel/		Plumbing	[C1]*[Size1]+[C2]	mm		0	8	0		8	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. High Pressure.
	Fitting/H.P./Straight//Brass/		Plumbing	[C1]*[Size1]+[C2]	mm		0.87	-3.64	0		-3.64	15-Mar-11	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. High Pressure.
	Fitting/H.P./Straight//Steel/		Plumbing	[C1]*[Size1]+[C2]	mm		0.53	3.43	0		3.43	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. High Pressure.
	Fitting/L.P./Cap//Aluminum/Anodized		Plumbing	[C1]*[Size1]+[C2]	mm		0.66	-2.14	0		-2.14	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Cap//Steel/		Plumbing	[C1]*[Size1]+[C2]	mm		0.32	0	0		0	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/120 deg./Aluminum/Anodized		Plumbing	[C1]*[Size1]+[C2]	mm		0.35	34.4	0		34.4	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/120 deg./Aluminum/Crimp		Plumbing	[C1]*[Size1]+[C2]	mm		2.23	13.11	0		13.11	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/150 deg./Aluminum/Anodized		Plumbing	[C1]*[Size1]+[C2]	mm		1.34	25.34	0		25.34	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Fitting/L.P./Elbow/150 deg./Aluminum/Crimp		Plumbing	[C1]*[Size1]+[C2]	mm		2.52	10.2	0		10.2	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/180 deg./Aluminum/Anodized		Plumbing	[C1]*[Size1]+[C2]	mm		1.77	19.75	0		19.75	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/180 deg./Aluminum/Crimp		Plumbing	[C1]*[Size1]+[C2]	mm		4.42	-19.21	0		-19.21	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/30 deg./Aluminum/Anodized		Plumbing	[C1]*[Size1]+[C2]	mm		2.1	4.59	0		4.59	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/30 deg./Aluminum/Crimp		Plumbing	[C1]*[Size1]+[C2]	mm		1.59	19	0		19	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/45 deg./Aluminum/Anodized		Plumbing	[C1]*[Size1]+[C2]	mm		2.11	-2.68	0		-2.68	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/45 deg./Aluminum/Crimp		Plumbing	[C1]*[Size1]+[C2]	mm		2.24	3.86	0		3.86	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/45 deg./Aluminum/Nickel-Plated		Plumbing	[C1]*[Size1]+[C2]	mm		1.6	13.4	0		13.4	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/45 deg./Steel/		Plumbing	[C1]*[Size1]+[C2]	mm		4.72	-8.04	0		-8.04	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/60 deg./Aluminum/Anodized		Plumbing	[C1]*[Size1]+[C2]	mm		2.1	4.59	0		4.59	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/60 deg./Aluminum/Crimp		Plumbing	[C1]*[Size1]+[C2]	mm		1.06	29.53	0		29.53	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/90 deg./Aluminum/Anodized		Plumbing	[C1]*[Size1]+[C2]	mm		1.46	5.85	0		5.85	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/90 deg./Aluminum/Crimp		Plumbing	[C1]*[Size1]+[C2]	mm		2.37	1.22	0		1.22	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/90 deg./Aluminum/Nickel-Plated		Plumbing	[C1]*[Size1]+[C2]	mm		1.6	13.6	0		13.6	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Elbow/90 deg./Steel/		Plumbing	[C1]*[Size1]+[C2]	mm		4.78	-12.53	0		-12.53	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Male Flare to Pipe//Aluminum/Anodized		Plumbing	[C1]*[Size1]*[Size2]+[C2]	mm	mm	0.032	1.33	0	0	$ 1.33	11-Mar-09	[Size1]=Inlet Hose Size (mm), [Size2]=Outlet Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Male Pipe//Aluminum/		Plumbing	[C1]*[Size1]+[C2]	mm		2.73	6.7	0		6.7	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Orb/45 deg./Aluminum/		Plumbing	[C1]*[Size1]+[C2]	mm		2.2	24	0		24	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Orb/90 deg./Aluminum/		Plumbing	[C1]*[Size1]+[C2]	mm		0	65	0		65	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Straight/Aluminum/Anodized		Plumbing	[C1]*[Size1]+[C2]	mm		1.32	-6.08	0		-6.08	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Straight/Aluminum/Crimp		Plumbing	[C1]*[Size1]+[C2]	mm		1.64	-3.15	0		-3.15	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Straight/Aluminum/Nickel-Plated		Plumbing	[C1]*[Size1]+[C2]	mm		1.8	-6.45	0		-6.45	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Straight/Steel/		Plumbing	[C1]*[Size1]+[C2]	mm		6.52	-27.18	0		-27.18	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Tee/Flare-Flare-Pipe/Steel/		Plumbing	[C1]*[Size1]+[C2]	mm		0.2	8.9	0		8.9	26-Apr-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Tube Nut//Aluminum/Anodized		Plumbing	[C1]*[Size1]+[C2]	mm		0.368	-1.34	0		-1.34	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Tube Nut//Steel/		Plumbing	[C1]*[Size1]+[C2]	mm		0.11	1.71	0		1.71	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Tube Sleeve//Aluminum/Anodized		Plumbing	[C1]*[Size1]+[C2]	mm		0.18	0	0		0	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Fitting/L.P./Tube Sleeve/Brass		Plumbing	[C1]*[Size1]+[C2]	mm		0.07	0	0		0	15-Mar-11	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Fitting/L.P./Tube Sleeve/Steel/		Plumbing	[C1]*[Size1]+[C2]	mm		0.23	0	0		0	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Grease Nipple, 45 Deg.		Plumbing	$ 0.50	unit							1-May-09	Any size up to 6.35mm
	Grease Nipple, 90 Deg.		Plumbing	$ 0.50	unit							1-May-09	Any size up to 6.35mm
	Grease Nipple, Straight		Plumbing	$ 0.50	unit							1-May-09	Any size up to 6.35mm
	Hose, High Pressure, Stainless Steel Braided Outer		Plumbing	[C1]*[Size1]+[C2]	mm		2.47	-2.71	0		-2.71	12-Jun-11	[Size1]=Hose Size (mm). Cost is per meter of hose. Hydraulic, CO2, etc. up to 20.7 Mpa.
	Hose, Low Pressure, Fabric Outer		Plumbing	[C1]*[Size1]+[C2]	mm		3.24	9.72	0		9.72	12-Jun-11	[Size1]=Hose Size (mm). Cost is per meter of hose. Fuel, oil, coolant, air, etc. up to 7 Mpa.
	Hose, Low Pressure, Stainless Steel Braided Outer		Plumbing	[C1]*[Size1]+[C2]	mm		2.23	3.52	0		3.52	12-Jun-11	[Size1]=Hose Size (mm). Cost is per meter of hose. Fuel, oil, coolant, air, etc. up to 7 Mpa.
	Hose, Low Presure, Fabric Outer, Socketless		Plumbing	[C1]*[Size1]+[C2]	mm		0.99	4.5	0		4.5	12-Jun-11	[Size1]=Hose Size (mm). Cost is per meter of hose. Fuel, oil, coolant, air, etc. up to 1.7 Mpa.
	Hose, Polyurethane	Any	Plumbing	[C1]*[Size1]+[C2]	mm	m	0.07	0	0	0	0	12-Jun-11	[Size1]=Outer Diameter (mm). Price per meter of hose (m). Same cost with and without fiber reinforcement. For very low pressure applications such as pneumatic shfiters after regulator.
	Hose, Rubber	Any	Plumbing	[C1]*[Size1]+[C2]	mm	m	0.18	0	0	0	0	12-Jun-11	[Size1]=Outer Diameter (mm). Price per meter of hose (m). Same cost with and without fiber reinforcement. For very low pressure applications (cooling system, vacuum, carbereutered fuel systems, etc.)
	Hose, Rubber		Plumbing	[C1]*[Size1]+[C2]	mm		0.18	0	0		0	12-Jun-11	[Size1]=Outer Diameter (mm). Price per meter of hose (m). Same cost with and without fiber reinforcement. For very low pressure applications (cooling system, vacuum, carbereutered fuel systems, etc.)
	Hose, Silicone	Any	Plumbing	[C1]*[Size1]+[C2]	mm	m	0.47	0	0	0	0	12-Jun-11	[Size1]=Outer Diameter (mm). Price per meter of hose (m). Same cost with and without fiber reinforcement. For very low pressure applications (cooling system, vacuum, carbereutered fuel systems, etc.)
	Locknut/L.P.///Steel/	0.126	Plumbing	[C1]*[Size1]+[C2]	mm		0.126	1.57	0		1.57	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Locknut/L.P./Flare//Aluminum/Anodized	0.385	Plumbing	[C1]*[Size1]+[C2]	mm		0.385	0.8	0		0.8	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Plug/L.P./Flare//Steel/	0.312	Plumbing	[C1]*[Size1]+[C2]	mm		0.312	0.905	0		0.905	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Plug/L.P./O-Ring Boss//Aluminum/Anodized	0.38	Plumbing	[C1]*[Size1]+[C2]	mm		0.38	5.418	0		5.418	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Plug/L.P./Pipe/Allen Head/Aluminum/Anodized	0.36	Plumbing	[C1]*[Size1]+[C2]	mm		0.36	1.78	0		1.78	11-Mar-09	[Size1]=Hose Size (mm), e.g. AN4 = 4/16 inch = 6.35mm. Low Pressure.
	Rotating Union, GAT, Rotodisk	GAT	Plumbing	$ 473.00	unit							29-Mar-09	
	Tubing, Steel		Plumbing	$ 2.25	kg							11-Mar-09	Cost using area, length and density and include process cost for flaring of tube ends, etc. Can also cost off steel or stainless steel raw material (same cost).
	Aluminum Metal Matrix Composite	Any	Raw Material	$ 33.00	kg								Density= 2500kg/m^3
	Aluminum, Normal	Any	Raw Material	$ 4.20	kg								Density= 2712kg/m^3 e.g. 2024, 6061, A356, A380
	Aluminum, Premium	Any	Raw Material	$ 4.20	kg								Density= 2712kg/m^3 e.g. 7075
	Brass	Any	Raw Material	$ 2.20	kg								Density= 8500kg/m^3
	Bronze	Any	Raw Material	$ 2.20	kg								Density= 8500kg/m^3
	Copper	Any	Raw Material	$ 2.20	kg								Density= 8940kg/m^3
	Cork	Any	Raw Material	$ 0.0050	cm^3							18-Apr-10	
	Foam, Expanding, Non-Structural	Any	Raw Material	$ 15.00	kg								Density= 25kg/m^3 Expanding foam such as is used for seats. Not to be used as core in a composite sandwhich panel.
	Inconel	Any	Raw Material	$ 22.00	kg								Density= 8497kg/m^3
	Iron	Any	Raw Material	$ 1.00	kg								Density= 7850kg/m^3
	Magnesium	Any	Raw Material	$ 6.00	kg								Density= 1738kg/m^3
	Magnet, ferrite	Any	Raw Material	$ 10.00	kg							20-Mar-14	Density= 7850kg/m^3

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Magnet, neodymium high strength	Any	Raw Material	$ 80.00	kg							20-Mar-14	Density= 7850kg/m^3
	Nickel	Any	Raw Material	$ 2.20	kg								Density= 8908kg/m^3
	Plastic, ABS	Any	Raw Material	$ 3.30	kg								Density= 1060kg/m^3 PVC, Thermoplastic
	Plastic, Acetal	Any	Raw Material	$ 3.30	kg								Density= 1420kg/m^3 Delrin, Turcite, Acetal Copolymer
	Plastic, Acrylic	Any	Raw Material	$ 3.30	kg								Density= 1190kg/m^3 Extruded, Cast
	Plastic, Flouropolymers	Any	Raw Material	$ 3.30	kg								Density= 2170kg/m^3 Teflon® PTFE, PTFE (polytetrafluoroethylene), ETFE (ethylene tetrafluoroethylene), PFA (perfluoroalkoxy fluorocarbon), CTFE (chlorotrifluoroethylene), PVDF (Kynar), ECTFE (Halar), FEP (fluorinated ethylene-propylene), Rulon®
	Plastic, Garolite	Any	Raw Material	$ 3.30	kg								Density= 1250kg/m^3 Industrial Laminates, Phenolics, Thermosets
	Plastic, Nylon	Any	Raw Material	$ 3.30	kg								Density= 1140kg/m^3 Nylon 6/6, Nylon 6/12
	Plastic, PEEK	Any	Raw Material	$ 3.30	kg								Density= 1320kg/m^3
	Plastic, Polycarbonate	Any	Raw Material	$ 3.30	kg								Density= 1200kg/m^3
	Plastic, Polyethelene	Any	Raw Material	$ 3.30	kg								Density= 950kg/m^3 LDPE (low density polyethylene), UHMW (ultra high molecular weight), HDPE (high density polyethylene), VHMW (very high molecular weight)
	Plastic, Polyoxymethylene (POM)	Any	Raw Material	$ 3.30	kg								Density= 1420kg/m^3 Delrin
	Plastic, Polypropolene	Any	Raw Material	$ 3.30	kg								Density= 900kg/m^3
	Plastic, PVC	Any	Raw Material	$ 3.30	kg								Density= 1390kg/m^3 Type I, Type II, CPVC, Expanded Rigid PVC
	Rubber	Any	Raw Material	$ 3.30	kg								Density= 1100kg/m^3
	Silicon Carbide (or any ceramic)	Any	Raw Material	AIR	kg								Please submit an Add Item Request
	Steel, Alloy	Any	Raw Material	$ 2.25	kg								Density= 7850kg/m^3 e.g. 4130, Chrome Moly, etc.
	Steel, Mild	Any	Raw Material	$ 2.25	kg								Density= 7850kg/m^3 e.g. 1010, 1025 etc.
	Steel, Stainless	Any	Raw Material	$ 2.25	kg							2-Mar-09	Density= 7850kg/m^3
	Titanium	Any	Raw Material	$ 22.00	kg								Density= 4500kg/m^3 e.g. Ti6Al4V
	Wood, Hard	Any	Raw Material	$ 0.004	cm^3								Oak, Maple, Birch
	Wood, Medium Density Fiberboard	Any	Raw Material	$ 0.002	cm^3							20-Apr-10	MDF
	Wood, Soft	Any	Raw Material	$ 0.003	cm^3							29-Sep-09	Balsa, Bass
	Aluminum Metal Matrix Composite (per kg)	Any	Raw Material (per kg)	$ 33.00	kg							29-Sep-09	Density= 2500kg/m^3
	Aluminum, Normal (per kg)	Any	Raw Material (per kg)	$ 4.20	kg							29-Sep-09	Density= 2712kg/m^3 e.g. 2024, 6061, A356, A380
	Aluminum, Premium (per kg)	Any	Raw Material (per kg)	$ 4.20	kg							29-Sep-09	Density= 2712kg/m^3 e.g. 7075
	Brass (per kg)	Any	Raw Material (per kg)	$ 2.20	kg							29-Sep-09	Density= 8500kg/m^3
	Bronze (per kg)	Any	Raw Material (per kg)	$ 2.20	kg							29-Sep-09	Density= 8500kg/m^3
	Copper (per kg)	Any	Raw Material (per kg)	$ 2.20	kg							29-Sep-09	Density= 8940kg/m^3
	Foam, Expanding, Non-Structural (per kg)	Any	Raw Material (per kg)	$ 15.00	kg							29-Sep-09	Expanding foam such as is used for seats. Not to be used as core in a composite sandwhich panel.
	Iron (per kg)	Any	Raw Material (per kg)	$ 1.00	kg							29-Sep-09	Density= 7850kg/m^3
	Magnesium (per kg)	Any	Raw Material (per kg)	$ 6.00	kg							29-Sep-09	Density= 1738kg/m^3
	Nickel (per kg)	Any	Raw Material (per kg)	$ 2.20	kg							29-Sep-09	Density= 8908kg/m^3
	Plastic, ABS (per kg)	Any	Raw Material (per kg)	$ 3.30	kg							29-Sep-09	PVC, Thermoplastic
	Plastic, Acetal (per kg)	Any	Raw Material (per kg)	$ 3.30	kg							29-Sep-09	Delrin, Turcite, Acetal Copolymer
	Plastic, Acrylic (per kg)	Any	Raw Material (per kg)	$ 3.30	kg							29-Sep-09	Extruded, Cast
	Plastic, Flouropolymers (per kg)	Any	Raw Material (per kg)	$ 3.30	kg							29-Sep-09	Teflon® PTFE, PTFE (polytetrafluoroethylene), ETFE (ethylene tetrafluoroethylene), PFA (perfluoroalkoxy fluorocarbon), CTFE (chlorotrifluoroethylene), PVDF (Kynar), ECTFE (Halar), FEP (fluorinated ethylene-propylene), Rulon®
	Plastic, Garolite (per kg)	Any	Raw Material (per kg)	$ 3.30	kg							29-Sep-09	Industrial Laminates, Phenolics, Thermosets
	Plastic, Nylon (per kg)	Any	Raw Material (per kg)	$ 3.30	kg							29-Sep-09	Nylon 6/6, Nylon 6/12
	Plastic, PEEK (per kg)	Any	Raw Material (per kg)	$ 3.30	kg							29-Sep-09	
	Plastic, Polycarbonate (per kg)	Any	Raw Material (per kg)	$ 3.30	kg							29-Sep-09	
	Plastic, Polyethelene (per kg)	Any	Raw Material (per kg)	$ 3.30	kg							29-Sep-09	LDPE (low density polyethylene), UHMW (ultra high molecular weight), HDPE (high density polyethylene), VHMW (very high molecular weight)

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Plastic, Polyoxymethylene (POM) (per kg)	Any	Raw Material (per kg)	$ 3.30	kg							29-Sep-09	Delrin
	Plastic, Polypropolene (per kg)	Any	Raw Material (per kg)	$ 3.30	kg							29-Sep-09	
	Plastic, PVC (per kg)	Any	Raw Material (per kg)	$ 3.30	kg							29-Sep-09	Type I, Type II, CPVC, Expanded Rigid PVC
	Rubber (per kg)	Any	Raw Material (per kg)	$ 3.30	kg							29-Sep-09	
	Steel, Alloy (per kg)	Any	Raw Material (per kg)	$ 2.25	kg							29-Sep-09	Density= 7850kg/m^3 e.g. 4130, Chrome Moly, etc.
	Steel, Mild (per kg)	Any	Raw Material (per kg)	$ 2.25	kg							29-Sep-09	Density= 7850kg/m^3 e.g. 1010, 1025 etc.
	Steel, Stainless (per kg)	Any	Raw Material (per kg)	$ 2.25	kg							29-Sep-09	Density= 7850kg/m^3
	Titanium (per kg)	Any	Raw Material (per kg)	$ 22.00	kg							29-Sep-09	Density= 4500kg/m^3 e.g. Ti6Al4V
	Harness, Driver	Any	Safety	$ 45.00	unit								Any harness, any latch style, any number of belts. Includes harness with built in attachment points but no hardware.
	Seal, O-Ring, Elastomer	Any	Seals	$ 0.05	unit								Any size, any material
	Seal, Radial Lip Seal	Any	Seals	$ 1.00	unit								Any Size, any style
	Sensor, Accelerometer, 1 Axis	Any	Sensors	$ 4.00	unit								
	Sensor, Accelerometer, 3 Axis	Any	Sensors	$ 8.00	unit								
	Sensor, Air Temperature	Any	Sensors	$ 4.00	unit								OEM quality sensor
	Sensor, Angular Position	Any	Sensors	$ 4.00	unit								e.g. Throttle Position Sensor (TPS)
	Sensor, Fluid Pressure	Any	Sensors	$ 4.00	unit								
	Sensor, GPS	Any	Sensors	$ 20.00	unit							11-Nov-16	
	Sensor, Gyroscope	Any	Sensors	$ 15.00	unit							20-Mar-15	
	Sensor, Fluid Pressure & Temperature	Any	Sensors	$ 10.00	unit								
	Sensor, Hall Effect	Any	Sensors	$ 4.00	unit								e.g. Wheel Speed Sensor
	Sensor, Load Cell	Any	Sensors	$ 200.00	unit								Tension or compression, S-style, load washer, shear pin, load bolt, rotary torque
	Sensor, LVDT	Any	Sensors	$ 12.00	unit								Linear Variable Differential Transformer
	Sensor, Manifold Absolute Pressure (MAP)	Any	Sensors	$ 4.00	unit								OEM quality sensor
	Sensor, Mass Air Flow (MAF)	Any	Sensors	$ 25.00	unit								OEM quality sensor
	Sensor, Pitot Tube	Any	Sensors	$ 3.00	unit							11-Nov-16	
	Sensor, Strain Gauge	Any	Sensors	$ 2.50	unit							11-Nov-16	
	Sensor, Switching Air Fuel Ratio	Any	Sensors	$ 15.00	unit								Switches output (high/low) when transition from rich to lean detected
	Sensor, Temperature	Any	Sensors	$ 8.00	unit							10-May-09	
	Sensor, Thermocouple	Any	Sensors	$ 8.00	unit								
	Sensor, Two State Position	Any	Sensors	$ 4.00	unit								
	Sensor, Wide Band Air Fuel Raito	Any	Sensors	$ 35.00	unit								Output proportional to air fuel ratio
	Fabric	Any	Sheet Material	$2.50	m^2							1-Mar-09	Any fabric including dacron for body covering, seats, etc.
	Glass	Any	Sheet Material	$ 10.00	m^2								
	Leather	Any	Sheet Material	$100.00	m^2							1-Mar-09	
	Suede	Any	Sheet Material	$100.00	m^2							1-Mar-09	
	Air Pressure Regulator	Any	Shifter	$10.00	unit							23-May-10	
	CO2 Regulator	Any	Shifter	$ 50.00	unit							22-Feb-09	
	CO2 Tank, Composite	Any	Shifter	[C1]*[Size1]+[C2]	cc		0.05	0.85	0		0.85	2-Feb-09	
	CO2 Tank, Metallic	Any	Shifter	[C1]*[Size1]+[C2]	cc		0.044	-5.44	0		-5.44	2-Feb-09	
	N2 Regulator	Any	Shifter	$ 50.00	unit							22-Feb-09	
	N2 Tank, Composite	Any	Shifter	[C1]*[Size1]+[C2]	cc		0.05	0.85	0		0.85	2-Feb-09	
	N2 Tank, Metallic	Any	Shifter	[C1]*[Size1]+[C2]	cc		0.044	-5.44	0		-5.44	2-Feb-09	
	Pneumatic Cylinder, Double Acting	Any	Shifter	$ 25.00	unit							22-Feb-09	
	Pneumatic Cylinder, Single Acting	Any	Shifter	$ 20.00	unit							22-Feb-09	
	Pneumatic fluidic muscle	Festo	Shifter	$ 60.00	unit							18-Mar-14	Any size
	Pneumatic Valve, Two Position	Any	Shifter	$ 25.00	unit							22-Feb-09	Two position valve (open/closed).
	Shift Lever, Bicycle OEM	Any	Shifter	$ 20.00	unit							23-May-10	Any make/model of bicycle (push bike) handle bar lever. Includes lever only.
	Shift Lever, Honda, 0143719	Honda	Shifter	$ 25.00	unit							10-Mar-10	
	Shifter, Automatic, Flat Shifter Expert	Flat Shifter	Shifter	$ 446.00	unit							1-Mar-10	
	Shifter, Automatic, Flat Shifter Max	Flat Shifter	Shifter	$ 370.00	unit							1-Mar-10	
	Shifter, Automatic, Kartech, Me-Shifter F1	Kartech	Shifter	$ 590.00	unit							1-Mar-09	
	Shifter, Automatic, Kliktronics	Kliktronics	Shifter	$ 360.00	unit							1-Mar-09	

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Shifter, Automatic, Pingel Easy Shift Kit	Pingel	Shifter	$ 375.00	unit							1-Mar-09	
	Shifter, Automatic, ProShift PSU Bike Kit	Proshift	Shifter	$ 700.00	units							9-Mar-16	
	Shifter, Automatic, TransLogic TLS-PS1	TransLogic	Shifter	$ 400.00	units								Includes actuator, wiring and 2 buttons.
	Spring, Small gas spring (General)	Any	Springs	$ 25.00	unit							17-May-16	For all uses requiring forces < 150 N. Not for suspensions.
	Spring, Compression (General)	Any	Springs	$ 1.00	unit								For all uses requiring forces < 100 N. Not for suspensions.
	Spring, Tension (General)	Any	Springs	$ 1.00	unit								For all uses requiring forces < 100 N. Not for suspensions.
	Spring, Torsion (General)		Springs	$ 1.00	unit							17-Mar-09	For all uses requiring forces < 100 N. Not for suspensions.
	Suspension Springs, Coil Spring, Steel	Any	Springs	$ 25.00	unit								Any Steel coil compression spring
	Suspension Springs, Coil Spring, Titanium	Any	Springs	$ 110.00	unit								Titanium Spring
	Steering Column Universal Joint	Any	Steering	$ 20.00	unit								
	Steering Column Universal Joint, Double	Any	Steering	$ 38.50	unit							26-Jun-14	
	Steering Pinion (All Cost as Made)	Any	Steering	$ -	unit								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Steering Rack (All Cost as Made)	Any	Steering	$ -	unit								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Steering Rack Housing (All Cost as Made)	Any	Steering	$ -	unit								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Steering Wheel (All Cost as Made)	Any	Steering	$ -	unit								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Steering Wheel, Quick Release (All Cost as Made)	Any	Steering	$ -	unit								This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	A-Arms (All Cost as Made)	Any	Suspension	$ -	unit							26-Mar-10	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Wishbones (All Cost as Made)	Any	Suspension	$ -	unit							26-Mar-10	This item should be cost as made whether the team made it or bought it. Please see Rule C3.12 for more information.
	Tire, American Racer, M32, 8"-15.0 x7.0	American Racer	Tire	$ 68.00	unit							16-Jun-13	8 inch rim diameter
	Tire, American Racer, SD44, 8"-15.0 x6.0	American Racer	Tire	$ 68.00	unit							14-Jun-13	8 inch rim diameter
	Tire, American Racer, SD44, 8"-15.0 x8.0	American Racer	Tire	$ 68.00	unit							15-Jun-13	8 inch rim diameter
	Tire, American Racer,M32, 8"-15.0 x7.0	American Racer	Tire	$ 68.00	unit							26-Oct-14	8 inch rim diameter
	Tire, American Racer,SD44, 8"-15.0 x6.0	American Racer	Tire	$ 68.00	unit							24-Oct-14	8 inch rim diameter
	Tire, American Racer,SD44, 8"-15.0 x8.0	American Racer	Tire	$ 68.00	unit							25-Oct-14	8 inch rim diameter
	Tire, American Racer,M28, 13"-21.8 x10	American Racer	Tire	$ 68.00	unit							16-Dec-14	13 inch rim diameter
	Tire, Avon, A45, 10"-16.0 x 7.2	Avon	Tire	$ 100.00	unit							28-May-15	
	Tire, Avon, A45, 13"-20.0 x 6.2	Avon	Tire	$ 100.00	unit								
	Tire, Avon, A45, 13"-20.0 x 7.2	Avon	Tire	$ 100.00	unit								
	Tire, Avon, A45, 13"-20.0 x 8.2	Avon	Tire	$ 100.00	unit								
	Tire, Bridgestone, 13"-180mm/510mm	Bridgestone	Tire	$ 100.00	unit								
	Tire, Continental, 13"	Continental	Tire	$ 80.00	unit							26-Jun-14	
	Tire, Dunlop Motorsport, 10", 160mm/490mm	Dunlop	Tire	$ 150.00	unit							2-Jun-14	
	Tire, Dunlop Motorsport, 13", 175mm/505mm	Dunlop	Tire	$ 87.00	unit							6-May-09	
	Tire, Goodyear, D2692, 13"-20.0 x 7.0	Goodyear	Tire	$ 100.00	unit							22-Feb-09	
	Tire, Goodyear, R065, 13"-20.0 x 7.0	Goodyear	Tire	$ 100.00	unit								
	Tire, Goodyear, R075, 13"-20.0 x 7.0	Goodyear	Tire	$ 100.00	unit								
	Tire, Hoosier, LC0, 10"-18.0 x 6.0	Hoosier	Tire	$ 85.00	unit							29-Mar-09	
	Tire, Hoosier, LC0, 10"-18.0 x 7.0	Hoosier	Tire	$ 85.00	unit								
	Tire, Hoosier, R25B, 10"-18.0 x 6.0	Hoosier	Tire	$ 85.00	unit								
	Tire, Hoosier, R25B, 10"-18.0 x 7.5	Hoosier	Tire	$ 85.00	unit								
	Tire, Hoosier, R25B, 10"-19.5 x 6.5	Hoosier	Tire	$ 85.00	unit								
	Tire, Hoosier, R25B, 10"-19.5 x 7.5	Hoosier	Tire	$ 85.00	unit								
	Tire, Hoosier, R25B, 13"-20.0 x 7.5	Hoosier	Tire	$ 85.00	unit								
	Tire, Hoosier, R25B, 13"-20.0 x 8.0	Hoosier	Tire	$ 85.00	unit							22-Feb-09	
	Tire, Hoosier, R25B, 13"-20.0 x 9.0	Hoosier	Tire	$ 85.00	unit							22-Feb-09	
	Tire, Hoosier, R25B, 13"-20.5 x 6.0	Hoosier	Tire	$ 85.00	unit								
	Tire, Hoosier, R25B, 13"-20.5 x 7.0	Hoosier	Tire	$ 85.00	unit								
	Tire, Hoosier, Wet, 10"-19.5 x 6.5	Hoosier	Tire	$ 80.00	unit								
	Tire, Hoosier, Wet, 13"-20.0 x 7.5	Hoosier	Tire	$ 100.00	unit								

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Tire, Hoosier, Wet, 13"-21.0 x 6.5	Hoosier	Tire	$ 100.00	unit								
	Tire, Kumho, ECSTA, 13"-170mm/515mm	Kumoh	Tire	$ 80.00	unit								
	Tire, Michelin, P220, 13"-20.9 x 6.3	Michelin	Tire	$ 100.00	unit								
	Tire, Michelin, S6B, 13"-20.9 x 6.3	Michelin	Tire	$ 100.00	unit								
	Tire, Pirelli, 13"-180mm/530mm	Pirelli	Tire	$ 123.00	unit							27-Aug-14	
	Tire, Pirelli, 13"-200mm/540mm	Pirelli	Tire	$ 130.00	unit							30-Mar-16	
	Tire, Pirelli, 13"-250mm/575mm SUPERSOFT	Pirelli	Tire	$ 135.00	unit							30-Mar-16	
	Tire, Treaded Production Car Not Listed Above	Any	Tire	$ 40.00	unit								
	Tire, Yokohoma, ADVAN Dry, 13" 160-55	Yokohoma	Tire	$ 135.00	unit							7-May-11	
	Tire, Yokohoma, ADVAN Wet, 13" 160-55	Yokohoma	Tire	$ 160.00	unit							7-May-11	
	Valve Stem (and Tire Inflation)	Any	Tire	$ 1.00	unit							22-Feb-09	Includes tire inflation
	Wheel Center, Any Size, Student Made	Student Built	Wheel	$ -	unit							27-Dec-11	
	Wheel Shells, 10", 2 Piece, Keizer, Aluminum	Keizer	Wheel	$ 85.00	unit							26-Jun-14	
	Wheel Shells, 10", 3 Piece, Keizer, Aluminum	Keizer	Wheel	$ 57.50	unit							8-Mar-09	Wheel shells include outer rim but no center
	Wheel Shells, 13" Inner, 4" Wide, Kodiak, Aluminum	Kodiak	Wheel	$ 93.00	unit							3-Aug-09	Kodiak Part Number I13406
	Wheel Shells, 13" Inner, 4.5" Wide, Kodiak, Alum.	Kodiak	Wheel	$ 93.00	unit							3-Aug-09	Aluminum. Kodiak Part Number I134506
	Wheel Shells, 13" Inner, 5" Wide, Kodiak, Alum.	Kodiak	Wheel	$ 100.00	unit							3-Aug-09	Aluminum. Kodiak Part Number I113506
	Wheel Shells, 13" Inner, 6" Wide, Kodiak, Alum.	Kodiak	Wheel	$ 104.00	unit							3-Aug-09	Aluminum. Kodiak Part Number I13606
	Wheel Shells, 13" Outer, 1" Wide, Kodiak, Alum.	Kodiak	Wheel	$ 85.00	unit							3-Aug-09	Aluminum. Kodiak Part Number O13106
	Wheel Shells, 13" Outer, 1.5" Wide, Kodiak, Alum.	Kodiak	Wheel	$ 91.50	unit							3-Aug-09	Aluminum. Kodiak Part Number O131506
	Wheel Shells, 13" Outer, 2" Wide, Kodiak, Alum.	Kodiak	Wheel	$ 91.50	unit							3-Aug-09	Aluminum. Kodiak Part Number O13206
	Wheel Shells, 13", 3 Piece, Jongbloed, Alum.	Jongbloed	Wheel	$ 287.50	unit							8-Mar-09	Wheel comes with solid center, no machining for hub attachment
	Wheel Shells, 13", 3 Piece, Jongbloed, Magnesium	Jongbloed	Wheel	$ 287.50	unit							8-Mar-09	Wheel comes with solid center, no machining for hub attachment
	Wheel Shells, 13", 3 Piece, Keizer, Aluminum	Keizer	Wheel	$ 82.50	unit							17-Mar-09	Wheel shells include inner & outer rim but no center
	Wheel Shells, 13", 3 Piece, Weld, Aluminum	Weld	Wheel	$ 114.00	unit							3-Aug-09	Includes Inner (P850-3478) and Outer (P851-3318)
	Wheel Weights (and Balancing)	Any	Wheel	$ 4.00	unit								Includes weights, balancing and installation labor for wheel weight
	Wheel, 10", 1 Piece OEM, Aluminum	Any	Wheel	$ 77.50	unit								Wheel comes with solid center, no machining for hub attachment
	Wheel, 10", 1 Piece OEM, Magnesium	Any	Wheel	$ 108.00	unit								Wheel comes with solid center, no machining for hub attachment
	Wheel, 10", 1 Piece OEM, Steel	Any	Wheel	$ 40.00	unit								Wheel comes with solid center, no machining for hub attachment
	Wheel, 10", 1 Piece, Carbon Fiber, Purchased	Any	Wheel	AIR	unit								Please submit Add Item Request
	Wheel, 10", 1 Piece, Carbon Fiber, Student Made	Student Built	Wheel	$ -	unit								
	Wheel, 10", 1 Piece, DWT, Alumalite, Aluminum, Model 011-05	DWT	Wheel	$ 63.00	unit							18-Jun-13	sport blue label 0.125" thickness
	Wheel, 10", 1 Piece, DWT, Alumalite, Aluminum, Model 011-05	DWT	Wheel	$ 63.00	unit							28-Oct-14	sport blue label 0.125" thickness
	Wheel, 10", 1 Piece OZ, Magnesium	OZ Racing	Wheel	$ 150.00	unit							21-Oct-16	
	Wheel, 10", 2 Piece, HiPer Racing, Carbon-plastic, CF1, Inner Half	HiPer Racing	Wheel	$ 37.50	unit							31-Mar-10	
	Wheel, 10", 2 Piece, HiPer Racing, Carbon-plastic, Tec 3, Inner Half	HiPer Racing	Wheel	$ 22.50	unit							31-Mar-10	
	Wheel, 10", 3 Piece, Force-Racing V5, Aluminum	Force Racing	Wheel	$ 123.00	unit							14-May-14	
	Wheel, 10", 3 Piece, Keizer, Aluminum	Keizer	Wheel	$ 77.50	unit								Wheel comes with solid center, no machining for hub attachment
	Wheel, 13", 1 Piece OEM, Aluminum	Any	Wheel	$ 115.00	unit								Wheel comes with solid center, no machining for hub attachment
	Wheel, 13", 1 Piece OEM, Magnesium	Any	Wheel	$ 161.00	unit								Wheel comes with solid center, no machining for hub attachment

Material ID	Material	Supplier	Category	Table Price	Unit 1	Unit 2	C1	C2	Size1	Size2	Calc Value	Modified	Comments
	Wheel, 13", 1 Piece OEM, Steel	Any	Wheel	$ 50.00	unit								Wheel comes with solid center, no machining for hub attachment
	Wheel, 13", 1 Piece OZ, Aluminum	OZ Racing	Wheel	$ 80.00	unit							26-Jun-14	
	Wheel, 13", 1 Piece OZ, Magnesium	OZ Racing	Wheel	$ 150.00	unit							24-Feb-15	
	Wheel, 13", 1 Piece, Braid, Formrace, Aluminum, Model 16, 7" Wide	Braid	Wheel	s	unit							9-May-10	
	Wheel, 13", 1 Piece, Braid, Sturace, Aluminum, 7" Wide	Braid	Wheel	$ 180.00	unit							28-Mar-15	
	Wheel, 13", 1 Piece, Carbon Fiber, Purchased	Any	Wheel	AIR	unit								Please submit Add Item Request
	Wheel, 13", 1 Piece, Carbon Fiber, Student Made	Student Built	Wheel	$ -	unit								
	Wheel, 13", 1 Piece, Compomotive XR1380	Compomotive	Wheel	$ 94.00	unit							23-May-10	
	Wheel, 13", 1 Piece, Orbital 861, Aluminum	Orbital	Wheel	$ 80.00	unit							7-May-11	
	Wheel, 13", 1 Piece, Volk TE37, Aluminum	Volk	Wheel	$ 200.00	unit								
	Wheel, 13", 1 Piece, Watanabe, Magnesium, 6-Spoke, Widths 10-12	Watanabe	Wheel	$ 250.00	unit							18-Apr-10	
	Wheel, 13", 1 Piece, Watanabe, Magnesium, 6-Spoke, Widths 8-9.5	Watanabe	Wheel	$ 235.00	unit							18-Apr-10	
	Wheel, 13", 2 Piece, Braid, Formrace, Aluminum, Model 16, 6" Wide	Braid	Wheel	$ 96.50	unit							9-May-10	
	Wheel, 13", 3 Piece, Bogar RT-4, Aluminum	Bogart	Wheel	$ 150.00	unit							1-Mar-09	
	Wheel, 13", 3 Piece, Force-Racing DSY, Aluminum	Force Racing	Wheel	$ 163.00	unit							26-May-14	
	Wheel, 13", 3 Piece, Jongbloed, Aluminum	Jongbloed	Wheel	$ 287.50	unit								Wheel comes with solid center, no machining for hub attachment
	Wheel, 13", 3 Piece, Jongbloed, Magnesium	Jongbloed	Wheel	$ 287.50	unit								Wheel comes with solid center, no machining for hub attachment
	Wheel, 13", 3 Piece, Keizer, Aluminum	Keizer	Wheel	$ 115.00	unit								Wheel comes with solid center, no machining for hub attachment
	Wheel, 13", 3 Piece, Keizer, Magnesium	Keizer	Wheel	$ 140.00	unit								Wheel comes with solid center, no machining for hub attachment
	Wheel, 13", 3 Piece, Weld, Aluminum	Weld	Wheel	$ 201.50	unit							8-Mar-09	Includes center (P613-7096), Inner (P850-3478) and Outer (P851-3318)
	Wheel, 13", BBS, Magnesium, Cast, R-RE-325	BBS	Wheel	$ 340.00	unit							1-Mar-09	
	Wheel, 13", Magnesium, BBS, Forged	BBS	Wheel	AIR	unit								Please submit Add Item Request
	Wheel, 15", 1 Piece OEM, Aluminum	Any	Wheel	$ 140.00	unit								
	Wheel, 15", 1 Piece OEM, Magnesium	Any	Wheel	$ 196.00	unit								
	Wheel, 15", 1 Piece OEM, Steel	Any	Wheel	$ 60.00	unit								
	Wheel, 15", 1 Piece, Carbon Fiber, Purchased		Wheel	AIR	unit								
	Wheel, 15", 1 Piece, Carbon Fiber, Student Made	Student Built	Wheel	$ -	unit								
	Wheel, 8", 1 Piece, DWT, Alumalite, Aluminum, 7-8"	DWT	Wheel	$ 39.00	unit							17-Jun-13	sport blue label 0.125" thickness
	Wheel, 8", 1 Piece, DWT, Alumalite, Aluminum, 7-8"	DWT	Wheel	$ 39.00	unit							27-Oct-14	sport blue label 0.125" thickness

Lampiran 13

Process Table. Posted Version 9, 29-Oct-2013

Process ID	Process	Unit Cost	Unit	Category	Tooling Required	Near Net Shape	Multiplier Type Used	Modified	Comments
	None	$ -							
	Die Casting	$ 4.00	kg	Basic Forming	Yes	Yes			
	Investment Casting	$ 8.00	kg	Basic Forming		Yes			
	Plastic injection molding	$ 2.75	kg	Basic Forming	Yes	Yes			
	Powder Metal Forming	$ 3.00	kg	Basic Forming	Yes	Yes			
	Rapid Prototype - Composite	$ 175.00	kg	Basic Forming		Yes		11-Nov-16	
	Rapid Prototype - Metal	$ 330.00	kg	Basic Forming		Yes		13-Oct-13	Updated terminology for clarity
	Rapid Prototype - Plastic	$ 32.00	kg	Basic Forming		Yes		13-Oct-13	Updated terminology for clarity
	Sand Casting	$ 3.00	kg	Basic Forming	Yes				
	Vacuum Form	$ 10.00	m^2	Basic Forming	Yes			30-Mar-12	
	Exhaust System Ceramic Coating	$ 25.00	m	Coating				24-Feb-09	Linear distance of coating on exhaust header and tubing including all runners, etc. Material included.
	Cure, Autoclave	$ 50.00	m^2	Composite	Yes				Includes all consumable materials and labor.
	Cure, Oven	$ 20.00	m^2	Composite	Yes				Includes all consumable materials and labor.
	Cure, Room Temperature	$ 10.00	m^2	Composite	Yes			24-Feb-09	Includes all consumable materials and labor. Cannot be used with prepreg composites
	Lamination, Fillament Winding	$ 25.00	kg	Composite				26-Mar-09	Cost based on finished part mass of composite fibers and resin.
	Lamination, Manual	$ 35.00	m^2	Composite					
	Potting	$ 0.50	cm	Composite				26-Apr-09	Cost based on perimeter of insert. Includes potting compund material cost
	Resin application, Infusion Molding	$ 2.50	m^2	Composite					
	Resin application, Manual	$ 5.00	m^2	Composite					If prepreg composites are used do not included the resin application step.
	Attach Wire, Fork	$ 0.25	unit	Electrical - Attach Wires					
	Attach Wire, Quick connect terminal	$ 0.10	unit	Electrical - Attach Wires					
	Attach Wire, Ring	$ 0.48	unit	Electrical - Attach Wires					
	Attach Wire, Solder wire, bent	$ 0.35	unit	Electrical - Attach Wires					
	Attach Wire, Solder wire, not bent	$ 0.52	unit	Electrical - Attach Wires					
	Attach Wire, Terminated wire with screw	$ 0.35	unit	Electrical - Attach Wires					
	Attach Wire, Terminated wire with screw and nut	$ 0.52	unit	Electrical - Attach Wires					
	Attach Wire, Wire to screw	$ 0.48	unit	Electrical - Attach Wires					
	Attach Wire, Wire to screw with nut	$ 0.65	unit	Electrical - Attach Wires					
	Attach Wire, Wire to terminal block	$ 0.35	unit	Electrical - Attach Wires					
	Attach Wire, Wire wrap around terminal post	$ 0.27	unit	Electrical - Attach Wires					
	Install Tie Wrap (Zip Tie, Cable Clamp)	$ 0.09	unit	Electrical - Bundle Install				17-Feb-09	
	Wire Dressing (Install and route)	$ 1.00	m	Electrical - Bundle Install					
	Insert Bundle Into Tube or Sleeve	$ 0.02	m	Electrical - Bundle Processing				24-Jan-09	
	Install Adhesive Cable Clamp	$ 0.19	unit	Electrical - Bundle Processing					
	Lace	$ 0.15	unit	Electrical - Bundle Processing					
	Shrink Tube	$ 0.15	cm	Electrical - Bundle Processing				26-Mar-09	

	Taping Wire Bundle	$ 0.04	cm	Electrical - Bundle Processing				26-Mar-09	
	Connector Install, Circular, Bayonet	$ 0.11	unit	Electrical - Connections					
	Connector Install, Circular, Friction	$ 0.14	unit	Electrical - Connections					
	Connector Install, Circular, Screw Thread	$ 0.24	unit	Electrical - Connections					
	Connector Install, Square, Friction	$ 0.14	unit	Electrical - Connections					
	Connector Install, Square, Latch/Snap-on Type	$ 0.17	unit	Electrical - Connections					
	Connector Install, Square, Screw (x2)	$ 0.50	unit	Electrical - Connections					
	Connector Install, Square, Spring Clip	$ 0.20	unit	Electrical - Connections					
	Lay Wire - Control	$ 0.02	m	Electrical - Layout				25-Jan-09	
	Lay Wire - Power	$ 0.03	m	Electrical - Layout				25-Jan-09	
	Lay Wire - Signal	$ 0.02	m	Electrical - Layout				25-Jan-09	
	Crimp Wire	$ 0.17	unit	Electrical - Prep					
	Cut wire	$ 0.08	unit	Electrical - Prep					
	Strip Multi-Conductor	$ 0.13	wire(s)	Electrical - Prep				24-Jan-09	
	Strip Wire	$ 0.08	unit	Electrical - Prep					
	Tin Wire	$ 0.13	unit	Electrical - Prep					
	Connector Assembley, Crimp	$ 0.36	contacts	Electrical - Wire in Connector				24-Jan-09	
	Connector Assembley, Solder	$ 0.24	contacts	Electrical - Wire in Connector				24-Jan-09	
	Hand - Start Only	$ 0.12	unit	Fasteners					
	Hand, Loose <= 25.4 mm	$ 0.50	unit	Fasteners					
	Hand, Loose <= 6.35 mm	$ 0.25	unit	Fasteners					
	Hand, Loose > 25.4 mm	$ 0.75	unit	Fasteners					
	Hand, Tight <= 6.35 mm	$ 0.50	unit	Fasteners					
	Power Tool <= 25.4 mm	$ 0.25	unit	Fasteners			Fastener Installation		
	Power Tool <= 6.35 mm	$ 0.25	unit	Fasteners			Fastener Installation		
	Power Tool > 25.4 mm	$ 0.50	unit	Fasteners			Fastener Installation		
	Ratchet <= 25.4 mm	$ 0.75	unit	Fasteners			Fastener Installation		
	Ratchet <= 6.35 mm	$ 0.50	unit	Fasteners			Fastener Installation		
	Ratchet > 25.4 mm	$ 1.50	unit	Fasteners			Fastener Installation		
	Reaction Tool <= 25.4 mm	$ 0.25	unit	Fasteners					
	Reaction Tool <= 6.35 mm	$ 0.25	unit	Fasteners					
	Reaction Tool > 25.4 mm	$ 0.50	unit	Fasteners					
	Screwdriver < 1 Turn	$ 0.12	unit	Fasteners			Fastener Installation		
	Screwdriver > 1 Turn	$ 0.50	unit	Fasteners			Fastener Installation		
	Wrench <= 25.4 mm	$ 1.50	unit	Fasteners			Fastener Installation		

	Wrench <= 6.35 mm	$ 1.00	unit	Fasteners			Fastener Installation		
	Wrench > 25.4 mm	$ 2.00	unit	Fasteners			Fastener Installation		
	Braze	$ 0.15	cm	Joining	Yes			26-Mar-09	
	Sewing	$ 0.08	cm	Joining					
	Weld	$ 0.15	cm	Joining	Yes			24-Feb-09	
	Adjustment - Misc.	$ 5.00	unit	Labor					Chain tension, etc.
	Aerosol Apply	$ 5.25	m^2	Labor					
	Annodize	$ -	unit	Labor				25-Feb-09	It is not necessary to include any cost for annodizing. Included for reference only.
	Assemble, >20 kg, Interference	$ 5.63	unit	Labor			Assembly		
	Assemble, >20 kg, Line-on-Line	$ 3.75	unit	Labor			Assembly		
	Assemble, >20 kg, Loose	$ 1.88	unit	Labor			Assembly		
	Assemble, 1 kg, Interference	$ 0.19	unit	Labor			Assembly		
	Assemble, 1 kg, Line-on-Line	$ 0.13	unit	Labor			Assembly		
	Assemble, 1 kg, Loose	$ 0.06	unit	Labor			Assembly		
	Assemble, 10 kg, Interference	$ 1.88	unit	Labor			Assembly		
	Assemble, 10 kg, Line-on-Line	$ 1.25	unit	Labor			Assembly		
	Assemble, 10 kg, Loose	$ 0.63	unit	Labor			Assembly		
	Assemble, 15 kg, Interference	$ 2.81	unit	Labor			Assembly		
	Assemble, 15 kg, Line-on-Line	$ 1.88	unit	Labor			Assembly		
	Assemble, 15 kg, Loose	$ 0.94	unit	Labor			Assembly		
	Assemble, 20 kg, Interference	$ 3.75	unit	Labor			Assembly		
	Assemble, 20 kg, Line-on-Line	$ 2.50	unit	Labor			Assembly		
	Assemble, 20 kg, Loose	$ 1.25	unit	Labor			Assembly		
	Assemble, 3 kg, Interference	$ 0.56	unit	Labor			Assembly		
	Assemble, 3 kg, Line-on-Line	$ 0.38	unit	Labor			Assembly		
	Assemble, 3 kg, Loose	$ 0.19	unit	Labor			Assembly		
	Assemble, 5 kg, Interference	$ 0.94	unit	Labor			Assembly		
	Assemble, 5 kg, Line-on-Line	$ 0.63	unit	Labor			Assembly		
	Assemble, 5 kg, Loose	$ 0.31	unit	Labor			Assembly		
	Brake Bleed - Per Bleeder Valve	$ 2.50	unit	Labor					
	Brush Apply	$ 0.02	cm^2	Labor					For use with glue, adhesives, paint, resin, etc.
	Chrome plating	$ -	unit	Labor				19-May-15	It is not necessary to include any cost for Chrome plating. Included for reference only. Applies to any type of chrome plating.
	Cut (scissors, knife)	$ 0.06	cm	Labor					
	Engine first start, includes fuel	$ 50.00	unit	Labor				40991	Includes Fuel
	Galvanize coating	$ -	unit	Labor				19-May-15	It is not necessary to include any cost for Galvanize coating. Included for reference only. Applies to any type of galvanize coating. Does not need to be used on standard fasteners.
	Heat Treatment	$ -	unit	Labor				30-Apr-09	It is not necessary to include any cost for heat treatment. Included for reference only.
	Liquid Applicator Gun	$ 0.02	cm	Labor					For use with glue, adhesives, paint, resin, etc.
	Liquid Apply - Pour Expanding Foam	$ 2.00	m^3	Labor	Yes - if not fully captured			29-Oct-13	Cost based on volume of fully expanded final part before trimming. Added note explaining that if final part is foam (not fully contained in something else) than tooling is required and added tooling for liquid pour operations to tooling table.
	Liquid Apply - Spot	$ 0.10	unit	Labor					For use with glue, adhesives, paint, resin, etc.

	Machining Setup, Change	$ 0.65	unit	Labor				01-Mar-09	The quantity for this process may be used to scale the cost to the number of parts yielded from each setup. For example if 4 parts can be machined from a single plate then the quantity per part may be set to 0.25 to spread the cost out over each part.
	Machining Setup, Install and remove	$ 1.30	unit	Labor				01-Mar-09	The quantity for this process may be used to scale the cost to the number of parts yielded from each setup. For example if 4 parts can be machined from a single plate then the quantity per part may be 0.25 to spread the cost out over each part.
	Riveting	$ 0.25	unit	Labor				17-Feb-09	
	Safety Wire, Install	$ 0.60	unit	Labor				17-Feb-09	Unit includes each item or hole included in safety wire path. One item could include bolt, nut, hole in an axle, hub, etc.
	Suspension Setup - Solid Axle (per corner)	$ 4.50	unit	Labor					
	Suspension Setup-Independent Susp. (per corner)	$ 8.75	unit	Labor					
	Tape	$ 0.80	m	Labor					
	Broach, External	$ 0.50	cm	Material Removal				17-Feb-09	Linear distance of broach
	Broach, Internal	$ 0.50	cm	Material Removal				17-Feb-09	Linear distance of broach
	Drilled hole < 50.8 mm dia.	$ 0.70	hole	Material Removal			Drill & Tap		Holes >= 50.8 mm must be machined
	Drilled holes < 25.4 mm dia.	$ 0.35	hole	Material Removal			Drill & Tap		
	EDM - Plunge	$ 0.30	cm^3	Material Removal			Machining		
	EDM - Wire	$ 0.20	cm	Material Removal			Machining		
	Gear Shaping (hobbing)	$ 0.50	cm	Material Removal			Machining	09-May-10	Linear travel of gear shaping. A half-shaft end 5cm long would cost $2.50
	Grind, Cylindrical	$ 0.15	cm^2	Material Removal			Machining		0.25mm machine stock
	Grind, Flat	$ 0.15	cm^2	Material Removal			Machining		0.25mm machine stock
	Grind, Profile	$ 0.15	cm^2	Material Removal			Machining		0.25mm machine stock
	Hand Finish - Material Removal	$ 0.20	cm^3	Material Removal			Machining	20-Feb-09	Hand sanding, grinding, shaping. Any manual material removal process.
	Hand Finish - Surface Preperation	$ 0.02	cm^2	Material Removal			Machining	20-Feb-09	Hand sanding, cleaning or other operations used to prepare the surface, such as for bonding.
	Knurling	$ 0.10	cm	Material Removal			Machining	24-Feb-09	Linear distance of knurl on part (length of knurl, not diameter)
	Laser Cut	$ 0.01	cm	Material Removal			Machining	24-Oct-10	Revised cost for 2011 Competition Years
	Machining	$ 0.04	cm^3	Material Removal			Machining	25-Sep-10	Machining can include roughing (1.5mm machine stock min., Tol +/- 0.5mm) and/or finishing (0.5mm machine stock min.). All parts should include the minimum 1.5mm material stock except parts produced by "near net shaped" basic forming processes. It is not necessary to break down rough and finish cuts, only use the correct minimum stock in the calculation of material removed.
	Mill - Form Cutter	$ 0.10	cm	Material Removal			Machining		0.5mm machine stock min. Linear distance of cutter motion.
	Non-metallic cutting <= 25.4 mm	$ 0.35	cut	Material Removal			Machining		
	Non-metallic cutting <= 50.8 mm	$ 0.70	cut	Material Removal			Machining		
	Non-metallic cutting <= 76.2 mm	$ 1.05	cut	Material Removal			Machining		
	Non-metallic cutting > 76.2 mm	$ 1.40	cut	Material Removal			Machining		
	Plasma Cutting	$ 0.10	cm	Material Removal			Machining		
	Reemed hole	$ 0.35	hole	Material Removal			Machining		Reemed holes must first be drilled or machined
	Saw or tubing cuts	$ 0.40	cm	Material Removal			Machining		
	Tapping holes	$ 0.35	hole	Material Removal			Drill & Tap		
	Threading, External (machining)	$ 0.10	cm	Material Removal				17-Feb-09	Linear distance of thread (length of bolt thread, not diameter)
	Threading, Internal (machining)	$ 0.10	cm	Material Removal				17-Feb-09	Linear distance of thread (length of bolt thread, not diameter)
	Waterjet Cut	$ 0.01	cm	Material Removal			Machining	24-Oct-10	Revised cost for 2011 Competition Years

	Spinning, Metal	$ 0.02	cm^3	Shaping				26-Mar-09	Cost based on the total volume created between the metal starting position and final position.
	Sheet metal bends	$ 0.25	bend	Sheet Materials					
	Sheet metal punching	$ 0.03	cm^2	Sheet Materials					
	Sheet Metal Saw Cut	$ 0.20	cm	Sheet Materials				17-Feb-09	Includes linear saw cuts and hole saw cuts. Linear cuts by linear distance and hole saw cuts by hole circumference.
	Sheet metal shearing	$ 0.25	cut	Sheet Materials					
	Sheet metal stamping	$ 0.03	cm^2	Sheet Materials					
	Tube bends	$ 0.75	bend	Tubing					
	Tube cut	$ 0.15	cm	Tubing				24-Jan-09	Use diameter of tube
	Tube end preperation for welding	$ 0.75	end	Tubing					Includes mitering, nothing, sanding, wire wheeling and surface prep. All steps necessary for welding of one tube end except cutting and welding.
	Tube Flare/Bead	$ 0.45	end	Tubing				24-Feb-09	Form flare or bead for brake lines, cooling lines, etc. in hard lines
	Weld - Round Tubing	$ 0.38	cm	Tubing				24-Jan-09	Use diameter for dimension. Ratio of pi included. For complex tube assemblies only. EXAMPLE: Exhaust manifolds.

Lampiran 14

Process Multipliers Table. Posted Version 1.3, 28-Nov-2010

Process MultiplierID	Process Multiplier	Multiplier	Use	Comments
1	Assemble - Length > 0.5m	1.25	Assembly	
2	Disassemble	0.8	Assembly	To be used when removing parts or fasteners
3	Fastener Engagement Length > 2D	1.25	Fastener Installation	
4	Fastener Engagement Length > 4D	1.5	Fastener Installation	
5	Machine - Hole Length >= 4D	1.5	Drill, Tap	
6	Machine - Hole Length >= 8D	3	Drill, Tap	
7	Material - Composite	2	Machining	
8	Material - Aluminum	1	Machining	
9	Material - Brass	0.8	Machining	
10	Material - Bronze	1.33	Machining	
11	Material - Cast Iron	2.5	Machining	
12	Material - Foam	0.33	Machining	
13	Material - Inconel	4	Machining	
14	Material - Magnesium	0.8	Machining	
15	Material - MMC	4.25	Machining	
16	Material - Nickel	1.33	Machining	
17	Material - Plastic	0.5	Machining	
18	Material - Stainless Steel	3.75	Machining	
19	Material - Steel	3	Machining	
20	Material - Titanium	3.65	Machining	
21	Material - Wood (Hard or soft)	0.5	Machining	
22	Repeat 2	2		Optional, to show repetition of processes.
23	Repeat 3	3		Optional, to show repetition of processes.
24	Repeat 4	4		Optional, to show repetition of processes.
25	Repeat 5	5		Optional, to show repetition of processes.
26	Repeat 6	6		Optional, to show repetition of processes.
27	Repeat 7	7		Optional, to show repetition of processes.
28	Repeat 8	8		Optional, to show repetition of processes.
29	Repeat 9	9		Optional, to show repetition of processes.
30	Repeat 10	10		Optional, to show repetition of processes.

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FAKULTAS TEKNIK

KARTU BIMBINGAN PROYEK AKHIR/TUGAS AKHIR SKRIPSI

FRM/OTO/04-00
27 Maret 2008

Nama Mahasiswa : Deni Restu Widodo

No. Mahasiswa : 14504241011

Judul PA/TAS : *Cost Report Analysis* Pada Material Dan Proses Manufaktur *Frame* Kendaraan *Formula Garuda* 2016 (FG16) *Garuda UNY Racing Team* Sebagai Pengembangan Materi Mata Kuliah Manajemen Industri Otomotif

Dosen Pebimbing : Dr. Zainal Arifin, M.T.

Bimb. Ke	Hari/Tanggal Bimbingan	Materi Bimbingan	Catatan Dosen Pembimbing	Tanda Tangan Dosen Pemb.
1	Kamis, 21/12. 17	Judul & BAB I	Revisi Judul & Batasan	
2	Selasa, 26/12. 17	BAB I	Latar Belakang & Batasan	
3	Kamis, 28/12. 17	BAB II	Cantumkan Sumber tabel/Gr	
4			Isi Kajian dikonkapi	
5	Senin, 1/1. 18	BAB II & III	Tambah Material Frame	
6	Selasa, 30/1. 18	BAB III & IV	Metode Penelitian → Deskriptif	
7	Senin, 5/2. 18	BAB IV	Tabel Data → Lampiran	
8			Penulisan Format Data	
9	Senin, 19/2. 18	BAB IV	Pembahasan SW + IH	
10			& Penempatan Chart.	
11	Senin, 26/2. 18	BAB V	Simpulan	
12		Siapkan ujian		
13				
14				
15				

Keterangan :
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2. Kartu ini wajib dilampirkan pada laporanPA/TAS

UNIVERSITAS NEGERI YOGYAKARTA
FAKULTAS TEKNIK

BUKTI SELESAI REVISI PROYEK AKHIR D3/S1

FRM/OTO/11-00
27 Maret 2008

Nama Mahasiswa : Deni Restu Widodo
No. Mahasiswa : 14504241011
Judul PA D3/S1 :
Cost Report Analysis Pada Material dan Proses Manufaktur Frame Kendaraan Formula Garuda 2016 (FG16) Garuda UNY Racing Team (Sebagai Pengembangan Materi Mata Kuliah Manajemen Industri Otomotif).
Dosen Pembimbing : Dr. Zainal Arifin, M.T.

Dengan ini Saya menyatakan Mahasiswa tersebut telah selesai revisi.

No	Nama	Jabatan	Paraf	Tanggal
1	Dr. Zainal Arifin, M.T.	Ketua Penguji		20.03.2018
2	Prof. Dr. Herminarto Sofyan, M.Pd.	Sekretaris Penguji		20-3-2018
3	Drs. Kir Haryana, M.Pd.	Penguji Utama		20-3-2018

Keterangan :
1. Arsip Jurusan
2. Kartu wajib dilampirkan dalam laporan Proyek Akhir D3/S1