A Proposal On

The Taylor’s Grand Challenge Scholars Programme

By

Taylor’s University’s School of Engineering, Malaysia
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover Page</td>
<td>1</td>
</tr>
<tr>
<td>Contents</td>
<td>2</td>
</tr>
<tr>
<td>Nomenclature</td>
<td>3</td>
</tr>
<tr>
<td>Preamble</td>
<td>4</td>
</tr>
<tr>
<td>1.0 Taylor’s Grand Challenge Scholars Programme Vision</td>
<td>5</td>
</tr>
<tr>
<td>1.1 Measurements and Attainment of TGCSP LOs</td>
<td>7</td>
</tr>
<tr>
<td>1.2 Recommended Programme Structure</td>
<td>8</td>
</tr>
<tr>
<td>2.0 Governance</td>
<td>9</td>
</tr>
<tr>
<td>2.1 Selection Criteria and Process</td>
<td>10</td>
</tr>
<tr>
<td>2.1.1 Continuation in the TGCSP</td>
<td>11</td>
</tr>
<tr>
<td>2.2 Selection Committee Members</td>
<td>12</td>
</tr>
<tr>
<td>2.3 Programme Requirements</td>
<td>12</td>
</tr>
<tr>
<td>2.3.1 Implementation of Programme Requirements</td>
<td>12</td>
</tr>
<tr>
<td>2.3.2 Fulfilling the Entrepreneurial Experience</td>
<td>17</td>
</tr>
<tr>
<td>2.4 The GC Culture in SoE</td>
<td>21</td>
</tr>
<tr>
<td>2.4.1 Examples of GC Related Projects and Activities in the School</td>
<td>23</td>
</tr>
<tr>
<td>2.4.2 Example of a Module</td>
<td>30</td>
</tr>
<tr>
<td>3.0 Summary</td>
<td>31</td>
</tr>
</tbody>
</table>
Nomenclature

CQI  Continual Quality Improvement
GC   Grand Challenge
GCPO Taylor’s Grand Challenge Scholar Programme Learning Outcome
GCSC Grand Challenge Scholars Program Steering Committee
LO   Taylor’s School of Engineering Module Learning Outcomes
NAE  National Academy of Engineering
OBE  Outcome-Based Education
PEO  Taylor’s School of Engineering Programme Educational Objectives
PO   Taylor’s School of Engineering Programme Learning Outcomes
SoE  Taylor’s School of Engineering
TGCSP Taylor’s Grand Challenge Scholar Programme
ToR  Terms of Reference
Preamble

The Taylor’s Grand Challenge Scholars Programme (TGCSP) runs in parallel to the Taylor’s School of Engineering Degree. A student who enrolls into any one the School’s degree programmes in year 1 (semester 1) (upon satisfying the School’s enrolment criterion) have the option to enroll into the TGCSP, however another application process and selection criterion needs to occur before the student is successful in becoming a TGCSP Scholar.

Scholars are free to leave the TGCSP if they wish and will continue to be a School’s student and hence graduate with a Taylor’s School of Engineering Degree, however since withdrawal from the TGCSP was sought, the student will not receive the NAE certificate.

The following proposal has been rewritten to reflect the feedback provided by the GCSC committee. The proposal details the selection process, criteria and requirements needed to successfully complete the TGCSP. Among changes to be noted are the removal of the additional modules and to allow a Scholar to follow the existing curriculum structure of the School, but with specific and tailored requirements necessary and worthy of a TGCSP Scholar. These requirements are further detailed in Section 2.3. The benefits of allowing the Scholar to follow an existing curriculum structure is to ensure that structured assessments are made available, consistent assessor feedback is provided on all assessments (based on relevant rubrics) and the scores of the assessments contribute towards the attainment and computation of the Scholars TGCSP Learning Outcomes. This information is further detailed in Section 1.1 and 2.0.

This 4th version of the proposal has attempted to incorporate the 3rd set of comments and feedback from GCSC. A summary of the feedback as well as a description on how each was addressed is provided in Table 10 (of Section 3.0) at the end of the proposal.
1.0 Taylor’s Grand Challenge Scholars Programme (TGCSP) Vision

The vision of TGCSP is encapsulated in the following vision statement:

“To empower engineers to achieve their full potential and be the solution to humankind’s Grand Challenges”

The Vision of the Programme is in line with the Taylor’s School of Engineering (SoE) Programme Educational Objectives (PEOs) as detailed in Table 1.

<table>
<thead>
<tr>
<th>Table 1 SoE’s PEOs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PEO1</strong></td>
</tr>
<tr>
<td><strong>PEO2</strong></td>
</tr>
<tr>
<td><strong>PEO3</strong></td>
</tr>
<tr>
<td><strong>PEO4</strong></td>
</tr>
</tbody>
</table>

Table 2 details the TGCSP’s learning outcomes (GCPOs) expected of an Engineering graduate upon the completion of the TGCSP. These outcomes are modeled on the five learning components of the NAE’s GCSP.

<table>
<thead>
<tr>
<th>Table 2 TGCSPs GCPOs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GCPO 1</strong></td>
</tr>
<tr>
<td><strong>GCPO 2</strong></td>
</tr>
<tr>
<td><strong>GCPO 3</strong></td>
</tr>
<tr>
<td><strong>GCPO 4</strong></td>
</tr>
<tr>
<td><strong>GCPO 5</strong></td>
</tr>
</tbody>
</table>
SoE itself prescribes to a set of Programme Learning Outcomes (POs). The POs describe what is expected of a SoE graduate upon the completion of the Programme and are listed in Table 3. The 5 GCPOs are mapped to SoE’s own POs. This is detailed in Table 4.

Table 3 SoE’s POs

<table>
<thead>
<tr>
<th>PO</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PO1</td>
<td>Apply the knowledge of mathematics, science, Engineering practices, innovation techniques, entrepreneurship and human factors to provide value-adding solutions to complex Engineering challenges.</td>
</tr>
<tr>
<td>PO2</td>
<td>Identify, formulate, analyse and document complex Engineering challenges to arrive at viable solutions and substantiated conclusions.</td>
</tr>
<tr>
<td>PO3</td>
<td>Conceive, Design, Implement and Operate solutions for complex Engineering challenges that meet specified requirements with appropriate consideration for public health and safety, cultural, societal, environmental and economical considerations.</td>
</tr>
<tr>
<td>PO4</td>
<td>Conduct research and investigation into complex challenges using methods which include experiment design, analysis of data and synthesis of information to provide valid conclusions.</td>
</tr>
<tr>
<td>PO5</td>
<td>Create, select and apply appropriate techniques, resources, and modern Engineering and IT tools, including prediction and modelling, to complex Engineering activities, with an awareness of the accompanying assumptions and limitations.</td>
</tr>
<tr>
<td>PO6</td>
<td>Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, economical and cultural issues and the consequent responsibilities relevant to professional Engineering practice.</td>
</tr>
<tr>
<td>PO7</td>
<td>Explain the global impact of professional Engineering solutions in societal, economical and environmental contexts and demonstrate knowledge of and need for sustainable development.</td>
</tr>
<tr>
<td>PO8</td>
<td>Apply professional and ethical responsibilities of Engineering practice.</td>
</tr>
<tr>
<td>PO9</td>
<td>Effectively communicate complex Engineering activities, both orally and in a written form, in both technical &amp; non-technical contexts.</td>
</tr>
<tr>
<td>PO10</td>
<td>Function effectively as an individual and in multidisciplinary settings with the capacity to be a leader.</td>
</tr>
<tr>
<td>PO11</td>
<td>Recognise the importance of lifelong learning and engaging in continuous professional development activities in accordance with technological change.</td>
</tr>
<tr>
<td>PO12</td>
<td>Effectively manage projects in multidisciplinary environments and apply project management tools and techniques to one’s own work, as a member and leader in a team to satisfy stakeholder requirements.</td>
</tr>
</tbody>
</table>
Table 4 Mapping between GCPOs and POs

<table>
<thead>
<tr>
<th></th>
<th>PO 1</th>
<th>PO 2</th>
<th>PO 3</th>
<th>PO 4</th>
<th>PO 5</th>
<th>PO 6</th>
<th>PO 7</th>
<th>PO 8</th>
<th>PO 9</th>
<th>PO 10</th>
<th>PO 11</th>
<th>PO 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCPO 1</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GCPO 2</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GCPO 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GCPO 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GCPO 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

Based on the mapping, the TGCSP is in line with the current objectives and outcomes of SoE. These outcomes will allow Scholars to fulfill their academic requirements while working on complex projects addressing NAE’s Grand Challenges.

The TGCSP will continuously support and enhance the school’s strengths, particularly in the areas of project-based learning (structured through the application of the Conceive-Design-Implement-Operate CDIO™ framework). By subscribing to the School’s POs, the TGCSP will educate qualified candidates who will be able to:

• Gain the Appropriate Fundamental and Advanced Engineering Knowledge (which includes Project Management and Finance)
• Analyse Engineering Challenges
• Design and Development of Solutions
• Practice Research Based Knowledge when Performing an Investigation
• Utilise modern Engineering tools and techniques
• Understand the Role of an Engineer in Society and the Application of Ethics in Engineering
• Communicate and Function Effectively as an Individual or in a Team
• Practice Life Long Learning

1.1 Measurements and Attainment of TGCSP LOs

Since the GCPOs are clearly mapped to the POs, this would mean that the curriculum of the School is also mapped to the GCPOs. The reasoning for this is, in the spirit of Outcome-Based Education (OBE), upon the development of a set of POs, the curriculum would be developed and the modules created will consist of a set of module learning outcomes (LOs). Since these modules were created with the POs in mind, hence the LOs are linked to the POs and thus the GCPOs.

Each module in SoE consists of a set of assessments that are mapped to the LOs. Once marked according to prescribed rubrics, a Scholar will receive a score for each assessment component. Since these assessments are mapped to the LOs, thus a LO attainment score (based on the assessment scores) can also be obtained (for each Scholar). As the POs are mapped to the LOs, a Scholars PO
score can also be calculated and finally since the GCPOs are mapped to the POs, the GCPO attainment score can be obtained as well.

It should be noted that while the TGCSP LOs are mapped to the School’s POs, the attainment of the former is based on tasks and activities that are related to the GCs. This in itself requires a greater sense of initiative and pro-activeness from a TGCSP Scholar. Solving such activities would require students to have a greater sense of depth and breadth of the curriculum as it would also require more rigour. This in itself means that a Scholar that attains the TGCSP LOs has gone beyond the School’s POs to achieve greater heights.

1.2 Recommended Programme Structure

A TGCSP Scholar will be enrolled and will experience the same Programme structure as that of a normal SoE Student, however the requirements that the Scholar would need to meet will be different and will addressing the NAE GC five learning components. This is further detailed in Section 2.0.
2.0 Governance

The TGCSP will be governed by the existing administrative and academic structures present in the School. This includes the Schools Academic Services that oversees the administrative execution of items related to Scholar documentation and the School’s Academic Management that oversees academic execution of items related to Scholar experience by enrolling, monitoring, controlling and improving related activities. Each Scholar in the School is part of an academic Programme that is managed by a Programme Director.

At the core of the TGCSP is its committee members (consisting of TGCSP Scholars) and is governed by the Schools TGCSP Director who are responsible for the planning and execution of the TGCSP.

In order to effectively govern the planning and execution of the TGCSP, a Terms of Reference (ToR) of the School’s TGCSP committee is provided in Appendix 1. This ToR details the functions of the committee as well as how the TGCSP Director is appointed and his/her responsibilities.

In addition to this, a simple flow chart is provided to describe the overall governance of the TGCSP.

Figure 1 TGCSP Governance
Based on Figure 1, and referring to the flow process on the left of the diagram, applicants would have to go through the selection process (described in Section 2.1) and if successful, would become part of the TGCSP and hence a TGCSP Scholar. Scholars would then graduate (upon successful completion of the degree and the relevant TGCSP requirements) and as alumni (or stakeholder) would have the opportunity in providing feedback to the School, which would be required to further enhance and improve the TGCSP. This is done in the spirit of Continual Quality Improvement (CQI). Relevant CQI action plans would then be channeled through to the TGCSP committee that would then look into improving the administration of the programme based on the CQI action plans. It should also be noted that feedback would also be sought by existing TGCSP students to further improve the programme, hence the link between the TGCSP square block and the CQI circle in Figure 1. In summary, on an annual basis, input would be taken from the TGCSP (i.e. an analysis of the activities completed, overall results of the Scholars, TGCSP LO attainment scores etc.) as well as its graduates and an action plan would be developed in the spirit of CQI to enhance and improve the selection of the Scholars as well as the administration of the TGCSP.

If a student wishes to join the TGCSP in Year 2 of their programme, they would need to go through the same selection criteria as identified in Section 2.1. It should be noted however that the School would not allow students in Year 3 onwards to enroll into the TGCSP since more than 50% of their knowledge profile (of their degree programme) would have been completed in Year’s 1 and 2.

In terms of progression (i.e. programme yield vs. applicants), the School aims to ensure that 90% of its Scholars are to graduate. This would be made possible through the governance of the TGCSP and the relevant support given to the Scholars throughout their journey with the School.

2.1 Selection Criteria and Process

All incoming first and second year Engineering Degree Scholars at Taylor’s University School of Engineering are eligible to submit their application for admission into the TGCSP and will be subject to the same application process.

Candidates may obtain an application form from www.taylors.edu.my/grandchallengeScholars

In addition, the candidates must write a 1000 word essay about their Grand Challenge of interest. In this essay, candidates should elaborate on their passion for a particular Grand Challenge and how they intend to play their role in its solution.

The fully completed application form and essay would be submitted to SoE within two weeks from the start of the semester.
Shortlisted candidates will be notified a week from the submission deadline to attend an interview conducted by the selection committee. As part of the interview, the candidates are required present a 10 minutes presentation related to the essay they submitted and be prepared to respond to any queries.

Successful candidates will be notified within one week of the interview.

Selection of Scholars into the TGCSP will be at the sole discretion of the selection committee. The selection will be conducted rigorously and impartially. All candidates will be given the opportunity to prove their suitability for admission into TGCSP.

The selection committee will review candidates’ essays and application forms. Candidates will be shortlisted for an interview when the selection committee has unanimously agreed to it based on the information in the application form and the content of essay.

The selection committee will base the final selection of the candidate as a TGCSP Scholar on the assessment of the candidate during the interview.

It should be noted that students who are unsuccessful in becoming a Scholar at the first attempt would be allowed to appeal their application for it to be considered for another review.

2.1.1 Continuation in the TGCSP

To continue in the TGCSP, a student is expected to fulfill the following requirements:

1. Maintain a CGPA of 3.0 and above for each semester throughout all eight semesters of study.
2. Should a student fail to meet the CGPA 3.0 requirement, an appeal may be submitted to the committee to be put on probation if there are extenuating circumstances for not meeting these criteria.
3. A student file will be maintained for each student. This file will contain the application form, application essay, details of projects undertaken by the students in the project based modules, academic results as well as all related correspondence such as appeal letters, etc. The maintenance of the student file will come under the jurisdiction of the TGCSP Director. This file will be maintained electronically.
4. Upon completion of eight semesters of study, the name list of students who have successfully fulfilled all the requirements of the TGCSP will be submitted to the NAE for the award of the Grand Challenge Scholars Certificate.
5. The TGCSP Director (as well as other academic staff – depending on the number of Scholars) will serve as mentors to the students. They will monitor the students’ performance and their attainment of the LOs each semester. It should be noted that the School aims to achieve a
mentor to scholar ratio of 1:15 i.e. if there are 30 Scholars enrolled, there will be at least 2 mentors for the 30 students (each mentor will have a maximum of 15 Scholars to mentor).

6. They will counsel the students and advise on the projects and activities they will be expected to undertake to fulfill the requirements of the TGCSP. The roles and responsibilities of the mentors as well as how mentors will engage and support the students are provided in Appendix 1 – TGCSP Governance, Section 4.7.

2.2 Selection committee members

The selection committee comprises of the following members:

1. Dean, School of Engineering
2. Director of TGCSP
3. Director, Taylor’s Technology Innovation Centre

2.3 Programme Requirements

A TGCSP Scholar must demonstrate achievement in:

1. Each of the following five learning components:
   • Grand Challenge Project(s)
   • Interdisciplinary Experience
   • Entrepreneurial Experience
   • Global Awareness
   • Service Learning

2. The Creation of individual Grand Challenge Scholar Portfolio.

3. Active contribution as a member of the TGCSP committee.

4. Maintaining a CGPA of 3.0 and above for each semester throughout all eight semesters of study.

2.3.1 Implementation of Programme Requirements

The following section (in matrix form) describes in detail how a TGCSP Scholar would achieve the relevant TGCSP outcomes and requirements. It details the roadmap a Scholar would need to go through to successfully complete the TGCSP. It should be noted that a Scholar must satisfy all requirements detailed in Table 5 (also summarised in Section 2.3) in addition to the regular requirements of completing an Engineering degree in SoE.
The roadmap is divided into 4 items.

- The 1st item reflects the outcomes of the TGCSP (the column in Table 5 which is 1st from the right).
- The 2nd item highlights which learning component/area is addressed by the outcome (the column in Table 5 which is 2nd from the right).
- The 3rd item describes the requirements that are to be fulfilled by the Scholar (the column in Table 5 which is 3rd from the right). It should be noted that the overarching requirement is a Scholar must select one of the fourteen grand challenges and that all of their activities in the learning components/areas need to be focused on that challenge.
- The final and 4th item details what is the proposed implementation plan a Scholar would adopt in SoE (the column in Table 5 which is 4th from the right).

Table 5 Scholar Implementation Roadmap for TGCSP

<table>
<thead>
<tr>
<th>TGCSP Outcome</th>
<th>Programme Requirement</th>
<th>Requirement</th>
<th>Proposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrate the competence to undertake project or research activity related to a specific Grand Challenges theme or challenge.</td>
<td>One of the five learning components – Grand Challenge Project(s)</td>
<td>A Scholar must contribute (for at least one semester) to a group or individual project, which relates to a Grand Challenge. Note that the project selected by the Scholar must be one of the fourteen grand challenges and that all of their activities in this learning component/area need to be focused on that challenge.</td>
<td>SoE has a project-based learning module in each of its eight semesters. The first six modules require a Scholar to CDIO™ an Engineering system in a group while the remaining two modules is a Final Year Project. Each project must be related to a Grand Challenge. As such, the assessments are mapped to the relevant LOs which are in turn mapped to the POs and hence the GCSPOs. Exemplar All projects in SoE are mapped to a GC area. Examples of such projects include the Taylor’s Racing Team and the Thought Operated Wheelchair – further detailed in Section 2.4.</td>
</tr>
<tr>
<td>Demonstrate the ability to comprehend knowledge from non-Engineering disciplines and understand their importance in solving the Grand Challenges.</td>
<td>One of the five learning components – Interdisciplinary Experience</td>
<td>A Scholar must identify additional interdisciplinary coursework that may be applied to the Grand Challenge Project(s), industrial training, research, an elective module, or any other project or experience. Note that the coursework being Scholars in SoE need to undertake four university wide electives. These electives are from non-Engineering discipline based Programmes. Scholars are also able to enrol in electives that require the application of Engineering knowledge to interdisciplinary areas. It should be noted that the electives should clearly complement the Grand Challenge Portfolio of the Scholars. The selection of the electives would be guided by the TGCSP Committee.</td>
<td>Exemplar</td>
</tr>
</tbody>
</table>
undertaken by the Scholar must relate to a project that addresses one of the fourteen grand challenges and that all of their activities in this learning component/area need to be focused on that challenge.

Scholars have options to take interdisciplinary modules such as Engineering Engineering Biomimetics, Architecture and Nation Building, Entrepreneurship as well as Leading in the 21st Century to name a few. SoE also has a specific project-based learning module called Multidisciplinary Engineering Design that allows for Scholars to CDIO™ a project related to a Grand Challenge while being part of a multidisciplinary team.

Scholars are also exposed to a variety of lectures by guest speakers (some of whom are outside the Engineering discipline). These lectures share different approaches in industry and encourage Scholars to understand their future role in industry.

Demonstrate the ability for technical innovation, organizing events, raising funds and leading teams.

| Demonstrate the ability for technical innovation, organizing events, raising funds and leading teams. | Scholars need to successfully complete an activity related to an Entrepreneurial experience. This could be in the form of a competition or in taking a specific module. Note that the entrepreneurial activity selected by the Scholar must be addressing one of the fourteen grand challenges and that all of their activities in this learning component/area need to be focused on that challenge. |
| Scholars may take any one of the following initiatives to demonstrate their achievement of the “Entrepreneurial Experience” learning component. • Participation in competitions organized by the School and University that require some form of entrepreneurial skills. • Scholars would need to participate in selected modules and complete assessments that require them to manage a project to its intended success. In addition to this, scholars would need to experience what would entail in planning and executing a business that includes fund raising and leadership. **Exemplar** Scholars in SoE must enroll in a module that teaches them the fundamentals of project management. This module entitled Managing Projects for Success requires them to manage one of their design projects using the relevant Project Management tools and techniques learnt. Throughout the other design modules, Scholars are also required to include a section in their design reports on how they have implemented project management in all of their projects. Scholars would also submit assessment components from the module Engineering Design and Innovation which are related to |
In addition to the above, all Scholars would need to register for a module called Business Skills for Engineers. In this module, Scholars are exposed to a variety of entrepreneurial tools and techniques. The module is also offered as a Massive Open Online Course (MOOC) to students outside the university and around the world. Scholars from SoE are required to form a group with the international students to pick a project (that's related to a GC), and source for funding to implement this project.

In order to seek international exposure, one way to accomplish this would be to work in a company outside of the Scholar’s country of residence. In addition to this, a Scholar may choose to participate in an international exchange or by carrying out research work abroad.

**Exemplar**

It is a requirement for all Scholars to undergo industrial training in the short semester of their Programme prior to entering the final year. For a TGCSP Scholar, it would be a requirement for them to intern abroad.

The internship experience is related back to and relevant to one or more of the Grand Challenges and the Grand Challenge concept as appropriate to the individual Scholar. Scholars who qualify for this may be able to source for financial assistance from the School. The University’s career’s services centre assists all of its students in securing internships.

Scholars also have the opportunity to participate in the University’s student exchange programme as the School itself has accepted students from Finland and Belgium in the past and is working towards sending Malaysian students to the same countries.

In addition to this, the Scholars have the...
opportunity to travel abroad and represent the University at prestigious conferences (see Section 2.4.1). Students are also free to initiate research collaboration through the selection of key projects.

Demonstrate social awareness and the ability to bring technical expertise to bear on societal problems. This requires active participation in activities related to social concerns.

One of the five learning components – Service Learning

A leadership role in a service oriented activity.

Note that service oriented activity selected by the Scholar must be addressing one of the fourteen grand challenges and that all of their activities in this learning component/area need to be focused on that challenge.

Scholar’s need to lead and participate actively in service learning based activities.

Exemplar

As part of SoE’s module Professional Engineers & Society, Scholars are required to participate in performing a service-oriented activity as part of the assessment of the module. A Scholar would need to successfully lead a team in completing a service-oriented activity. Examples of some of the organisations that Scholars may work with to complete service oriented activities are provided in Section 2.4.1.

The Creation of individual Grand Challenge Scholar Portfolio

A cumulative written document to culminate experiences relating to the attainment of a Scholar throughout the TGCSP.

The production of a GCPO Portfolio.

All Scholars would need to prepare a GCPO portfolio that details the current GCPO attainment as well as the justifications to why they have achieved a certain GCPO. Scholars are also able to compare their own attainment scores to that of the computed GCPO scores (using the method described in Section 1.1) and perform a gap analysis if needed.

Exemplar

Scholar’s will produce a detailed GCPO portfolio at the end of their 3rd year or at the beginning of the 4th year of their Programme. A creative resume would also be produced. This resume will identify their strengths and growth opportunities based on the gap analysis performed on their GCPO attainment scores.
Active contribution as a member of the TGCSP committee

To participate in the planning, execution, monitoring and improving of the TGCSP.

All Scholars to hold a role and be part of the TGCSP committee.

The formation of this committee will be chaired and membered by the Scholars. The advisor will be the TGCSP Director.

Exemplar

The committee would aspire to:
Form a team of Scholars and Mentors to help the TGCSP program grow. This could be accomplished by recruiting new Scholars, involving alumni or industry in the Programme and collaborate with existing GC Programme around the globe (to facilitate the attainment of their GCPOs). The committee would also be tasked to organize events linked to the GC.

2.3.2 Fulfilling the Entrepreneurial Experience

In order to enhance and provide clarity on how a TGCSP Scholar would fulfill the entrepreneurial learning component, this sub-section will detail the entrepreneurial roadmap taken by the Scholar. Included in the roadmap are the associated activities and assessments they would need to complete to fulfill the learning component. Scholars have the opportunity to fulfill this learning component through the pedagogy and curriculum available in the School and through participation in competitions throughout their 4-year study period of the engineering degree.
Referring to Figure 2, a Scholars journey through the School's entrepreneurial experience begins with them participating in 3 project-based modules (not simultaneously, but progressively), namely, Engineering Design & Communication (in Semester 1), Engineering Design & Ergonomics (in Semester 2) and Multidisciplinary Engineering Design (in Semester 3). In these modules, Scholars are tasked with designing and building an engineering system that addresses a grand challenge and practice the concept of Return on Failure – an assessment component where they identify, analyse and review the failures that have occurred throughout their progress of designing and building the engineering system. This is key in entrepreneurial practice in order to identify growth opportunities so that future ventures do not suffer unsuccessful fates.

Upon successful completion of these modules, Scholars then proceed on to the module called Engineering Design and Innovation, a project-based module (in Semester 4) that represents the School's Innovation Incubation Lab. Scholars would be tasked with:
1. identifying a challenge that has business value and then,
2. proceed to design a system that addresses this challenge and finally,
3. look at ways of protecting the challenge solution through intellectual property/patenting.

Scholars then move on to the module, Capstone Project 1 and the module, Business Skills for Engineers. For the former, they are tasked with developing a business plan for an assembly/manufacturing/chemical plant that will be mass-producing an engineering system/product that they would be designing and building. For the module, Business Skills for Engineers, Scholars
are tasked with developing and executing a crowd funding campaign for a product/process they would like to commercialize. They are also required to develop a business plan and an entrepreneurial ecosystem for their chosen product/process.

Each of these modules as well as a description of some of its assessments is described in detail in Table 6.

<table>
<thead>
<tr>
<th>Year</th>
<th>Module</th>
<th>Assessment Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Engineering Design &amp; Communication</td>
<td>In these 3 modules, there is an assessment component called Return on Failure (RoF). In this assessment, students are tasked with filling up a RoF form throughout the duration of each of these modules. In this form, students identify what they did wrong, perform a root cause analysis and identify ways of avoiding such a failure from occurring again. This assessment is done in the spirit of continual quality improvement and aims to enable students to learn from their failures. Such a practice is key in entrepreneurial practice in order to identify growth opportunities so that future ventures do not suffer similar unsuccessful fates. A sample of the RoF form is provided in Appendix 2.</td>
</tr>
<tr>
<td></td>
<td>Engineering Design &amp; Ergonomics</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Multidisciplinary Engineering Design</td>
<td>This module represents the Innovation Incubation Lab of the School. As with the earlier 3 modules above, RoF is still a component for this module, however in this module, the depth of the entrepreneurial experience is further addressed. Students are tasked with conceiving, designing, implementing and operating an engineering system for this module (as with other project based modules as well) and the assessment requires the student to identify a challenge with business value, develop and protect the solution (via patenting) which addresses this challenge. Students are also tasked to develop a business model for their project, using the business model canvas as well as create a value proposition of their project. A sample of the business canvas used by the students is provided in Appendix 3. It should also be noted that the Scheme of Work (SoW) that details the learning outcomes, assessments and weekly plan of this module is provided in Appendix 6.</td>
</tr>
<tr>
<td></td>
<td>Engineering Design &amp; Innovation</td>
<td></td>
</tr>
</tbody>
</table>
| 3    | Group Project 1 (Capstone)                  | In this module, students are tasked at developing a business plan for an assembly/manufacturing/chemical plant that will be mass-producing an engineering system/product that they would be designing and building. Students prepared a business plan based on the 6 P’s – i.e. to develop a plant based on the following key areas:  
• **Premise** – students would have to determine the most appropriate location for the plant and do this based on relevant cost and economic analyses.  
• **Processes & Production** – students would need to determine what processes are needed to mass-produce their engineering system/product.  
• **People** – student would develop a detailed human resource plan, identifying key personnel to operate the plant and perform a cost analysis of salaries and benefits.  
• **Price** – students determine the price of one of their products based |
on their annual capital and operational expenditure.

- Promotion – students describe a simple marketing plan to market their product.

An example of the business plan is provided in Appendix 4 (See pp. 28 onwards). It should be noted that in order to assist the students in developing a realistic business plan, industrial experts are engaged by the School to share key industrial concepts which are – ethics, sustainability, manufacturing, project management and safety & health. Students would then extract once key learning area from this industrial engagement session (done through a guest lecture) and apply it to their business plan.

<table>
<thead>
<tr>
<th>3</th>
<th>Business Skills for Engineers</th>
</tr>
</thead>
</table>

This module covers the areas of engineering management in the business environment. Students also learn about the financial and legal aspects of doing business and e-commerce. As assessments, students are tasked with developing and executing a crowd funding campaign for a product/process they would like to commercialize. Students are given access to varied experts (through guest lectures) who are involved in the entrepreneurial industry. This would aid them in executing a good crowd funding campaign. The module also requires a student to develop an entrepreneurial ecosystem for their chosen product/process and to develop a business plan that would eventually lead to it being funded and commercialized. It should also be noted that the Scheme of Work (SoW) that details the learning outcomes, assessments and weekly plan of this module is provided in Appendix 5.

Upon completion of any one of the modules detailed in Table 6, students would need to defend their respective business plans and products at the School’s bi-annual engineering fair. This fair is competition based and judged by academics and industry based engineers. Students would showcase their product and present its business value to the judges.

In addition to the above a Scholar would also fulfill this learning component through the participation in competitions that are specifically geared towards entrepreneurship. Thus far, the School has had success in winning the Taylor’s Business Plan Challenge. The winning team’s business idea was to sell a service of producing new and innovative teaching and learning techniques by using the iPad. This idea addressed one of the grand challenges namely advance personalized learning. This is further illustrated in Figure 3.
Once again, it should be noted here that the Scholar must be addressing one of the fourteen grand challenges and that all of their activities (whether an assessment or participation in a competition) in this learning component/area need to be focused on that challenge.

2.4 The GC Culture in SoE

SoE is committed to addressing the GCs. This is evident in the organization of the research clusters in SoE. At present, there are five research clusters focused on addressing various grand challenges as shown in Table 6. These research clusters are multidisciplinary in nature comprising staff members...
from all three disciplines represented in the School of Engineering, namely, Chemical Engineering, Electrical & Electronic Engineering and Mechanical Engineering.

The final year projects are offered through these research clusters and the final year students by virtue of undertaking the final year project offered by a research cluster will automatically become a member of the research cluster. All final year projects are required to declare the GC that it is helping to address.

Table 7 Research Clusters

<table>
<thead>
<tr>
<th>Research Group</th>
<th>Grand Challenges addressed by the Research Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Computer Intelligence Applied (CIA)</td>
<td>Engineer the tools of scientific discovery</td>
</tr>
<tr>
<td></td>
<td>Advance health informatics</td>
</tr>
<tr>
<td></td>
<td>Engineer better medicines</td>
</tr>
<tr>
<td></td>
<td>Enhance virtual reality</td>
</tr>
<tr>
<td></td>
<td>Restore urban infrastructure</td>
</tr>
<tr>
<td>2 Energy Research Group</td>
<td>Make solar energy economical</td>
</tr>
<tr>
<td></td>
<td>Restore urban infrastructure</td>
</tr>
<tr>
<td></td>
<td>Engineer better medicines</td>
</tr>
<tr>
<td></td>
<td>Engineer the tools of scientific discovery</td>
</tr>
<tr>
<td>3 Environment Research Group</td>
<td>Provide access to clean water</td>
</tr>
<tr>
<td></td>
<td>Develop methods for carbon sequestration</td>
</tr>
<tr>
<td></td>
<td>Engineer the tools of scientific discovery</td>
</tr>
<tr>
<td></td>
<td>Restore urban infrastructure</td>
</tr>
<tr>
<td>4 Health Research Group</td>
<td>Advance health informatics</td>
</tr>
<tr>
<td></td>
<td>Engineer better medicines</td>
</tr>
<tr>
<td></td>
<td>Engineer the tools of scientific discovery</td>
</tr>
<tr>
<td>5 Engineering Education Lab</td>
<td>Advance personalized learning</td>
</tr>
<tr>
<td></td>
<td>Engineer the tools of scientific discovery</td>
</tr>
<tr>
<td></td>
<td>Reverse engineer the brain</td>
</tr>
</tbody>
</table>

The research framework for SoE is depicted in Figure 3. The figure shows a donut-like shape where all the research groups are driven by addressing the GCs. The students sit at the center of the framework where variety of research led activities, including curriculum design and teaching, are directed at them. The research groups do interface with the outer world, raising research funds, collaborating with the industry and community and disseminating knowledge.
2.4.1 Examples of GC Related Projects and Activities in the School

SoE prides itself on creating an environment where students maximise their potential. This is evident in the projects that they produce, which are in-line with the GCs. Students are tasked to CDIO™ an engineering system in every one of their eight semesters with SoE. This occurs through the implementation of SoE’s project-based learning module. Examples of successful projects include the Shell Eco Marathon Car as well as Taylor’s Racing Team.
A number of student projects represented the School at International and National conferences and competitions such as the CDIO international conference in Montreal 2010, CDIO regional conference in Beijing 2011, CDIO international conference in Copenhagen 2011 and Malaysian Technological Expos.
In order to enhance our students’ entrepreneurial capabilities, they are tasked with identifying a project with commercial value and based on its value proposition, to source for funding to further develop and execute the project. This in particular occurs in the module “Business Skills for Engineers” where students use a crowdsourcing platform called Pozible to source for funds that would be utilized to design and build their projects. An example of which can be viewed in Figure 5 and in its totality at this link: http://www.pozible.com/project/182688

The School is also exploring collaborations with service-learning based organizations that would allow its students to participate in activities that benefit the community. As part of a specific module called “Professional Engineers and Society”, students will need to pick a service-learning based activity and

Figure 7 Participating in a Collaborative Project with Tsing Hua University, China – Interdisciplinary and Global Awareness

Figure 8 Student’s GC Project on a Crowdsourcing Platform
complete it successfully as an assessment component. Students may choose for the following organisations:

“Do Something Good”: http://dosomething.gd
This organization consolidates all of the service learning activities across Malaysia and sources for volunteers on a regular basis. Students are free to choose any activity they wish as long as its related to a GC.

“Epic Homes”: https://www.epichome.org
This organization deals with recruiting volunteers to build a home for the needy. Such an activity is directly related to the “restore and improve urban infrastructure” GC.

“World Toilet Organisation”: http://worldtoilet.org
This organization aims to ensure that the global population gains access to hygienic sanitation needs. Such an activity if pursued by our students is directly related to the “restore and improve urban infrastructure” GC.

In addition to these organisations, Scholars are also free to source for service learning activities on their own. Some activities include the following.

• Participating in environmental clean-ups for orphanages, old folks homes and temples.
• Participation in the University’s Student Council

As evident from the examples described in the preceding text, the School’s students enhance their academic experience through a variety of projects and activities, all of which are culminated in a PO portfolio. The portfolio describes the student’s achievement of the POs to date and with the aid of input from the School, students are also able to identify gaps in their PO attainment and as such identify corrective measures to ensure that they fulfill their PO attainment. This gap analysis is summarized in a “Creative Resume” where students highlight their Vision, Growth Areas, Strengths and Projects. A sample of which is provided in Figure 6. Such a portfolio will serve as the GCPO portfolio for a TGCSP Scholar – with all of the activities relating to the GCs.
Figure 9 Student’s Creative Resume
The School has made a concerted effort to ensure that its deserving students are able to participate in work at an international stage. This includes participating in research collaborations with blue-chip universities across the globe as well as presenting their research work at prestigious international conferences.

Figure 10 A Student Participating in a Research Exchange Abroad – Interdisciplinary and Global Awareness
“Making SOE’s Presence Felt at MIT International Conferences in U.S.A.”

9th International CDIO Conference

June 9-13

You may ask “What do heart valves have to do with engineering?” Five final year students from Taylor’s University School of Engineering (SOE) answered that question through their project: “Mitral Valve Evaluation Protocol”. They were one of 31 student projects selected for presentation at the 2013 CDIO Academy held in conjunction with the 9th International CDIO Conference hosted by Massachusetts Institute of Technology (MIT) and Harvard University School of Engineering and Applied Sciences at Cambridge, Massachusetts, USA. The CDIO Academy was part of the 9th International CDIO Conference for engineering students to showcase their design-implement projects, meet and network with peers from engineering programmes around the world, and participate in workshops and plenary sessions presented by prominent leaders in engineering education.

Figure 11 Students Presenting Research Work at MIT International Conferences – Interdisciplinary and Global Awareness
2.4.2 Example of a Module

In this section, a detailed descriptive example of a module that a Scholar would have to complete (as part of their TGCSP journey) will be discussed.

The name of the module is entitled Engineering Design and Innovation. This is a 2nd year project based module. This module also represents one of the 8 project based modules offered by the School. The following is the synopsis of the module.

“This module equips engineering students with innovation techniques such as design thinking and TRIZ, sharpening their innovation skills. This will empower them to develop financially and economically sustainable solutions and enable them to play a key technical and economic role in activities ranging from creating jobs to addressing the Grand Challenges of the 21st Century.”

Referring to Appendix 6, the Scheme of Work (SoW) for this module, the LOs, assessments and weekly teaching plan are provided in detail. It should be noted that the GC theme permeates through the synopsis as well as content (present in the weekly teaching plan).

Also made available is the rubric for one of the assessment components of the module in Appendix 7.

It should also be noted that when a lecturer wishes to propose a project (that is to be undertaken by students in this module as an assessment component) they would need to fill in a project brief form. A sample of this form is provided in Appendix 8. From the form, it is clear that the GC related to this project must be identified.
3.0 Summary

The preceding information details how a TGCSP Scholar would begin his/her journey at Taylor’s SoE. Also detailed is the roadmap the Scholar would need to take and what requirements (s)he would need to satisfy in order to successfully complete the TGCSP. The information provided also addresses the feedback of the GCSC based on their assessment of the first version of this proposal. Table 8 details how the feedback was addressed.

Table 8 Responses to Feedback from GCSC on the 1st Version of the Proposal

<table>
<thead>
<tr>
<th>Feedback</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Entrepreneurship outcome statement does not need to be more clearly connected to entrepreneurship and not just focus on organizing events and raising funds, etc.</td>
<td>This has been addressed in Table 5.</td>
</tr>
<tr>
<td>Your application does cover all of the five required component areas, but your proposal only specifically addresses the Research Component.</td>
<td>The proposal has been revised to ensure that the flow of information relates how the TGCSP addresses the required five learning components.</td>
</tr>
<tr>
<td>Participation for at least a year seems to be required of students. This should be clarified.</td>
<td>This is further clarified in Section 2.3.1 where a Scholar must satisfy all requirements detailed in Table 5 (also summarised in Section 2.3) in addition to the regular requirements of completing an Engineering degree in SoE.</td>
</tr>
<tr>
<td>For the Interdisciplinary Component, although it is stated that the student must demonstrate knowledge from non-engineering disciplines, specifically the procedure (including examples) by which students will achieve this is not specified in the plan. This needs to be addressed.</td>
<td>These items have been addressed in Table 5.</td>
</tr>
<tr>
<td>The Grand Challenge Scholars Program is to be a combination of curricular (courses) and extracurricular experiences (activities beyond the curriculum and course work). The requirements for students to engage in activities beyond the curriculum must be spelled out.</td>
<td></td>
</tr>
<tr>
<td>It would be desirable to add an example or two of a hypothetical student, their project and how they map to this grid and achieve their project, along with a brief explanation of what each of these</td>
<td></td>
</tr>
</tbody>
</table>
Modules is (beyond such titles as Engineering Leadership 1, for instance).

From your proposal, it appears that you are requiring all students to participate from the second year onwards. What happens to students who start the program and don’t finish the program? Do they graduate?

All students are required to enroll into the programme in year 1 (semester 1). Students are free to leave the TGCSP if they wish and thus will become a normal SoE student and will graduate with a Taylor’s degree, but will not receive the additional NAE certificate.

In September 2014, feedback was received from the GCSC based on their assessment of the second version of this proposal. Table 9 details how the feedback was addressed.

Table 9 Responses to Feedback from GCSC on the 2nd Version of the Proposal

<table>
<thead>
<tr>
<th>Feedback</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TGCSP Learning Outcomes vis-à-vis SoE’s PO:</strong></td>
<td>The last paragraph in Section 1.1 has been provided to address this item.</td>
</tr>
<tr>
<td>We recommend that the authors, in addition to the mapping, present a description of how TGCSP Learning Outcomes go beyond PO's and allow TGCSP Scholars to achieve greater depth/breadth/rigor/coherence/etc. than non-TGCSP Scholars.</td>
<td>A new section, Section 2.4.2 was added (together with accompanying appendices) to address this item of providing a sample module.</td>
</tr>
<tr>
<td><strong>Description of modules and their role in the attainment of the TGCSP Learning Outcomes:</strong></td>
<td></td>
</tr>
<tr>
<td>We recommend that the authors define a module, present an example of a module, including its goals, activities, products, and outcomes, and follow this with a description of how such a module fits the overall TGCSP and its Learning Outcomes; at the moment the mention of the modules is scattered throughout the proposal and it is unclear how they fit the overall Programme. In addition, the proposal would be greatly strengthened if you were to add an example of how a student may utilize such modules in their trajectory towards a successful attainment of the TGCSP LO.</td>
<td></td>
</tr>
<tr>
<td><strong>TGCSP Assessment:</strong></td>
<td></td>
</tr>
<tr>
<td>We recommend that the authors address assessment of the TGCSP’s success separately</td>
<td></td>
</tr>
</tbody>
</table>
from the TGCSP Scholars’ success. In terms of Scholars’ assessment, we recommend that the authors describe how modules’ learning outcomes serve as the TGCSP’s LO and, for some, SoE’s PO’s; although the latter is addressed, the former is less clear. It would be helpful to understand the rubrics that may address the LO’s; this is where an example module may be useful.

**TGCSP Governance:**
We recommend that the authors briefly explain the structure of the Programme and how it fits the overall SoE, including how the administration of TGCSP is integrated, if at all, with the administration of the SoE, who elects TGCSP Director and who is eligible for this position, how long is the director’s term, etc. The same information about to the Selection Committee and the Programme Committee would also be beneficial, to answer who administers/oversees/assesses the Programme and how the mentorship structure is created, etc.

Section 2.0 has been detailed out more explicitly and a ToR for the governance process has been developed and provided in the appendix.

**TGCSP Selection Criteria:**
We recommend that the authors describe the selection criteria for the Programme. What is the expected Programme’s yield vs. the number of applicants? What about applicants in their second year at the University?

This has been discussed in the revised text provided in Section 2.0.

**TGCSP Requirements/Assessments:**
We recommend that the authors present information necessary to understand the TGCSP requirements; e.g., the minimum GPA and what happens if a student falls below 3.0, the portfolio and its goals/purposes/ways it fulfills overall TGCSP LO, etc.

A new section, Section 2.1.1 was added to address this item.

**Entrepreneurship and Service Learning Components:**
The authors seem to imply a certain working definition for entrepreneurship; we recommend that the authors make this definition explicit as it

The description of these components have been redefined (in Table 5) such that it doesn't only imply students would achieve this through participation in a module. Effort has been made to further detail how Scholars can achieve this
seems to be somewhat contextual and, as such, require further understanding by readers who may not be sharing the same context. It appears that the only way the student can meet the entrepreneurship component is to enroll in a course. There do not seem to be any co-curricular options for this component. Again, it may be that you do not have any such options available, but you mention later in the document your Racing Team and other activities, so we suggest that you think about the possibility of co-curricular options for this component, as well. Could students develop a business plan for one of these activities? Do you have a business plan competition on campus (or could you start one)? For the Entrepreneurial component, it states that the GC Scholars are required to form a group with the International Scholars -- but exactly what is meant by “the International Scholars” is not clear. Is this group the students from the MOOC offering of the course Business Skills for Engineers? This could be clarified with a couple of words.

**Service Learning Component:**

The authors seem to imply a certain working definition for service learning aspects of the TGCSP; we recommend that the authors make this definition explicit as it seems to be somewhat contextual and, as such, require further understanding by readers who may not be sharing the same context. The service learning component appears to be mostly technically oriented, but there are no examples of what type of service related project the teams would lead. Would it be designing a computer system for a local school, getting involved in Engineering World Health or Engineers without Borders, etc.? A brief clarification is needed in the table for the Service Learning Component—as it is clearly outlined later in the proposal regarding learning component through participation in competitions as well as through external bodies not related to the university.
potential service-learning organizations with which the students can interact (pp. 17-18). A brief reference to these in the table, or listing these organizations as a separate section of the proposal which can be indicated in the table, would quickly clarify this.

**Interdisciplinary Component:**
The interdisciplinary component lists only examples of courses that are closely related to engineering. Many international institutions don’t have the equivalent of general education courses available in the US, but it would be helpful to think about non-engineering course options here (such as medical ethics, business law, politics of South America, etc.). In addition, it appears that all Taylor’s students must take 4 interdisciplinary electives. Is the difference for the GC Scholar that their electives must be GC related—that is, no further elective is required, just the selection of the electives is more focused? This is not clear in the wording. Perhaps a phrase such as: “Scholars will also take 4 electives, but their electives (is it all 4 or just 2 or 3?) should clearly complement their Grand Challenge Portfolio”.

**Global Component:**
The global component only gives the student the option to secure an international internship. Clarification should be added here that the internship experience is related back to and relevant to one or more of the Grand Challenges and the Grand Challenge concept as appropriate to the individual Scholar. Can all of your students afford such an experience abroad? Do you provide assistance to students in securing such an internship? Could you also provide them the option of participating in an international exchange program or study abroad program? Does Taylor anticipate any other way the GC Scholar could fulfill a global component—such as research, service, etc? This is not

<table>
<thead>
<tr>
<th>Interdisciplinary Component:</th>
<th>The phrase has been added to this component in Table 5.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The interdisciplinary component lists only examples of courses that are closely related to engineering. Many international institutions don’t have the equivalent of general education courses available in the US, but it would be helpful to think about non-engineering course options here (such as medical ethics, business law, politics of South America, etc.). In addition, it appears that all Taylor’s students must take 4 interdisciplinary electives. Is the difference for the GC Scholar that their electives must be GC related—that is, no further elective is required, just the selection of the electives is more focused? This is not clear in the wording. Perhaps a phrase such as: “Scholars will also take 4 electives, but their electives (is it all 4 or just 2 or 3?) should clearly complement their Grand Challenge Portfolio”.</td>
<td></td>
</tr>
<tr>
<td>Global Component:</td>
<td>A clearer description of how Scholars may achieve this learning component has been highlighted in Table 5. Additional activities that address this are also provided in Figures 7 and 8 of this proposal.</td>
</tr>
<tr>
<td>The global component only gives the student the option to secure an international internship. Clarification should be added here that the internship experience is related back to and relevant to one or more of the Grand Challenges and the Grand Challenge concept as appropriate to the individual Scholar. Can all of your students afford such an experience abroad? Do you provide assistance to students in securing such an internship? Could you also provide them the option of participating in an international exchange program or study abroad program? Does Taylor anticipate any other way the GC Scholar could fulfill a global component—such as research, service, etc? This is not</td>
<td></td>
</tr>
</tbody>
</table>
required but if other modes are available to fulfill this component they should be mentioned here.

In January 2015, feedback was received from the GCSC based on their assessment of the third version of this proposal. Table 10 details how the feedback was addressed.

Table 10 Responses to Feedback from GCSC on the 3rd Version of the Proposal

<table>
<thead>
<tr>
<th>Feedback</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>It was not clear if you include a course on project management as one path to completing the entrepreneurship component. Project management is a great course, but not really entrepreneurship training. The Committee wondered if you have a business plan or business case competition or perhaps some innovation labs or related student groups related to entrepreneurship that you might be able to utilize here as a way for students to fulfill this component?</td>
<td>In order to enhance and provide clarity on how a Scholar would fulfill the entrepreneurial component, a new section, namely Section 2.3.2 focuses on the TGCSP entrepreneurial experience roadmap. This roadmap details the journey a Scholar would need to take through the School’s pedagogy and curriculum in fulfilling this component. This requires them to draft business plans for engineering systems/products, determine its business value, its value proposition and raise funds to their product. Scholars would then need to defend their products at the Schools engineering fair competition and have to convince engineering judges of its business value (amongst other requirements). In addition to this, information has been added on how a Scholar would participate in external competitions that would assist them in fulfilling this component.</td>
</tr>
</tbody>
</table>

Lastly, only a couple of the components mentioned on the grid specifically state that students must be pursuing the components with a focus on one of the grand challenges. It would be much clearer to state at the beginning (and repeat it under each component) that students must select one of the fourteen grand challenges and that all of their activities in the five areas need to be focused on that challenge. |

This statement has now been added explicitly to each component listed in Table 5.
In March 2015, feedback was received from the GCSC based on their assessment of the fourth version of this proposal. Table 11 details how the feedback was addressed.

Table 11 Responses to Feedback from GCSC on the 4th Version of the Proposal

<table>
<thead>
<tr>
<th>Feedback</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Selection Process (pg. 10-11) might be asking a lot of incoming</td>
<td>The School opens applications to the TGCSP from students who are either in their first and second years. When evaluating the suitability of the first year students, the selection committee will be mindful of the maturity of the students as indicated in the feedback. In order to clearly reflect this and the case of unsuccessful applicants, the following text has been added to pp. 10 and 11.</td>
</tr>
<tr>
<td>students who may be sufficiently aware of the value of becoming a GC</td>
<td></td>
</tr>
<tr>
<td>Scholar or could be intimidated by the essay/interview process. It</td>
<td></td>
</tr>
<tr>
<td>might be good to recruit second semester first year students or first</td>
<td></td>
</tr>
<tr>
<td>semester second year students as they will likely be more mature.</td>
<td></td>
</tr>
<tr>
<td>Currently, the operational document is unclear on the application process</td>
<td></td>
</tr>
<tr>
<td>for second-year students (in which semesters can they apply? Can they re-</td>
<td></td>
</tr>
<tr>
<td>apply if they do not get in?).</td>
<td></td>
</tr>
<tr>
<td>All incoming first and second year Engineering Degree Scholars at Taylor's University School of Engineering are eligible to submit their application for admission into the TGCSP and will be subject to the same application process.</td>
<td></td>
</tr>
<tr>
<td>It should be noted that students who are unsuccessful in becoming a</td>
<td></td>
</tr>
<tr>
<td>Scholar at the first attempt would be allowed to appeal their application</td>
<td></td>
</tr>
<tr>
<td>for it to be considered for another review.</td>
<td></td>
</tr>
<tr>
<td>The School will also ensure that the selection committee is mindful of</td>
<td></td>
</tr>
<tr>
<td>the maturity of the students who would be applying into the programme.</td>
<td></td>
</tr>
<tr>
<td>Regarding mentors, you are encouraged to think about whether or not you</td>
<td>Effort has now been made to add the specifics of the roles and responsibilities of a TGCSP mentor into Appendix 1 – TGCSP Governance of this report. The following text has been added into the main body of the report on pp. 11 and 12.</td>
</tr>
<tr>
<td>will have sufficient faculty and staff resources to provide the</td>
<td></td>
</tr>
<tr>
<td>monitoring and mentoring of what could be a substantial number of</td>
<td></td>
</tr>
<tr>
<td>Scholars. Under the current arrangement it is unclear if the TGSCP</td>
<td></td>
</tr>
<tr>
<td>Director will mentor all students, if it is the entire</td>
<td></td>
</tr>
</tbody>
</table>
| TGSCP Committee? Also, you will find it helpful to describe what the mentoring expectations are - keeping student records? Monitoring student progress? advising? How is the support for these students provided? | pp. 11  
The TGSCP Director (as well as other academic staff – depending on the number of Scholars) will serve as mentors to the students. They will monitor the students’ performance and their attainment of the LOs each semester. It should be noted that the School aims to achieve a mentor to scholar ratio of 1:15 i.e. if there are 30 Scholars enrolled, there will be at least 2 mentors for the 30 students (each mentor will have a maximum of 15 Scholars to mentor). |
| --- | --- |
|  | pp.12  
They will counsel the students and advise on the projects and activities they will be expected to undertake to fulfill the requirements of the TGSCP. The roles and responsibilities of the mentors as well as how mentors will engage and support the students are provided in Appendix 1 – TGSCP Governance, Section 4.7. |
| The flowchart (p. 9, Figure 1) is improved but still unclear. This will be an issue for your students and mentors. Can you specify what the flowchart represents? What are CQI's? This should be spelled out in the description on page 10 and at the top of the proposal with the rest of the acronyms. | The explanation of the flowchart has now been revised to ensure clarity and CQI has now been defined. The following text has bee added to pp. 10 to address this item.  

*Based on Figure 1, and referring to the flow process on the left of the diagram, applicants would have to go through the selection process (described in Section 2.1) and if successful, would become part of the TGSCP and hence a TGSCP Scholar. Scholars would then graduate (upon successful completion of the degree and the relevant TGSCP requirements) and as alumni (or stakeholder) would have the opportunity in providing feedback to the School, which would be required to further enhance and improve the TGSCP. This is done in the spirit of Continual Quality Improvement (CQI). Relevant CQI action plans would then be channeled through to the TGSCP committee that would then look into* |
improving the administration of the programme based on the CQI action plans. It should also be noted that feedback would also be sought by existing TGCSP students to further improve the programme, hence the link between the TGCSP square block and the CQI circle in Figure 1.

GCPO 2: We would suggest that you revisit the articulation of this GCPO. If this GCPO is about understanding the context by bringing in interdisciplinary thinking, then this needs to be clarified. Specifically, you might want to revise “demonstrate the ability to comprehend knowledge” to be more representative of the spirit and need for understanding an interdisciplinary context and applying this knowledge and relevant skills to find solutions to problems that are grounded in this context.

This item is noted and in the spirit of this feedback, GCPO 2 has been reworded to the following.

Demonstrate the ability to comprehend and apply interdisciplinary knowledge in solving the Grand Challenges.

In order to illustrate the roadmap a TGCSP Scholar would need to take, the following flow diagram incorporates the necessary information.

<table>
<thead>
<tr>
<th>Enrolment</th>
<th>Programme Requirements</th>
<th>Graduation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Candidate enrolls as a Taylor’s SoE Student&lt;br&gt;• Within 2 weeks of semester commencement, candidate applies to be a TGCSP Scholar&lt;br&gt;• If successful (based on selection criteria) a TGCSP Scholar is born</td>
<td>• Scholar begins life adopting the SoE Programme Structure&lt;br&gt;• Scholar is made aware of TGCSP requirements as well as roadmap and strives to achieve the requirements&lt;br&gt;• Achievement of the requirements would be based on structured assessments in the relevant modules and the GCPO attainment</td>
<td>• Scholar participates in GC related activities in SoE through the TGCSP committee&lt;br&gt;• Culminate TGCSP experience via a GCPO Portfolio&lt;br&gt;• Scholar graduates</td>
</tr>
</tbody>
</table>

Figure 9 Summary of a TGCSP Scholar’s Journey
Taylor’s Grand Challenge Scholar Programme Governance
<table>
<thead>
<tr>
<th>Section No.</th>
<th>Section Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Purpose</td>
<td>2</td>
</tr>
<tr>
<td>2.0</td>
<td>Scope</td>
<td>2</td>
</tr>
<tr>
<td>3.0</td>
<td>Definitions</td>
<td>2</td>
</tr>
<tr>
<td>4.0</td>
<td>Academic Governance Structure</td>
<td>3</td>
</tr>
<tr>
<td>4.2</td>
<td>Terms of Reference</td>
<td>3</td>
</tr>
<tr>
<td>4.2.1</td>
<td>TGCSP Committee</td>
<td>4</td>
</tr>
<tr>
<td>4.3</td>
<td>Frequency and Notice of Meetings</td>
<td>4</td>
</tr>
<tr>
<td>4.4</td>
<td>Reporting</td>
<td>4</td>
</tr>
<tr>
<td>4.5</td>
<td>Quorum</td>
<td>4</td>
</tr>
<tr>
<td>4.6</td>
<td>Selection of the TGCSP Director</td>
<td>5</td>
</tr>
<tr>
<td>4.6.1</td>
<td>Responsibilities of the TGCSP Director</td>
<td>5</td>
</tr>
<tr>
<td>4.7</td>
<td>Selection of TGCSP Mentors</td>
<td>5</td>
</tr>
<tr>
<td>4.7.1</td>
<td>Responsibilities of TGCSP Mentors</td>
<td>5</td>
</tr>
</tbody>
</table>
1.0 **Purpose**

The purpose of this document is to summarize and communicate the Schools Taylor’s Grand Challenge Scholar’s Programme (TGCSP) academic and administrative governance structure.

2.0 **Scope**

All aspects of governance carried out by the School for the TGCSP.

3.0 **Definitions**

3.1 Board refers to a group of select appointees in an advisory and governance capacity responsible for overseeing the implementation of scheduled programmes and activities.

3.2 Committee refers to a group of appointees responsible for thorough deliberation of plans, proposals and programmes, and the implementation thereof; an established committee generally reports to a board, typically a board of governance.

3.3 School refers to an established entity within the University that offers specific academic disciplines or programmes that promotes learning and provides supervision.

3.4 Programmes refer to the academic and academic related activities that are enacted and implemented by Taylor’s.

3.5 Governance refers to the execution of established rules, processes, best practices and leadership associated with the management and administration of the institution.
4.0 **Academic Governance Structure**

4.1 Committees/Meetings in establishment at the School that supports the TGCSP and reports to the Schools Board of Studies are as follows:

a) TGCSP Committee

4.2 **Terms of Reference**

4.2.1 **TGCSP Committee**

This committee is established to provides over all guidance on the planning and execution of TGCSP related activities, with the following objectives:

a) To regulate and keep under review admissions, teaching, curricula, and grading and examinations of the TGCSP

b) To review the TGCSP, changes to the curriculum and the Programme Review Report, as well as Module Review Report where necessary.

c) To discuss any critical issues and challenges related to the TGCSP

d) To facilitate industry attachments or placements to expose students to industry practices and to gain practical experience

e) To establish links that facilitates and enhances the employability of the TGCSP Scholars

f) To confirm the progression of TGCSP Scholars after considering all their results after every examination

g) To plan for the mentorship of TGCSP Scholars

*Membership:*

a) Chairperson: TGCSP Director

b) A minimum of four (4) representatives from the academic teaching staff of the School

c) A minimum of four (4) representatives from the TGCSP Scholars

Secretary: Appointed by the Chairperson

4.3 **Frequency and Notice of Meetings**

- TGCSP Committee
  - Once a month

4.4 **Reporting**

The TGCSP committee will report to the Schools Board of Studies – the overarching board, chaired by the Dean, that makes decisions in relation to the School’s strategic and operational goals.

4.5 **Quorum**

A quorum shall be half of the membership.
4.6 Selection of the TGCSP Director

The selection of the TGCSP Director is at the discretion of the Dean and is renewable on an annual basis.

4.6.1 Responsibilities of the TGCSP Director

The Director is responsible for the following:

1) Ensuring that the smooth planning and execution of the TGCSP is in line with the proposal as approved by the National Academy of Engineering (NAE)
2) Enabling the mentorship of TGCSP Scholars such that their achievements are in line with the TGCSP Learning Outcomes (LOs)
3) Propose relevant Continual Quality Improvement (CQI) action plans to the TGCSP committee to further enhance the TGCSP
4) Ensure timely reports on the performance of the TGCSP Scholars to the School’s Board of Studies
5) Managing the TGCSP committee in achieving its objectives

4.7 Selection of TGCSP Mentors

The selection of TGCSP Mentors is at the discretion of the TGCSP Director and the Dean of the School and is renewable on an annual basis.

4.7.1 Responsibilities of TGCSP Mentors

The Mentor is responsible for the following:

1) Monitoring Scholar performance and attainment of the TGCSP LO’s
2) Providing advice and feedback on how to enhance Scholar’s performance and attainment of the TGCSP LO’s
3) Counsel Scholars and advise on the projects and activities they will be expected to undertake to fulfill the requirements of the TGCSP
4) Mentors would be engaging the Scholars twice a month to address items (1) to (3) above.
5) Where appropriate, a set of meeting minutes would be maintained to capture the mentor-scholar meeting and allow for actionable items to be closed prior to a forthcoming meeting.
6) Mentors would also avail themselves for when Scholars would like to schedule an appointment to discuss items relating to the TGCSP or other matters.
Making mistakes and failing is an integral part of learning. Failures and mistakes can be the result of accidents, miscommunication, ignoring instructions or regulations or ignoring basic laws of nature. Failures can also be a result of trial and error when the correct answer or the right solution does nor exist or has not been discovered yet.

Failures are often a source of very valuable learning. In order for us to reap the full benefit of the failures we encounter and mistakes we make, it is necessary for us to see failure as an investment that we can seek return over. This form is named Return on Failure and is designed to help you analyse your failure and grow. Let us start!

Complete the sections below. You may expand the space and use diagrams and pictures as necessary.

### Describe the failure or mistake that you are analysing
(Describe whether the mistake or failure is physical, technical, relational or otherwise. If the failure was done in the course of a trial and error process, describe the cutting edge that you are exploring as well. The failure may happen while you are testing a new process or device or while you are trying a new skill. Use pictures, sketches and diagrams if necessary)

### Examine what was the Root Cause of the failure
(Ask 5 Why questions starting with “Why this failure happened?” if the answer is the failure occurred because of “X”, as “Why X happened?” and repeat this 5 times. This will yield the Root Cause of the failure)

### Are there any other ways that you could have failed to achieve your objectives?
(Here try to predict other ways that failure could have also happened)

### Describe how you will use the insight above so that you eliminate or minimise the possibility of failure in the future.

### What are the other key learnings from this failure?
School of Engineering

MEC 3913 Mechanical Engineering Group Project 1

Human-Powered Vehicle

2014

Project Supervisor: Dr. Yong Leng Chuan

Name: Yim Hoe Yen
Student ID: 0303533

Team: Escaping Darkness
Contents

Executive Summary .................................................................................................................. 3
Introduction .............................................................................................................................. 4
    The Challenge .................................................................................................................. 4
Objectives................................................................................................................................ 4
The HPV – 1st Objective ......................................................................................................... 6
    Design Process using CDIO ............................................................................................ 6
        Conceive - Brainstorming ............................................................................................ 6
        Decision Matrix .......................................................................................................... 9
    Design - ACID .................................................................................................................. 0
Suspension Design .................................................................................................................. 3
    Feature 1: Tilting ............................................................................................................. 3
    Feature 2: Recumbent ...................................................................................................... 5
    Feature 3: Four Wheels ................................................................................................. 5
    Suspension CAD Design ................................................................................................. 0
    Finite Element Analysis on Key Components .................................................................. 0
Tilt, the HPV of the 21st Century ........................................................................................... 8
Business Plan – 2nd Objective ............................................................................................... 9
    Core Purpose .................................................................................................................. 9
    Premise ........................................................................................................................... 9
        5-tier Security System ................................................................................................. 9
        Strategic location ..................................................................................................... 10
    Modern, Multi-Functional Plant Design ...................................................................... 10
    Floor Plan, Pricing and Development Details .................................................................. 12
Processes and Production ..................................................................................................... 13
    Stations ........................................................................................................................... 13
    Storage ............................................................................................................................. 13
    Manufacturing of Chassis and Suspension ................................................................... 14
    Painting ............................................................................................................................ 16
Executive Summary

Mechanical Engineering Design Group Project consists of a select team of members, all of them who are from Mechanical Engineering discipline. Group Project 1 is the first part of the module, and it concerns the application of the first two parts of the CDIO initiative; Conceive and Design. The required artifact to design is a Human Powered Vehicle, or referred to from now on as HPV.

The human-powered vehicle (HPV), like its name suggests, is a vehicle that is powered solely by the power provided by its rider. In HPVs today, this power is generated by the contraction of muscles in a human body, since no one has invented a HPV that is powered by natural gases that a human body emits for example.

The need for mankind to travel in a safe and sustainable way is now greater than ever. Overconsumption of fossil fuels has the potential to plummet the world into a catastrophic situation. In hopes of sparking a change in the way we travel, the project aims to design and build a Human Propelled Vehicle that can be used by anyone without any extraordinary athletic ability. Conceptualization and design would be done in this semester, whereas implementation and operation (construction and building) will take place in the following semester.

The design that the group has chosen is a four-wheel contraption that would be powered by legs via the use of pedals. The user sits in the chassis comfortably. Steering is done by shifting the weight of the user, causing the vehicle to tilt; the edges of the wheels will bite the road, and turn the vehicle. By means of an oscillating axle, stability in corners is increased due to the tilting.

Initial brainstorming sessions led to more creative design sessions. Using proper decision making tools, the current design was chosen. It was sketched out, rendered, criticized, re-sketchet and re-rendered.

It is hoped that the project would inspire a next-generation form factor of transportation that would overcome all the shortcomings of current solutions of travelling. In the coming semester, it is the group’s goal to win the race of Human Powered Vehicles by being the best solution of transportation available. The budget proposed for this project is RM500.00.

With that said, the goal given to us, the Escaping Darkness, is to design a state of the art HPV that exceeds expectations, at the same time come up with business plan to bring the entire concept to reality.
Introduction

The Challenge

“Humankind needs a safe and sustainable way to travel small distances (up to 100 km) without using energy generated from fossil fuels. Current solutions are expensive and are not user friendly for children (between the ages of 12-18). Your team is tasked to conceive, design, implement and operate an engineering system that can be used to travel distances of up to 100 km without using energy generated from fossil fuels. The system must cost RM500 or less, be safe to use and be of sound engineering analysis i.e. an efficient and effective engineering system. The system is to be used by children from ages 12 to 18 and by adults from ages 18 to 60 (one size fits all). The system must also be capable of reaching an average speed of 15 km/h by its user (who aren’t trained athletes).”

The most popular HPV of today remains to be the versatile, economical and environmentally friendly bicycle. Powered by the largest muscle in the human body, the gluteus maximus, bicycles can travel up to speeds of 25 miles an hour, and is used to cover distances of over 100 miles. However, this claimed performance can only be produced by trained athletes in condition. Daily cyclists still face many challenges that can be solved in a better designed HPV. We are going to address some of these challenges in our design, to bring forth innovation in HPVs.

Objectives

There are two goals given by the technical experts in this course, which are to conceive and design a human-powered vehicle, and also come up with a business plan for the human powered vehicle. In order to further define the goals into clear objectives for the project, the root-cause analysis is carried out to identify the challenges that we are trying to solve in short-distance travelling. A fishbone diagram is used for the analysis, but the format is changed for the better use of paper real estate.
From the diagram above, it is clear that there is a lot that can be done in today’s transportation. Vehicles that utilize fossil fuels, also known as combustion engine vehicles, are not economical to travel short distances, especially journeys less than 10km. In urban and suburban areas, this is even truer with congestion issues. The roads in cities are now extremely jammed during peak hours, and parking is a round-the-clock challenge. Thus, in many metropolitan areas such as London and Singapore, bicycles are the way to travel within the city. However, bicyclists face different challenges. Bicycles are inherently unstable, causing them to be highly impractical in start-stop traffic. On top of that, bicycles cannot stop in short distances due to its braking relying mostly on a free-to-rotate front wheel, making collision between bicyclists and pedestrians extremely common. Bicycles are also not ergonomic, causing many injuries to the groin and back. Most importantly, not everyone can learn how to balance on a two wheeled vehicle. The team then decides that a HPV should be designed with the following criteria.

In the range of 50 kilometers, the HPV has to outperform the most conventional HPV of today, which is the bicycle in all aspects, which are cost, safety, user friendliness, sustainability and endurance. At the same time, the HPV has to be more sustainable than other forms of vehicles such as the combustion engine and electric vehicles in the said range of travel. With that said,
the team’s engineering know-how such as structural analysis, ergonomics and dynamics is put to the test in order to conceive and design the revolutionary HPV.

Then, the business objectives for the project to make the team’s HPV the most popular form of HPV in South-East Asia within a decade. A three year plan to realize part of this grand mission is written clearly in the form of words and diagrams in this report. Numerous successful business concepts used today will be implemented.

The HPV – 1st Objective

**Design Process using CDIO**

According to the CDIO website, the CDIO initiative is “an innovative educational framework for producing the next generation of engineers. Utilized by multitudes of schools of engineering worldwide, it aims to nurture young students into competent engineers by providing an outcome-based education.

CDIO stands for Conceive, Design, Implement, and Operate. It is used as a general framework in designing the project. While this semester will be used to cover Concieving and Designing, next semester will be used to Implement and Operate, which is to build the HPV.

**Conceive - Brainstorming**

During the early stages of the project, the team gathered together to brainstorm ideas. This is the Conceive process of CDIO. During brainstorming, no ideas are rejected; an emphasis is placed on quantity, instead of quality of ideas. Brainstorming this way encourages critical thinking; it is also a method in which we are trained to solve problems. As we progress further and further into our course, we get better and better at solving problems and coming up with solutions. Also, by collecting the different viewpoints of other people, the resulting solution might end up to be something fresh and usable.
The ideas that were mentioned were categorized under two characteristics, the traits and ideas. Figure 1 show all the list of ideas under the traits and ideas mentioned by the group members which may be wild, new and innovate.
A weightage number was given to each idea which was according to the group the most important for the designing of the HPV. The higher the number the more important is the ideas according to the group members after an intense discussion.

![Decision Matrix](image)

**Figure 4: Decision matrix**

The decision matrix allow to rate the ideas based on the specification which was number by allowing a weightage number. All the ideas were rated based on the decision matrix and the best design which is the 4 wheeler chassis scores the most.
## Decision Matrix

<table>
<thead>
<tr>
<th></th>
<th>Hands</th>
<th>Stepping</th>
<th>Bounce</th>
<th>Rowing</th>
<th>Tilting</th>
<th>3Wheels</th>
<th>4wheels</th>
<th>Hand-leg convertible</th>
<th>Hand leg together</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ergonomics</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Cornering fast</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>6</td>
<td>9</td>
<td>7</td>
<td>8</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Endurance</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>9</td>
<td>8</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>safety</td>
<td>7</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>8</td>
<td>9</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Cost</td>
<td>9</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>8</td>
<td>7</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Disabled Friendly</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Lightweight</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>1</td>
<td>4</td>
<td>9</td>
<td>8</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>8</td>
<td>7</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Adjustability</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Ease of assembly</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>9</td>
<td>8</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

Figure 5: Decision Matrix
Design - ACID

The ACID method in designing refers to the systematic process in which engineers can design a certain product. ACID stands for Product Architecture, Configuration Design, Integrated Design and Detailed Design. The ACID method of designing was extensively used.

As discussed in the logbook, the team has decided to jump right into utilizing SolidWorks to produce rough sketches because:

1. To reduce the need to repeatedly draw the model in different views.
2. The rough sketch can be used as a basic geometry to the actual CAD drawing, meaning that the initial sketches can be reference points to the different parts during design/assembly.
3. The team is quite well trained in SolidWorks at this stage due to frequent usage.

The Product Architecture of the HPV is based on a recumbent human being. Thus, the 95th percentile sized male was sketched into SolidWorks as a guide to how the different parts of the vehicle will be built about. The dimensions of the sketch is defined by anthropometric data obtained from the internet. The positions of the limbs are also put based on ergonomic data found on bicycle forums. According to most forums, there are not absolute correct position of hands and legs. However, the team has taken the values suggested by most riders posting on the forum.
After that, the wheel base of the HPV was drawn into a separate sketch based on the center of gravity. This is an important part of the Product Architecture as the position of the wheels will ultimately define vehicle dynamics. Having the center of gravity positioned right in the middle of the wheelbase will allow the vehicle to be more balanced, thus maximizing the amount of traction during acceleration (braking, taking corners, propulsion). On top of that, balance of vehicle affects rider’s confidence.

After producing the sketch of the 95th percentile sized male and the wheels of the HPV, the crank and chain route is drawn based on the positions of both the wheels and the rider. This ultimately defines where the powertrain of the vehicle would be. This signifies the beginning of the Configuration Design stage, where the configuration of the drive train is defined.
The HPV was then divided into different categories which consist of the chassis, powertrain, steering system, braking system and the suspension. In this report, the configuration design of the suspension will be scrutinized as the author of this report is in charge of the suspension. Other configuration designs of the HPV will be discussed in detail in the other team members’ reports. At this point, the mock driver and seats were also put into the CAD in order to design ergonomically.
Suspension Design

Feature 1: Tilting

When a regular non-tilting vehicle takes a corner, the effective weight of the car is transferred from the inside wheels to the outer wheels due to a phenomenon known as lateral weight transfer (Adams, 1993). This is due to the moment created as the centripetal force (described as the cornering force in figure) acts from a distance upon where the wheels contact the ground (H in figure).

Therefore, in order to achieve dynamic stability, engineers design vehicles with low center of gravity, wide track (significantly larger than height of the center of gravity). In a human powered vehicle, an overly large track would mean that the vehicle would affect the maneuverability at low speeds and pedestrian walkways, thus rendering the vehicle less functional. On top of that, the height of the center of gravity must be as low as possible in a regular vehicle. A human powered vehicle however, must maintain a certain minimum height as an extremely low vehicle might not be noticed on the road, resulting in accidents. Still, with the two criteria in mind, engineers still face challenges in maintaining the dynamic stability of typical human powered vehicles – there are a variety of pictures and videos showing human powered vehicles tip over.
Thus, the solution of a tilting vehicle. In a tilting vehicle, the position of the center of gravity changes, allowing an equal amount of weight to be placed on each wheel, improving stability at the same time increasing traction. Above that, the human powered vehicle can be designed with a narrow track and reasonable center of gravity height.
Feature 2: Recumbent

The team decided to design the human powered vehicle with a recumbent seating position instead of an upright position. Having a recumbent seating position is much more ergonomic and comfortable when the vehicle is used for long distance travels as it reduces the hypertension or strain to the wrist, neck and back. Besides, a recumbent seating position is safer than an upright position as it prevents the rider from flying over the handlebars in a panic stop. On a recumbent bike, the rider would have a better view. On an upright position, the rider’s head would tend to face the ground while on a recumbent position the rider’s head would face forward.

Dynamically speaking as well, the recumbent design wins the upright position hands down. The recumbent design allows the center of gravity to be placed lower, allowing for better cornering at higher speeds. Also, the lateral position of the center of gravity can be adjusted better in the recumbent design. In the best case scenario, the center of gravity should be slightly behind the center of the vehicle, so that the vehicle has a weight distribution biasing towards the rear. Having a rear biased weight distribution, like a typical sports car, will allow the vehicle to brake better as the weight transfers to the front during deceleration. In an upright bicycle, the weight of the rider is placed mostly on the front wheel. Paired with the height of the center of gravity in an upright bicycle, bicyclists have the tendency to tip over the front when braking too hard. This can be avoided altogether in a recumbent design.

![Figure 15: Recumbent seating position compared with upright position](image)

Feature 3: Four Wheels

Having four wheels instead of three of two will mean that the vehicle will be dynamically more stable as the weight is more easily distributed between wheels. Having better weight distribution will mean that all wheels will experience the same amount of weight being placed upon them. In the case of the popular three-wheeler, normally more weight is distributed to the single wheel as compared to the paired wheel, regardless whether the paired wheels are placed in front or rear of the vehicle. As seen in the following figure, the weight (larger circle) will normally be
placed in the center of the vehicle, causing the single wheel (smaller circle) to experience more weight to be placed upon them.

![Diagram showing weight distribution in three-wheel vehicles](image)

**Figure 16: Three-Wheeler Weight Distribution**

This means that the amount of traction available from any given tire is not equally utilized. As seen in the graph below, the typical traction performance of a tire rubber compound reduces as the weight is increased. *This means that a three wheeler will never have as much traction as a four wheeler, which explains why people do not make race cars with three wheels, and heavier vehicles such as a lorry will have more than four, but even number of wheels.*

![Tire Performance Curve](image)

**Figure 17: Tire Performance Curve**
Suspension CAD Design

An Overview

The following pictures present an overview of the suspension CAD design. The suspension components are mostly blue in order for easy identification. In the front, a special-combined-double-wishbone design is implemented. Trailing arms (forks) are implemented for the rear suspension, along with shock absorbers mounted for extra comfort and anti-rolling capabilities. 20 inch BMX wheels are used instead of larger wheels as less gyroscopic procession is required to keep the vehicle in balance. Uprights produced using mild-steel tubes are designed with cost of production in mind (yellow, attached to front wheels). Camber gain is inherent in a tilting vehicle as the wheels camber when tilting. Castor angle for self-centering is implemented for hands-free cruising. All-in-all, a very well designed suspension system worthy of a world-classed HPV.

Figure 18: Standard Views of the Suspension CAD Design
Finite Element Analysis on Key Components

There are many methods in analyzing a component so that it can withstand the applied loads. In this project, FEA (Finite Element Analysis) in the SolidWorks program is used to analyze the components of the suspension to ensure that there will not be failure during operation. The finite element analysis is a numerical technique for finding approximate solutions to boundary value problems for differential equations.

When using FEA to analyze a certain model, the 3D model is broken down into tetrahedral or triangular “elements”. Those elements then connect to one another to form a “mesh”. At the points where elements link to one another, “nodes” are formed where unknowns are determined through computation. These unknowns can be a range of quantities including stress, displacement and moments. Material and structural properties are defined into the structure so that it will react to certain loading conditions.

The governing equations in solving the broken down links are the same as the ones that are applied in engineering. For example, to determine the stiffness of a structure, Hooke’s law is applied (F=lx).

Higher density of nodes are assigned at areas in the structure that anticipates higher level of loads. Higher density of nodes are also assigned to points of interests, where the structure is known to have failed in the past.

Some of the unknowns (quantities) that SolidWorks computes:

- Mass, volume, temperature
- Strain energy, stress strain
- Force, displacement, velocity, acceleration
- Synthetic (Users may define a certain quantity through a mathematical function)

Several loading conditions can be applied onto the structure:

- Point, pressure, thermal, gravity, and centrifugal static loads
- Thermal loads from solution of heat transfer analysis
- Enforced displacements
- Heat flux and convection
- Point, pressure and gravity dynamic loads

Structural analysis will be used to analyze the structural integrity of most of the suspension components under load. There are two types of structural analysis, namely the linear and nonlinear models. Linear models assumes that the material does not deform plastically whereas non-linear models has parameters that stresses a material beyond elasticity. For the application of this project, where the forces are relatively small, the linear model is adopted.
Figure 19: A model displaying “elements”, “nodes” and “mesh” (Esfand, 2013)

Figure 20: Deflection of suspension components when load is applied (Asad, 2011)
Calculation of Boundary Conditions

Before FEA is executed on the CAD models, basic calculations were made in order to find the forces and torque to be applied. Conservative figures (worst case scenarios all the time, very pessimistic) are used in all assumptions. In a typical bicycle, the acceleration experienced is about 0.5g (Wikipedia, 2014) as it is limited by the amount of traction that its tires can provide.

\[ F = ma \]
\[ = 80 \times 9.81 \text{ m/s}^2 \div 2 \text{ wheels} \]
\[ = 392.4 \text{ N} \]

Torque experienced at any given wheel in a 1G acceleration (forward & backward)

\[ T = Fr \]
\[ = 392.4 \text{ N} \times \frac{20.13}{2} \times \frac{25.9}{1000} \]
\[ = 99.67 \text{ Nm} \]

Forces experienced at the outside wheel during cornering (sideways) 1G.

\[ F_3 = 99.67 \text{ Nm} \times \frac{110}{130} \div 0.11m \]
\[ = 766.69 \text{ N} \]
\[ F_3 = 76669 \text{ N} \text{ (equals to } F_2) \]

Thus, bearings will need to sustain about 800N of force.
**FEA on Upright**

Forces experienced by the upright in the worst case scenario, where the HPV experiences a hard bump, whilst braking and cornering at the same time.

- Fixture at wheel mounting point (green fixtures)
- 100Nm braking torque (green arrows, applied to brake mounting points)
- 100Nm torque to represent cornering force at 1g acceleration (purple arrows, applied along body of upright)
- 800N force to represent a 4g bump (80kg/4 wheels*4*10m/s^2)

**Results:**

- Factor of safety of 1.3 is achieved
- Forces are evenly distributed (redder parts are evenly spread, showing that the material throughout the body is utilized).
- Safe to carry a passenger of up to 80kg.

![Figure 22: Upright FEA Results](image)
**FEA on Suspension Arms**

Forces experienced by the suspension arm in the worst case scenario, where they are subject to a 2g acceleration whilst carrying an 80kg load.

- Fixture at wheel mounting point (green fixtures)
- 800N force to represent a load accelerated at 2g (80kg/2 suspension arms*2*10m/s^2)

**Results:**

- Factor of safety of 1.3 is achieved
- Forces are evenly distributed (redder parts are evenly spread, showing that the material throughout the body is utilized).
- Safe to carry a passenger of up to 80kg.

![Figure 23: Suspension Arms FEA Results](image-url)
**FEA on Rod-End Bearings**

Forces experienced by the rod-end bearings holding the uprights in the worst case scenario, where they are subject to a braking torque at 1g deceleration and 2g bump carrying an 80kg load whilst cornering (100 percent weight transfer to the outside wheels).

- Fixture at wheel mounting point (green fixtures)
- 800N force to represent a load accelerated at 2G (80kg/2 bearings holding upright*2*10m/s^2)
- 200N force sideways to represent braking torque at 1g deceleration

**Results:**

- Factor of safety of 1.2 is achieved
- Safe to carry a passenger of up to 80kg.

![Rod-End Bearing FEA Results](image)
Industrial Specifications of bearing connecting upright to suspension arms

When taking into account only the forces experienced by the bearing in cornering, the industrial specifications are taken as these forces are applied to the bearings are purely compressive and tensile forces in the direction axial to the rod-end.

Figure 25: Rod-End Bearing Table

Factor of Safety \(= \frac{8650N}{800N} = 10.8\)
Calculations for the Rear Shock Absorber

The following calculations were made in order to tilt the HPV a minimum of 25 degrees. The shock absorber implemented will be a 6 inch in length, 750 pound per inch, spring type shock absorber.

\[ \sin 25^\circ = \frac{200}{350} \]

\[ \sin 25^\circ = \frac{200}{350} = 0.571 \]

To find portion of shocker:

\[ x = 73.96 \text{ mm} \]

Find x:

\[ \frac{254}{73.96} \times 400 \text{ mm} = 137.3 \text{ mm} \]

Figure 26: Rear Shock Absorber Calculation and Design
Tilt, the HPV of the 21st Century

Integrating the suspension design into the full design, Tilt, the four-wheeler-tilting-recumbent HPV is born.

Tilt can easily out-perform the bicycle in the range of 50 kilometers. It is cost effective, safer, user-friendly, sustainable, and has an endurance higher than that of a bicycle.
Business Plan – 2nd Objective

Having a business objective to make **Tilt** the most popular form of HPV in South-East Asia within a decade, the team has dug deep into alma-matters to craft the plans and strategies for the **three years** into business. Six different core aspects were taken into consideration, namely premise, processes, production, people, price and promotion. On top of that, the **core purpose** of the business is explored and defined in this report.

**Core Purpose**
Transportation is inseparable from the daily lives of any human being. A person’s occupation is highly dependent on the kind of transportation he or she has access to, needless to say leisurely and social activities. Since the dawn of mankind, developmental changes in transportation have greatly influenced the advancements of civilizations. The economy of these civilizations are powered by their capabilities in enabling the exchange of goods, meetings, distributions and consumption. The Romans managed to build a great Empire because of their vast network of roads. The Egyptians managed architectural wonders because they had an ingenious method of transporting stone from their quarries to their building sites.

However, transportation is often limited by the availability of resources. Transportation in the 21st century becomes even dependent on the resources consumed as petrol and raw materials becomes more and more limited. Urbanization also gives an additional aspect to consider as vehicles of today easily cause congestion in slow traffic as they are large and not versatile. It is necessary for engineers of today to come up with a solution for the betterment of transportation.

Thus, Escaping Darkness has envision to revolutionize the way people travel in metropolitan regions through innovative and sustainable transportation solutions.

**Premise**
The premise chosen will be at the Skyline Industrial Park. The Skyline Industrial Park is developed by Jaymuda Group. Jaymuda was established over two decades ago by the late Datuk Low. Having property development as its core business since inception, Jaymuda is well-known for its reliability and trustworthiness. With the customers’ sense of satisfaction as their motivation, the team has full confidence on this chosen premise.

**5-tier Security System**
The Skyline Industrial Park is the only industrial hub in Melaka with a 5-tier security system. Having a centralized, round-the-clock surveillance control center, paired with high definition recording equipment and high luminance lighting at strategic locations, criminal activities can be easily identified in prime time. There is also a guard patrol system to address emergencies.
Strategic location
The Skyline Industrial Park lies in an extremely convenient location, being in close proximity to the Ayer Keroh Plus Highway, and also a local airport (Batu Berendam). On top of that, it is close to state administrative centers, allowing business dealings to be handled with ease. The state of Malacca is also within one hour road travelling to the major ports and international airports. Most importantly, Seremban, Johor and Klang (south-west of Selangor) has many industrial areas, making the procurement of raw materials easy.

Malacca, being a city, has a population of more than 200,000. Malacca also has amenities such as shopping centers, financial institutes, hospital and school. This makes the Skyline Industrial Park an attractive place to work at, thus the availability of workforce can be ensured.

Modern, Multi-Functional Plant Design

Figure 28: Site Map and Location

Figure 29: Plant Design
The Skyline Industrial Park features different plan design options, and the most appealing design will be the “1-storey Detached Factory with 3-storey Office”. The design incorporates four different aspects of a commercial block into one single unit, which are the warehouse, production factory, office and showroom. The team will be able to get the most out of the property by integrating all processes in the business into the unit. Having all processes integrated within one single building will mean that the team will save in the long term, as no extra property is required.

Suitable electrical supply of 33KVA PPU and 11KV SSU. 100A 3 Phase is also provided, adequate to power-up all machineries in plan.

The unit integrates a glass façade at the front-facing, three-floor segment, making the three floors extremely useful for the showroom and offices. The team has decided to utilize the floors as below.

**First floor** – showroom. Customers can walk in and make purchase

**Second floor** - R&D and Engineering Center, where engineering work is carried out and future vehicles designed.

**Third floor** – Administrative office
Floor Plan, Pricing and Development Details

<table>
<thead>
<tr>
<th>Development:</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected Commencement Date</td>
<td>Jan 2013</td>
<td>Jan 2015</td>
</tr>
<tr>
<td>Expected Completion Date</td>
<td>Early 2015</td>
<td>Dec 2017</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>1-Storey Detached Factory With 3-Storey Office</th>
<th>1-Storey Semi-D Factory With Mezzanine Office</th>
<th>1-Storey Linked Factory With Mezzanine Office</th>
<th>2-Storey ShopOffice</th>
<th>2-Storey Main Distribution Centre</th>
<th>3-Storey GMP Food Factory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area</td>
<td>100 x 200 ft²</td>
<td>50 x 100 ft²</td>
<td>30 x 100 ft²</td>
<td>22 x 70 ft²</td>
<td>13.1 ac</td>
<td>4 ac</td>
</tr>
<tr>
<td>Built-up</td>
<td>11,498 ft²</td>
<td>3,500 ft²</td>
<td>2,522 ft²</td>
<td>2,862 ft²</td>
<td>290,000 ft²</td>
<td>126,000 ft²</td>
</tr>
<tr>
<td>No of units</td>
<td>32</td>
<td>32</td>
<td>44</td>
<td>44</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Price</td>
<td>RM 638,800</td>
<td>RM 58,800</td>
<td>RM 58,990</td>
<td>RM 68,880</td>
<td>RM 40,400</td>
<td>RM 50,000</td>
</tr>
</tbody>
</table>

Development: approx. 65 acres

**Development:**

**Phase 1**
- Expected Commencement Date: Jan 2013
- Expected Completion Date: Early 2015

**Phase 2**
- Expected Commencement Date: Jan 2015
- Expected Completion Date: Dec 2017

<table>
<thead>
<tr>
<th>Type</th>
<th>1-Storey Detached Factory With 3-Storey Office</th>
<th>2-Storey Shop Office</th>
<th>2-Storey Bungalow House</th>
<th>2-Storey Semi-D House</th>
<th>2-Storey Terrace House</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area</td>
<td>100 x 200 ft²</td>
<td>22 x 70 ft²</td>
<td>14,500 ft²</td>
<td>60 x 60 ft²</td>
<td>1,548 ft²</td>
</tr>
<tr>
<td>Built-up</td>
<td>11,498 ft²</td>
<td>2,862 ft²</td>
<td>2,800 ft²</td>
<td>12,508 ft²</td>
<td>1,600 ft²</td>
</tr>
<tr>
<td>No of units</td>
<td>32</td>
<td>60</td>
<td>5</td>
<td>72</td>
<td>140</td>
</tr>
</tbody>
</table>
Processes and Production

Stations
Below are the stations (8 of them), and the flow of manufacturing from storage of raw materials and parts to delivery of a complete item.

![Manufacturing Flow Chart]

Storage

The storage of the factory is pretty straightforward. A large compartmented shelf will be storage to all the raw materials and parts that are delivered to the factory. As the team plans to mass produce for high volume sales, the Planning Officer and Logistics Officer are in charge of ensuring that the raw materials and parts reach just-in-time for production.

With all aspects of the company is placed in one single building, synergy between the front and back offices can happen easily.
Manufacturing of Chassis and Suspension

To make the factory as lean and specialized as possible, only the chassis and suspension components are made in—house. These two components are mainly metal works with steel tubes. Other parts are purchased from a third-party, saving the company costs in terms of purchasing, operation and maintenance of machinery.

Below are all of the machinery that are used for metal works. The company believes that in order for the employees to produce the best in class HPV, the best, complete set of tools and equipment have to be provided.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Description</th>
<th>Specification</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cutter</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Maktec Metal cut-off 355mm(14’’), 2000W, 3800rpm, 16kg MT240</td>
<td></td>
<td>RM380</td>
</tr>
<tr>
<td></td>
<td>• RM380</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Circular Saw</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Borch circular saw 7’’(190mm), 14000W, 5500rpm, 4.1kg GKS190</td>
<td></td>
<td>RM390</td>
</tr>
<tr>
<td><strong>CNC Machine</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Haas VF-0E CNC vertical machining center mill rigid tap 4th axis pre-wire</td>
<td></td>
<td>RM60246</td>
</tr>
<tr>
<td><strong>Lathe Machine</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Bolton 16” x 20” metal lathe mill drill head milling combo machine</td>
<td></td>
<td>RM6657</td>
</tr>
<tr>
<td><strong>Hand grinder</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Bosch angle grinder 4”, 580W, 11000rpm, 1.8kg GW550</td>
<td></td>
<td>RM148</td>
</tr>
<tr>
<td><strong>Bench grinder</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• SKIL bench grinder 150mm(6”), 250W, 2800rpm, 10.2kg 3000</td>
<td></td>
<td>RM170</td>
</tr>
<tr>
<td><strong>Milling machine</strong></td>
<td><img src="image" alt="Milling machine" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xest Ling Drilling and milling machine 16mm, 550W, 80kg ZX-7016</td>
<td>RM1350</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Welder</strong></td>
<td><img src="image" alt="Welder" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200AMP DC inverter tig mma welding machine welder stainless/carbon steel 220v</td>
<td>RM900</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G-Clamp</strong></td>
<td><img src="image" alt="G-Clamp" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irwin Record G-clamp 4”(100mm)frame load:545kg 1kg T120/4</td>
<td>RM30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tube bending machine</strong></td>
<td><img src="image" alt="Tube bending machine" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tauring tube and pipe roller BS50M angle extrusion roll bending machine bender</td>
<td>RM20000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Air compressor</strong></td>
<td><img src="image" alt="Air compressor" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hitachi Bebicon air compressor 1/2HP, 8Bar, 30kg 0.4LE-8S5A</td>
<td>RM4300</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Air grinder</strong></td>
<td><img src="image" alt="Air grinder" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GISON air angle die grinder ¼”, 20000rpm, 0.7kg GP-824TA</td>
<td>RM190</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Painting

Upon completion at the chassis and suspension manufacturing station, the parts will be sent for painting. The Duplex painting system is adopted, to ensure that the HPV chassis and suspension will last for its service duration in the hot and humid South-East Asia. The Duplex painting system comprises of a dual process, which are the galvanization process and powder paint coating.

The galvanization process involves providing a charge to the metal surfaces of the chassis and suspension, then spraying a thin layer of zinc-based white paint. This zinc surface prevents the metal surfaces to corrode shall the outer layer of paint chips off.

Instead of charging up the metal parts, the second part of the painting process, which is the powder paint coating, involves spraying charged particles of paint molecules onto the surface of metal. As the paint molecules are charged, they tend to be attracted to the ferromagnetic surfaces of the steel chassis and suspension, giving it an even and glossy finishing.

The painted components are then left to dry naturally at a designated area outside the painting station.

| Paint sprayer | 5/8 Horsepower airless paint sprayer kit | RM670 |
Assembly
As mentioned in earlier parts of this report, not all components will be manufactured in-house. Majority of the components are purchased to be assembled together for a leaner manufacturing plant. Below are the components that are purchased.

- Brakes
- Wheels
- Seats
- Sprocket
- Chains
- Bearings
- Bolts and nuts

Thus, the assembly station will be handling all of the following in procedural steps.

- Assembly of arms to the chassis
- Assembly of steering system
- Assembly of chain drive mechanism
- Assembly of brake system
- Assembly of wheels
- Assembly of seat
- Alignment of wheels

Quality control
Quality control. Check on entire assembly. Road surface test to determine the functionality of suspension system.

The fully assembled HPV is then brought to the quality control section to be scrutinized by inspectors to make sure there are no damages or faults to the HPV frame or to its fairing body cover. The quality control area is very brightly lit so that any dents, marks, scratches or imperfections on any surfaces will be amplified so that they are easily spotted and marked to be sent to the repair garage.

Testing
Each assembled Tilt will be tested for basic functions by a Quality Assurance staff. A checklist will be provided in order to ensure all mechanisms are functioning. At the same time, welds and paint work will be scrutinized. Most importantly, crucial parts of Tilt will be measured using appropriate devices to ensure that each Tilt is as close to the CAD design as possible.

On top of that, samples of Tilt will be taken to be tested on a closed area of the car park. The brakes, cornering capabilities and drivetrain will be rigorously checked to ensure that Tilt does not fail in specified conditions.

Any testing failures will be reported to the R&D and Engineering Department. Then, the faulty Tilt will be sent to the factory to be reworked on.
Packaging and Delivery

Two types of packaging will be implemented, the first being Complete Build-Up (CBU) and the second being Complete Knock-Down (CKD). The reason for the two kinds of packaging is to appeal to both the local and overseas market.

Local buyers, those who purchase from the showroom, will be able to have their HPVs delivered to them fully assembled.

In order to promote export to other South-East Asian countries, the Ikea concept of self-assembly packaging is adopted. Tilt will be knocked-down, just like a Complete Knock-Down (CKD) vehicle, into easy to assemble components to facilitate transport. This dramatically reduce shipping costs.

Figure 31: CKD Packaging

Delivery of the vehicles to abroad will be fully outsourced to shipping companies in order to save operational costs.
Safety Considerations

*Job Hazard Analysis (JHA)*

**Air and Noise Pollution Control**

As the plant is a closed area, industrial ventilation and sound proofing is required to reduce the workers’ exposure to air and noise pollution. This is crucial as extensive metal works and painting jobs will be carried out in the plant. A ventilation system can remove harmful vapors such as welding fumes and solvent vapors. As there will be a partition between the factory section and the sales and management section in the plant, a sound proofed wall (yellow line) should be implemented.

![Sound Proofed Wall](image)

*Figure 32: Sound Proofed Wall*

There are generally three kinds of industrial ventilation, namely the indoor air quality ventilation, dilution ventilation and local exhaust ventilation. The indoor air quality ventilation is basically an industrial air-conditioning system equipped with filters that are able to remove impurities. This system will be implemented for throughout the manufacturing section of the plant, so that the workers can work comfortably in a cool and dry environment. The dilution ventilation is an exhaust system that removes the contaminated air, at the same time drawing in clean air from outside, diluting the polluted air within the plant. The dilution ventilation system will be placed at the storages as air-conditioning is not necessary at that location. Local exhaust ventilations are machines that capture emissions directly from the pollution source, thus can be applied at the paint station in the plant.

**Personal Protective Equipment**

Personal Protective Equipment (PPE) is absolutely necessary once entering the factory section of the plant. All basic equipment should be provided at necessary stations so that workers are protected. On top of that, workers should be educated on the importance and correct methods of using the PPEs. Rules should be enforced in the plant so that fines will be imposed if the workers do not adhere.
Emergency and Evacuation

To ensure that employees have an escape plan just in case there is an emergency in the factor, safety routes and exits will be detailed and labelled at highly visible areas. An evacuation planned in advance is an extremely effective disaster control measure as time is an extremely limited commodity during emergencies – lives could be threatened every single minute.

To ensure that all employees understands the standards of procedures and evacuation plans during an emergency, safety drills should be held every 6 months.

![Evacuation Diagram](image)

Figure 33: Example of an Evacuation Diagram

Elements of on-site emergency plans:

- Leadership and Administration
- Role and Responsibilities of Key Personnel
- Emergency action
- Light and Power
- Source of energy control
- Protective and rescue equipment
- Communication
- Medical care
- Mutual Aid
- Public relation
- Protection of vital records
- Training
- Periodical revision of plan

Action plans should include the following:

- Designated Emergency Control Centre/Room
- Key personnel for specific emergencies
Job Description

Managing director – responsible for directing the activities of a specific department or departments within an organization. Manages other employees and ensures all business goals and objectives are reached.

Financial and accounting manager – responsible for applying his or her professional knowledge and skills in the preparation and presentation of financial orientated information to assist management in formulation of policies and also managing the business team.

Legal advisors - Legal advisors are lawyers specialized in a particular field. They are employed to prevent from any legal disputes in their clients’ companies. While advising they must compare those cases with previous similar cases. They should be able to apply those laws and terms on their clients’ issues.

Accounting officer - An account officer is responsible to look after the financial part of a firm or a particular company. He is also given the responsibility of financial planning and record keeping of all the account.

Accounting staff - A staff accountant usually has a large amount of responsibility, as he or she is frequently the accountant for all of the departments of an office building. The staff accountant’s role is vital to the finances of a business, as there can be far-reaching financial problems without a competent accountant.

Sales and marketing manager - Accomplishes business development activities by researching and developing marketing opportunities and plans; implementing sales plans; managing staff.

Sales Executive - Builds business by identifying and selling prospects; maintaining relationships with clients.

Cashier – Responsible for taking money in the form of cash, check, or credit card from patrons in exchange for services or objects.

Receptionist – Responsible for handling front office reception and administrative duties, including greeting guest and offering them a beverage, answering phone, handling company inquiries and sorting and distributing mail.

Promoters – Responsible for promoting the features of a product to an audience or client. Shows how a product work, takes questions and attempts to persuade consumers or clients to buy the product.

Customer service officer – Responsible for acting as a liaison between customers and companies. Assist with complaints, orders, errors, account questions, billing, cancellations, and other queries.

Marketing executive - involved in developing marketing campaigns to promote a product, service or idea. It is a varied role that includes planning, advertising, public relations, event organization, product development, distribution, sponsorship and research.
Credit Analyst – Responsible for analyzing credit and financial reports to determine risk involved in loaning money or extending credit. Scrutinizes financial data such as market share, income growth and management quality to decide if loans will be lucrative.

Market Analyst – Responsible for performing research and providing insights regarding the market, trends, competitors, potential and existing customers and current campaigns.

Webmaster – Responsible for maintaining websites. Ensure sites are functioning properly and are available to users. Test speed of access and improves upon loading speed.

Quality control manager – ensure that the product or service an organization provides is fit for purpose, is consistent and meets both external and internal requirements. This includes legal compliance and customer expectations.

Quality assurance manager - Assures consistent quality of production by developing and enforcing good automated manufacturing practice (GAMP) systems; validating processes; providing documentation; managing staff.

R&D manager - lead a team of employees in conducting research and development for an organization. This may include investigating technology development, concept development, and new product development, among other areas. Many times, research and development teams work to improve an existing product or service. They identify areas for improvement and how any changes might be conducted. Research and development managers oversee this process and suggest recommendations to the organization's leaders.

Design Engineers – Responsible for researching and developing ideas and processes for new products. Improves upon the performance and design of existing products and oversee production and packaging of final product.

Planning officers - cover a wide range of fields including urban design, environmental issues, management, regeneration and development. Planning jobs require knowledge of legislation, environmental and social responsibilities and entail a very rewarding career.

Human resourced manager - Maintains and enhances the organization's human resources by planning, implementing, and evaluating employee relations and human resources policies, programs, and practices.

Recruitment officer - Achieves staffing objectives by recruiting and evaluating job candidates; advising managers; managing relocations and intern program.

Medical officer - otherwise known as health officer and health administrator who work for administering different aspects of health care center or hospital. He is responsible for providing quality services within the system or hospital.

Security officer - Maintains safe and secure environment for customers and employees by patrolling and monitoring premises and personnel.

HR secretary - Enhances effectiveness by providing information management support.
Production manager – Responsible for managing and directing production activities within an industrial facility or organization. Coordinates the production of goods, ensures machines are repaired and running smoothly and manages workers on the production line.

Engineering supervisors - To supervise workshop staff including daily workloads, routine maintenance, unplanned breakdowns and organizing holiday cover. Manage maintenance budget including cost control and production of monthly spend reports. Produce monthly reports including breakdown analysis and downtime.

Mechanical engineers – Designs mechanical and electromechanical products and systems by developing and testing specifications and methods.

Electrical engineers - Designs electrical systems by developing and testing components.

Machine Operation supervisor - Supervises and coordinates the work of employees who set up and operate machines. Prepares work schedules, assigns work, and oversees the work product. Ensures machine function and output is according to specifications.

Operators – Responsible for operating the machines

Logistics supervisor - Organize the storage and distribution of goods. In this role you would ensure the right products are delivered to the right location on time and at a good cost. You may be involved in transportation, stock control, warehousing and monitoring the flow of goods.

Surveyors - Make exact measurements and determine property boundaries. Provide data relevant to the shape, contour, gravitation, location, elevation, or dimension of land or land features on or near the earth’s surface for engineering, mapmaking, mining, land evaluation, construction, and other purposes.

Truck/lorry driver – Responsible for driving a lorry to deliver and pick up packages. Takes orders, intercepts package, and delivers to appropriate person.

Packaging staffs – Responsible for stacking and piling goods into their correct containers and preparing them for shipment using various equipment.
Ethics that will be Cultivated in the Company

Safety Ethics
As safety is paramount within a plant, below are the general ethics set to be cultivated within the company. These code of ethics will be exposed to any employee once they join the company.

1. Value for human life – The belief that preservation and protection of human life supersedes other goods.
2. Integrity – That the commitment to telling the truth and keeping promises, plus applying the best of one’s abilities, promise worker loyalty and commitment.
3. Justice – That a strong sense of fair dealing with employees establishes trust between leaders and their reports.
4. The good of the many – That excellence stems from a concern for the achievement of the common good (as opposed to what is good just for the individual person or company).
5. Excellence – The belief that whatever degree of safety or integrity we have achieved, we always have the opportunity to improve.

Engineering Ethics
The engineering ethics that will be cultivated will be in accordance to the American Society of Engineers. Below are the 7 general principles.

A whistleblower portal will be created within the Intranet of the company so that any employee can alert the Executive Board directly.

1. Engineers shall hold paramount the safety, health and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties.
2. Engineers shall perform services only in areas of their competence.
3. Engineers shall issue public statements only in an objective and truthful manner.
4. Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest.
5. Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others.
6. Engineers shall act in such a manner as to uphold and enhance the honor, integrity, and dignity of the engineering profession and shall act with zero-tolerance for bribery, fraud, and corruption.
7. Engineers shall continue their professional development throughout their careers, and shall provide opportunities for the professional development of those engineers under their supervision.
Price
This author has decided to provide information about the pricing of the business in the form of an infographics to entice investors. All the numbers in the infographic are backed-up with financial calculations presented in the form of tables at the following pages.

Minimize Chart Junk

100% ROI in 3 Years

10,000 units of share available
RM100 per unit share

The investment of the century. Tilt will be the most popular form of HPV of the century. Make a 100 percent return of investment in just three years.

South-East Asia
By 2017, over 20,000 Tilt will be sold throughout South-East Asia.
By 2025, Tilt will be the most popular form of HPV, bicycles will belong in the museum.
### Cost of Human Resource

<table>
<thead>
<tr>
<th>Position</th>
<th>Salary per month</th>
<th>Quantity</th>
<th>Subtotal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managing Director</td>
<td>12000</td>
<td>1</td>
<td>12000</td>
</tr>
<tr>
<td>Financial and Accounting Manager</td>
<td>7500</td>
<td>1</td>
<td>7500</td>
</tr>
<tr>
<td>Financial Officer</td>
<td>3500</td>
<td>1</td>
<td>3500</td>
</tr>
<tr>
<td>Legal Advisor</td>
<td>4500</td>
<td>1</td>
<td>4500</td>
</tr>
<tr>
<td>Accounting Officer</td>
<td>2000</td>
<td>1</td>
<td>2000</td>
</tr>
<tr>
<td>Accounting Staff</td>
<td>1700</td>
<td>1</td>
<td>1700</td>
</tr>
<tr>
<td>Sales and Marketing Manager</td>
<td>7000</td>
<td>1</td>
<td>7000</td>
</tr>
<tr>
<td>Sales Executive</td>
<td>3000</td>
<td>1</td>
<td>3000</td>
</tr>
<tr>
<td>Cashier</td>
<td>3000</td>
<td>1</td>
<td>3000</td>
</tr>
<tr>
<td>Receptionist</td>
<td>1700</td>
<td>1</td>
<td>1700</td>
</tr>
<tr>
<td>Promoters</td>
<td>1700</td>
<td>1</td>
<td>1700</td>
</tr>
<tr>
<td>Customer Service Officer</td>
<td>2000</td>
<td>1</td>
<td>2000</td>
</tr>
<tr>
<td>Marketing Executive</td>
<td>3500</td>
<td>1</td>
<td>3500</td>
</tr>
<tr>
<td>Credit Analyst</td>
<td>4000</td>
<td>1</td>
<td>4000</td>
</tr>
<tr>
<td>Market Analyst</td>
<td>4500</td>
<td>1</td>
<td>4500</td>
</tr>
<tr>
<td>Webmaster</td>
<td>3400</td>
<td>1</td>
<td>3400</td>
</tr>
<tr>
<td>Quality Control Manager</td>
<td>6300</td>
<td>1</td>
<td>6300</td>
</tr>
<tr>
<td>Quality Assurance Officer</td>
<td>3300</td>
<td>1</td>
<td>3300</td>
</tr>
<tr>
<td>Quality Control Staffs</td>
<td>2000</td>
<td>1</td>
<td>2000</td>
</tr>
<tr>
<td>R&amp;D Manager</td>
<td>7500</td>
<td>1</td>
<td>7500</td>
</tr>
<tr>
<td>Design Engineers</td>
<td>3600</td>
<td>1</td>
<td>3600</td>
</tr>
<tr>
<td>Planning Officers</td>
<td>2600</td>
<td>1</td>
<td>2600</td>
</tr>
<tr>
<td>Human Resource Manager</td>
<td>6000</td>
<td>1</td>
<td>6000</td>
</tr>
<tr>
<td>Recruitment Officer</td>
<td>5000</td>
<td>1</td>
<td>5000</td>
</tr>
<tr>
<td>Medical Officer</td>
<td>5000</td>
<td>1</td>
<td>5000</td>
</tr>
<tr>
<td>Security Officer</td>
<td>3000</td>
<td>3</td>
<td>9000</td>
</tr>
<tr>
<td>HR Secretary</td>
<td>2500</td>
<td>1</td>
<td>2500</td>
</tr>
<tr>
<td>Production Manager</td>
<td>8000</td>
<td>1</td>
<td>8000</td>
</tr>
<tr>
<td>Engineering Supervisor</td>
<td>3000</td>
<td>1</td>
<td>3000</td>
</tr>
<tr>
<td>Mechanical and Electrical Engineers</td>
<td>3000</td>
<td>6</td>
<td>18000</td>
</tr>
<tr>
<td>Engineering Staffs</td>
<td>2500</td>
<td>3</td>
<td>7500</td>
</tr>
<tr>
<td>Machine Operation Supervisor</td>
<td>5300</td>
<td>1</td>
<td>5300</td>
</tr>
<tr>
<td>Operators</td>
<td>2000</td>
<td>3</td>
<td>6000</td>
</tr>
<tr>
<td>Logistics Supervisor</td>
<td>2300</td>
<td>1</td>
<td>2300</td>
</tr>
<tr>
<td>Surveyors</td>
<td>3000</td>
<td>1</td>
<td>3000</td>
</tr>
<tr>
<td>Lorry Drivers</td>
<td>1700</td>
<td>2</td>
<td>3400</td>
</tr>
<tr>
<td>Packaging Staffs</td>
<td>1500</td>
<td>2</td>
<td>3000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>144100</strong></td>
<td><strong>50</strong></td>
<td><strong>177300</strong></td>
</tr>
</tbody>
</table>
Cost of Materials
Costs of materials are an estimate based on purchase in bulk. Prices are about 30% lesser than price if bought in 1 unit.

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Supplier</th>
<th>Price per unit (RM)</th>
<th>Quantity</th>
<th>Total (RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mountain Bike Rear Shock Absorber 750lbs</td>
<td>Shin Cheng, China</td>
<td>50</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Crank Set and Pedals</td>
<td>Shin Cheng, China</td>
<td>50</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>Shipping</td>
<td>China Post</td>
<td>100</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>20” Aluminium BMX Wheels</td>
<td>Speedwheelers, Malacca</td>
<td>40</td>
<td>4</td>
<td>160</td>
</tr>
<tr>
<td>5</td>
<td>Brake Caliper and Rotor</td>
<td>Speedwheelers, Malacca</td>
<td>40</td>
<td>2</td>
<td>80</td>
</tr>
<tr>
<td>6</td>
<td>Bolts &amp; Nuts</td>
<td>Local Hardware Supplier</td>
<td>30</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>7</td>
<td>Chain and guiding gears</td>
<td>Speedwheelers, Malacca</td>
<td>50</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>8</td>
<td>Mild-steel Rod</td>
<td>Local Hardware Supplier</td>
<td>30</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>600</td>
</tr>
</tbody>
</table>

Cost of Tools and Machines
As required in the production and processes.

<table>
<thead>
<tr>
<th>Tool or machine</th>
<th>Price, RM</th>
<th>Unit</th>
<th>Total Price, RM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutter</td>
<td>380</td>
<td>1</td>
<td>380</td>
</tr>
<tr>
<td>Circular Saw</td>
<td>390</td>
<td>1</td>
<td>390</td>
</tr>
<tr>
<td>CNC machine</td>
<td>60246</td>
<td>1</td>
<td>60246</td>
</tr>
<tr>
<td>Lathe Machine</td>
<td>6657</td>
<td>2</td>
<td>13314</td>
</tr>
<tr>
<td>Hand grinder</td>
<td>148</td>
<td>2</td>
<td>296</td>
</tr>
<tr>
<td>Bench grinder</td>
<td>170</td>
<td>1</td>
<td>170</td>
</tr>
<tr>
<td>Milling machine</td>
<td>1350</td>
<td>2</td>
<td>2700</td>
</tr>
<tr>
<td>Welder</td>
<td>900</td>
<td>2</td>
<td>1800</td>
</tr>
<tr>
<td>G-clamp</td>
<td>30</td>
<td>8</td>
<td>240</td>
</tr>
<tr>
<td>Tube bending machine</td>
<td>20000</td>
<td>1</td>
<td>20000</td>
</tr>
<tr>
<td>Air compressor</td>
<td>4300</td>
<td>2</td>
<td>8600</td>
</tr>
<tr>
<td>Air grinder</td>
<td>190</td>
<td>2</td>
<td>380</td>
</tr>
<tr>
<td>Paint sprayer</td>
<td>670</td>
<td>1</td>
<td>670</td>
</tr>
<tr>
<td>Total</td>
<td>109186</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Statement of Financial Position upon Initiation of Business

### Assets

<table>
<thead>
<tr>
<th>Non-Current Assets</th>
<th>RM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premise</td>
<td>263800</td>
</tr>
<tr>
<td>Equipment</td>
<td>109186</td>
</tr>
<tr>
<td>Lorry</td>
<td>600000</td>
</tr>
<tr>
<td><strong>Total Non-Current Assets</strong></td>
<td><strong>2747986</strong></td>
</tr>
</tbody>
</table>

### Current Assets

<table>
<thead>
<tr>
<th>Current Assets</th>
<th>RM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventories (materials required to build the first 100 HPVs)</td>
<td>50000</td>
</tr>
<tr>
<td>Retail and miscellaneous (cash to run the showroom, webpage)</td>
<td>1000</td>
</tr>
<tr>
<td>Logistics (fuel, toll, service for lorries)</td>
<td>10000</td>
</tr>
<tr>
<td>Administrative (4 months’ salary)</td>
<td>854000</td>
</tr>
<tr>
<td><strong>Total Current Assets</strong></td>
<td><strong>2752986</strong></td>
</tr>
</tbody>
</table>

### Equity and Liabilities

<table>
<thead>
<tr>
<th>Equity</th>
<th>RM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share Capital (10000 units, RM100 per unit)</td>
<td>1000000</td>
</tr>
<tr>
<td><strong>Total Equity</strong></td>
<td><strong>1000000</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-current liabilities</th>
<th>RM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-term borrowings (1 million from investors, remainder from the bank, loaned for a duration of 10 years)</td>
<td><strong>1798986</strong></td>
</tr>
<tr>
<td><strong>Total liabilities</strong></td>
<td><strong>1798986</strong></td>
</tr>
<tr>
<td><strong>Total equity and liabilities</strong></td>
<td><strong>2798986</strong></td>
</tr>
</tbody>
</table>
Cost Analysis

The retail price of 1 unit HPV is adjusted to make a net-profit of RM1 million, equivalent to 100% (RM100) profit per unit share, in the period of 3 years

<table>
<thead>
<tr>
<th>Net Profit</th>
<th>1000000</th>
</tr>
</thead>
</table>

**Expenditure**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Human Resources in 3 years including 5% per year increment</td>
<td>6707259</td>
</tr>
<tr>
<td>Depreciation of Non-Current Assets (excluding premise) in 3 years, calculated in linear 10%.</td>
<td>212755.8</td>
</tr>
<tr>
<td>Bank loan to be paid for 3 years, with 10% per year interest</td>
<td>576388.2</td>
</tr>
<tr>
<td>Overhead (estimated RM1000 per month)</td>
<td>36000</td>
</tr>
<tr>
<td>Logistics (fuel, toll, service for lorries, RM2000 per month)</td>
<td>72000</td>
</tr>
<tr>
<td>Cost of Materials</td>
<td>12000000</td>
</tr>
</tbody>
</table>

**Gross Profit**

| 20604403 |

**Retail Pricing**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Materials for 1 unit</td>
<td>600</td>
</tr>
<tr>
<td>Markup (percent)</td>
<td>45</td>
</tr>
<tr>
<td>Retail Price</td>
<td>870</td>
</tr>
</tbody>
</table>

| Number of to be HPVs Sold (including net profit) | 23683 |
| Number of to be HPVs Sold (to breakeven)        | 8741  |
### Sales Targets

**Sales Target to profit 100%**
Sales are expected to increase at a steady rate of 15% per quarter for the first year, 10% per quarter for the second year, 5 percent per quarter for the third year.

<table>
<thead>
<tr>
<th>First Year</th>
<th>Second Year</th>
<th>Third Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial sales (sales in first quarter)</td>
<td>1037</td>
<td>1735</td>
</tr>
<tr>
<td>2nd quarter</td>
<td>1193</td>
<td>1909</td>
</tr>
<tr>
<td>3rd quarter</td>
<td>1372</td>
<td>2099</td>
</tr>
<tr>
<td>4th quarter</td>
<td>1577</td>
<td>2309</td>
</tr>
<tr>
<td>1st quarter</td>
<td>1735</td>
<td>2425</td>
</tr>
<tr>
<td>2nd quarter</td>
<td>1909</td>
<td>2546</td>
</tr>
<tr>
<td>3rd quarter</td>
<td>2099</td>
<td>2673</td>
</tr>
<tr>
<td>4th quarter</td>
<td>2309</td>
<td>2807</td>
</tr>
<tr>
<td>Total</td>
<td>23683</td>
<td>Total 8741</td>
</tr>
</tbody>
</table>

**Sales Target to Breakeven**
Sales are expected to increase at a steady rate of 15% per quarter for the first year, 10% per quarter for the second year, 5 percent per quarter for the third year.

<table>
<thead>
<tr>
<th>First Year</th>
<th>Second Year</th>
<th>Third Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial sales (sales in first quarter)</td>
<td>383</td>
<td>640</td>
</tr>
<tr>
<td>2nd quarter</td>
<td>440</td>
<td>704</td>
</tr>
<tr>
<td>3rd quarter</td>
<td>506</td>
<td>775</td>
</tr>
<tr>
<td>4th quarter</td>
<td>582</td>
<td>852</td>
</tr>
<tr>
<td>1st quarter</td>
<td>383</td>
<td>895</td>
</tr>
<tr>
<td>2nd quarter</td>
<td>440</td>
<td>940</td>
</tr>
<tr>
<td>3rd quarter</td>
<td>506</td>
<td>987</td>
</tr>
<tr>
<td>4th quarter</td>
<td>582</td>
<td>1036</td>
</tr>
<tr>
<td>Total</td>
<td>Total 8741</td>
<td>8741</td>
</tr>
</tbody>
</table>
Promotion
This section of the report is dedicated to explain the marketing ideas that the team has to make Tilt the most popular HPV in South-East Asia within a decade.

Tilt-Store
The Tilt-Store is an online portal, similar to the Apple iStore. At the Tilt-Store, all Tilt products and services, as well as the latest promotions are listed in the most attractive manner. On top of that, the Tilt-Store integrates services such as warranty and technical support for users to access easily.

In order to foster a fan-based community, the Tilt-Store also integrates an easy to use forum for technical and non-technical discussions about Tilt. In this company, the online fan-based community is highly valued as they carry out indirect marketing for the company when they talk about the product in social media, the media that penetrates through almost 100% of urban youths.

The Tilt-Store will integrate itself with social media websites such as Pinterest, YouTube and Instagram. Viral marketing videos will be posted every now and then to attract potential buyers. The involvement of the fan-based community will also be rewarded with Tilt-Lifestyle merchandises.

The Tilting Lifestyle
Besides an online community, the company have plans to form real life communities in the region. High schools will be visited so to form local riding communities. In these communities, Tilt riders will get the chance to gather and ride their Tilt together.

Instead of depending on HPV events organized by third parties, attempting to spend money to advertise at those event, Tilt-Races will be organized depending on the popularity of Tilt in the region. The company will garner sponsorships for the event in order for the events to be commercialized, providing side-income for the company.

The Tilting-Lifestyle will also be introduced to sports councils and communities to encourage more people to join in.

Tilt-Retail
Finally, Tilt-Retail will be the retail store that is set-up by independent business owners. In order to ensure that all Tilt-Retail stores will maintain the Tilt brand image, retail stores will be set-up in the supervision of a Tilt marketing employee.
Areas of Improvement

**Tilt Trim-lines**
Instead of having only one HPV variant, several trim lines can be designed. For example, different grades of materials can be used for the chassis of the HPV that is aluminum 6061 alloy, or even carbon fiber.

**Tilt-Accessories**
Add-on parts and components can be designed for separate selling. This can cater to customers who would like to have Tilt customized to their needs. For example, a body (fairing) can be an add-on option to the HPV.

**More Promotional Activities**
The promotional activities can be better developed and explored. An actual website can be built to gauge its efficacy.

**Alternative Funding**
Alternative funding is not explored within the business plan. Crowdfunding can be utilized to obtain to finance RnD, testing and prototyping. Thus, perhaps a business plan to garner sponsorships instead of setting up business to sell HPVs would be more practical.

**Time and Flow**
More time should be allowed for the conceptualizing, designing and planning in order for a more in-depth, detailed, report. For example, the business plan can be explored further into more than just 6 aspects.

I suggest that the business plan should be the key element in the *Interim Report* instead of the Final Report. This means that students will be deciding upon what kind of target market they are designing their HPV for, thus making their design more objective orientated. The business plan also integrates well with other elements of the Interim Report, such as brainstorming and decision matrix. For example, the brainstorming can have a better scope when the target market is defined beforehand, and the decision matrix will have a better outcome with the target markets’ needs in mind.
Conclusion and Recommendation

The objectives of this semester, which are to conceive and design an HPV to meet the challenge given, at the same time come up with a business plan for it, were met.

Looking back at the objectives set at the beginning, the HPV that is designed, Tilt, has to outperform the most conventional HPV of today, which is the bicycle in all aspects, within a range of 50km. We are confident that Tilt can outperform the bicycle in the aspects of cost, safety, user friendliness, sustainability and endurance. At the same time, Tilt will definitely be more sustainable as compared to other forms of vehicles such as the combustion engine and electric vehicles in the said range of travel. The team’s engineering know-how such as structural analysis, ergonomics and dynamics has been proven in the conceptualization and designing. I look forward to the next semester, in which we will implement and operate the project itself. We will have the chance to put what we have planned in the design phase into reality.

Then, the business objectives for the project to make the team’s HPV the most popular form of HPV in South-East Asia within a decade has been crafted out successfully. Self-assessing the business plan, we are confident that the business will succeed if the plans were put into action by investors.

I will like to take the chance to express that innovation is only worthwhile if it brings forth value. The HPV designed by any team should at least outperform the bicycle at the given challenge. This task is not easy as an extensive amount of engineering knowledge is required, but where’s the fun if there’s no challenge in the first place?
## Project Expenditure

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Supplier</th>
<th>Price per unit (RM)</th>
<th>Quantity</th>
<th>Total (RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mountain Bike Rear Shock Absorber 750lbs</td>
<td>ebay China</td>
<td>30</td>
<td>2</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>Shipping for shock absorber</td>
<td>China Post</td>
<td>26</td>
<td>1</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td>20&quot; Aluminium BMX Wheels</td>
<td>Wansin Fook Trading</td>
<td>95</td>
<td>2</td>
<td>190</td>
</tr>
<tr>
<td>4</td>
<td>Brake Caliper and Rotor</td>
<td>Wansin Fook Trading</td>
<td>68</td>
<td>2</td>
<td>136</td>
</tr>
<tr>
<td>5</td>
<td>Gear</td>
<td>Wansin Fook Trading</td>
<td>13</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td><strong>Grand Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>RM425.00</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Supplier</th>
<th>Price per unit (RM)</th>
<th>Quantity</th>
<th>Total (RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cardboard</td>
<td>Popular Bookstores</td>
<td>8.90</td>
<td>4</td>
<td>35.6</td>
</tr>
<tr>
<td>2</td>
<td>Tape</td>
<td>Popular Bookstores</td>
<td>7.90</td>
<td>1</td>
<td>7.9</td>
</tr>
<tr>
<td>3</td>
<td>Buncho Paint</td>
<td>Popular Bookstores</td>
<td>18.90</td>
<td>1</td>
<td>18.9</td>
</tr>
<tr>
<td>4</td>
<td>Paint brush and pallet</td>
<td>Popular Bookstores</td>
<td>4.90</td>
<td>2</td>
<td>9.8</td>
</tr>
<tr>
<td></td>
<td><strong>Grand Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>RM72.20</strong></td>
</tr>
</tbody>
</table>
Table of Figures

Figure 1: Fish Bone Diagram ........................................................................................................ 5
Figure 2: List of Ideas .................................................................................................................... 7
Figure 3: Weightage of the selected ideas .................................................................................. 7
Figure 4: Decision matrix ............................................................................................................ 8
Figure 5: Decision Matrix ........................................................................................................... 9
Figure 6: 95th percentile male sketch ....................................................................................... 0
Figure 7: Wheelbase sketch ........................................................................................................ 1
Figure 8: chassis sketch ............................................................................................................... 1
Figure 9: Important Geometries ................................................................................................. 2
Figure 10: HPV with Mock Seats and Rider ............................................................................... 2
Figure 11: Lateral weight transfer .............................................................................................. 3
Figure 12: HPV tipping over ....................................................................................................... 3
Figure 13: Position of Centre of Gravity (CoG) when tilting ..................................................... 4
Figure 14: Tilting trikes can corner at higher speeds................................................................. 4
Figure 15: Recumbent seating position compared with upright position .................................. 5
Figure 16: Three-Wheeler Weight Distribution ......................................................................... 6
Figure 17: Tire Performance Curve ............................................................................................ 6
Figure 18: Standard Views of the Suspension CAD Design ...................................................... 0
Figure 19: A model displaying “elements”, “nodes” and “mesh” (Esfand, 2013) ...................... 1
Figure 20: Deflection of suspension components when load is applied (Asad, 2011) ............ 1
Figure 21: Hand-Calculations for FEA ...................................................................................... 2
Figure 22: Upright FEA Results .................................................................................................. 3
Figure 23: Suspension Arms FEA Results .................................................................................. 4
Figure 24: Rod-End Bearing FEA Results ............................................................................... 5
Figure 25: Rod-End Bearing Table ............................................................................................ 6
Figure 26: Rear Shock Absorber Calculation and Design ......................................................... 7
Figure 27: Tilt, the HPV .............................................................................................................. 8
Figure 28: Site Map and Location .............................................................................................. 10
Figure 29: Plant Design .............................................................................................................. 10
Figure 30: Manufacturing Flow Chart ....................................................................................... 13
Figure 31: CKD Packaging ......................................................................................................... 18
Figure 32: Sound Proofed Wall .................................................................................................. 19
Figure 33: Example of an Evacuation Diagram ........................................................................ 20
References


<table>
<thead>
<tr>
<th>Subject</th>
<th>Business Skills for Engineer</th>
<th>Subject Code</th>
<th>ENG3413</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester/year</td>
<td>6/3</td>
<td>Date Prepared</td>
<td>March 2014</td>
</tr>
<tr>
<td>Lecturer</td>
<td>Prof. Dr. Mushtak Al-Atabi (Mechanical Engineering)</td>
<td>Credit Hours</td>
<td>Three (3)</td>
</tr>
<tr>
<td>Period</td>
<td>March – July 2014</td>
<td>Date(s) of Revision</td>
<td>N/A</td>
</tr>
<tr>
<td>Subject Synopsis</td>
<td>Covers the engineering and management and business environment, including the financial and legal aspects of doing business and E-Commerce.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact hours</td>
<td>Lecture : 2 hours per week; Tutorial : 2 hours per week</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluation</td>
<td>50% Continuous Assessment; 50% Final Exam (Hurdle*)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Hurdle is defined as follows</td>
<td>For modules which don’t have 100% continuous assessment and consist of a final exam component, a student enrolled in such a module would need to satisfy two conditions to progress on from the module.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. The final exam mark must be equal to or more than 50%.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. The overall assessment mark must be equal to or more than 50%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning Outcomes</td>
<td>On completion of this subject, students will be able to:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Describe the key factors in organizing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Explain the importance of meeting customer needs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Explain the importance of effective resources management</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Exemplify the widening job description of a professional engineer</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Explain the importance of human resource management</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Appraise the prospects of E-commerce projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assessment Methods</td>
<td>Distribution (%)</td>
<td>LO 1</td>
<td>LO 2</td>
</tr>
<tr>
<td>Quiz</td>
<td>10</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Online Activities</td>
<td>4</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Project Selection</td>
<td>10</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Team Formation</td>
<td>10</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Entrepreneurial Eco System</td>
<td>1</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Crowd Funding Campaign</td>
<td>15</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Final Exam</td>
<td>50</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Learning References

Additional References
**Program Outcomes (Chemical Engineering)**

| PO1 | Apply the knowledge of mathematics, science, engineering practices, innovation techniques, entrepreneurship and human factors to provide value-adding solutions to complex Chemical Engineering challenges. |
| PO2 | Identify, formulate, analyse and document complex engineering challenges to arrive at viable solutions and substantiated conclusions. |
| PO3 | Conceive, Design, Implement and Operate solutions for complex engineering challenges that meet specified requirements with appropriate consideration for public health and safety, cultural, societal, environmental and economical considerations. |
| PO4 | Conduct research and investigation into complex challenges using methods which include experiment design, analysis of data and synthesis of information to provide valid conclusions. |
| PO5 | Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an awareness of the accompanying assumptions and limitations. |
| PO6 | Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, economical and cultural issues and the consequent responsibilities relevant to professional engineering practice. |
| PO7 | Explain the global impact of professional engineering solutions in societal, economical and environmental contexts and demonstrate knowledge of and need for sustainable development. |
| PO8 | Apply professional and ethical responsibilities of engineering practice. |
| PO9 | Effectively communicate complex engineering activities, both orally and in a written form, in both technical & non-technical contexts. |
| PO10 | Function effectively as an individual and in multidisciplinary settings with the capacity to be a leader. |
| PO11 | Recognise the importance of lifelong learning and engaging in continuous professional development activities in accordance with technological change. |
| PO12 | Effectively manage projects in multidisciplinary environments and apply project management tools and techniques to one’s own work, as a member and leader in a team to satisfy stakeholders requirements. |

**Program Outcomes (Electrical and Electronic Engineering)**

| PO1 | Apply the knowledge of mathematics, science, engineering practices, innovation techniques, entrepreneurship and human factors to provide value-adding solutions to complex Electrical and Electronic Engineering challenges. |
| PO2 | Identify, formulate, analyse and document complex engineering challenges to arrive at viable solutions and substantiated conclusions. |
| PO3 | Conceive, Design, Implement and Operate solutions for complex engineering challenges that meet specified requirements with appropriate consideration for public health and safety, cultural, societal, environmental and economical considerations. |
| PO4 | Conduct research and investigation into complex challenges using methods which include experiment design, analysis of data and synthesis of information to provide valid conclusions. |
| PO5 | Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an awareness of the accompanying assumptions and limitations. |
| PO6 | Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, economical and cultural issues and the consequent responsibilities relevant to professional engineering practice. |
| PO7 | Explain the global impact of professional engineering solutions in societal, economical and environmental contexts and demonstrate knowledge of and need for sustainable development. |
| PO8 | Apply professional and ethical responsibilities of engineering practice. |
| PO9 | Effectively communicate complex engineering activities, both orally and in a written form, in both technical & non-technical contexts. |
| PO10 | Function effectively as an individual and in multidisciplinary settings with the capacity to be a leader. |
| PO11 | Recognise the importance of lifelong learning and engaging in continuous professional development activities in accordance with technological change. |
| PO12 | Effectively manage projects in multidisciplinary environments and apply project management tools and techniques to one’s own work, as a member and leader in a team to satisfy stakeholders requirements. |
## Program Outcomes (Mechanical Engineering)

<table>
<thead>
<tr>
<th>PO1</th>
<th>Apply the knowledge of mathematics, science, engineering practices, innovation techniques, entrepreneurship and human factors to provide value-adding solutions to complex Mechanical Engineering challenges.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PO2</td>
<td>Identify, formulate, analyse and document complex engineering challenges to arrive at viable solutions and substantiated conclusions.</td>
</tr>
<tr>
<td>PO3</td>
<td>Conceive, Design, Implement and Operate solutions for complex engineering challenges that meet specified requirements with appropriate consideration for public health and safety, cultural, societal, environmental and economical considerations.</td>
</tr>
<tr>
<td>PO4</td>
<td>Conduct research and investigation into complex challenges using methods which include experiment design, analysis of data and synthesis of information to provide valid conclusions.</td>
</tr>
<tr>
<td>PO5</td>
<td>Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an awareness of the accompanying assumptions and limitations.</td>
</tr>
<tr>
<td>PO6</td>
<td>Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, economical and cultural issues and the consequent responsibilities relevant to professional engineering practice.</td>
</tr>
<tr>
<td>PO7</td>
<td>Explain the global impact of professional engineering solutions in societal, economical and environmental contexts and demonstrate knowledge of and need for sustainable development.</td>
</tr>
<tr>
<td>PO8</td>
<td>Apply professional and ethical responsibilities of engineering practice.</td>
</tr>
<tr>
<td>PO9</td>
<td>Effectively communicate complex engineering activities, both orally and in a written form, in both technical &amp; non-technical contexts.</td>
</tr>
<tr>
<td>PO10</td>
<td>Function effectively as an individual and in multidisciplinary settings with the capacity to be a leader.</td>
</tr>
<tr>
<td>PO11</td>
<td>Recognise the importance of lifelong learning and engaging in continuous professional development activities in accordance with technological change.</td>
</tr>
<tr>
<td>PO12</td>
<td>Effectively manage projects in multidisciplinary environments and apply project management tools and techniques to one’s own work, as a member and leader in a team to satisfy stakeholders requirements.</td>
</tr>
</tbody>
</table>
### Weekly plan:

<table>
<thead>
<tr>
<th>No</th>
<th>Topic</th>
<th>Week/Date</th>
<th>Contents</th>
<th>LO</th>
<th>PO</th>
<th>Delivery Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction: Why Entrepreneurship?</td>
<td>25 &amp; 28 March</td>
<td>Module structure, Assessment and Learning Outcomes. Entrepreneurship is the art of making the world a better place, through orchestrating various resources with the intention of creating value and enriching life. Entrepreneurship represents a set of skills that can be utilised by anyone to enhance the quality of life in both for-profit and not-for-profit contexts. In this course you will work on a real-life project, together with your on-campus and online colleagues with the intention of realising opportunities and adding value. A cornerstone of this course is fund raising using crowd funding techniques. This lecture introduces the course, outlining the philosophy and the expectations.</td>
<td>4</td>
<td>6</td>
<td>Lecture/Tutorial</td>
</tr>
<tr>
<td>2</td>
<td>Entrepreneurship, Learning Language and the Brain</td>
<td>1 &amp; 4 April</td>
<td>Entrepreneurs are positive people who see opportunities where others see challenges. They do not stop at recognising the opportunity, they are willing to work hard and take risk to convert the opportunity into a real value. This lecture builds on the materials presented in the previous lecture and introducing Entrepreneurship as a frame of mind that can be learned and nurtured. Through the use of the right language and the correct technique, we can build myelin around rewire our brains to be highly effective entrepreneurs able to recognise opportunity and deliver value and make a difference in the world.</td>
<td>1,2,3,4</td>
<td>5</td>
<td>3,10, 12 Lecture/Tutorial</td>
</tr>
<tr>
<td>3</td>
<td>Crowd Funding</td>
<td>8 April</td>
<td>The 21st Century is the Century of entrepreneurs. It is for the first time in the history of humankind where technology enables and empowers every individual to be integrated into the global value network and compete with the big players. You can buy, sell and accept credit cards working from your garage, a feat that was considered impossible a decade or so ago. Technology enables the masses to organise themselves and work together towards a common cause. This lecture will introduce the</td>
<td>6</td>
<td>6</td>
<td>Lecture/Tutorial External Speaker from Pozible- Adrianna Tan</td>
</tr>
</tbody>
</table>
basics of crowd funding so that you can run a successful crowd funding campaign for your project. The lecture is delivered by Adrianna Tan from Pozible.com the crowd funding platform that we are collaborating with on this course.

4 Think Like an Entrepreneur 11 April
Thinking is a skill that can be developed and honed. In CDIO approach to entrepreneurship, thinking is the first step. It is the stage at which a challenge or an obstacle is transformed into an opportunity preparing the background to develop and deliver the value to the customer. In this lecture, we discuss a number of techniques that can improve thinking individually and in teams. The lecture explored brainstorming, trimming, random entry and blue ocean strategy techniques.

5 Vodafail: The Importance of Meeting Customer Needs 15 April
In this lecture, Adam Brimo, the CEO and cofounder of Open Learning shares his experiences as unhappy customer of Vodafone. He created a website vodafail.com on which thousands of customers reported their dissatisfaction. This led to class action case against Vodafone in Australia forcing the company to invest 1 billion Dollars to upgrade the service.

6 Branding: Brand Focused Merketers- BFM Brand Journey 18 April
Freda Lui from BFM (Business FM) shares with us strategies to brand and differentiate a business. Focusing on her experience BFM, she takes us on her personal journey on how she left the security of working for IBM to join the new adventure with BFM radio.

7 Entrepreneurship and Nation Building: Entrepreneurship in Malaysian Higher Education Sector 22 April
The Ministry of Education in Malaysia has an ambitious vision of developing entrepreneurial graduates. Datin Dr Syhira Hamidon, the Head of Entrepreneurship at the Ministry shares with us her views on how to achieve this goal.

8 Entrepreneurial Eco System 25 April
Entrepreneurs create products and services that we need and desire to have. These products and services make life easier, safer and more enjoyable. They affect the way work, study and play. Entrepreneurs achieve this through creating a balance between what is technologically feasible, economically viable and humanly desirable. The value is created and delivered to customers and funders.
<table>
<thead>
<tr>
<th>Week</th>
<th>Title</th>
<th>Date</th>
<th>Description</th>
<th>Days</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Build and Entrepreneurial Dream team</td>
<td>29 April</td>
<td>An Entrepreneurs’ goal is not fix all their weaknesses, but rather to amplify their strengths and surround themselves with people who can complement them. Building a successful team is a highly important skill and in this lecture you will learn the basics of building effective teams that will work towards having the core competencies necessary to deliver the promised value to the stakeholders.</td>
<td>5, 10</td>
<td>Lecture/ Tutorial</td>
</tr>
<tr>
<td>10</td>
<td>Social Entrepreneurship: What I learnt on the Way to the Toilet</td>
<td>2 May</td>
<td>Mr Jack Sim, founder of the World Toilet Organisation, shares with us his experiences and life lessons in this amusing, entertaining and engaging talk.</td>
<td>4, 6</td>
<td>Guest Speaker Jack Sim WTO</td>
</tr>
<tr>
<td>11</td>
<td>Project Feedback</td>
<td>6 May</td>
<td>A crowd funding expert is giving feedback on the quality of projects.</td>
<td>6, 6</td>
<td>Tutorial</td>
</tr>
<tr>
<td>12</td>
<td>Communicate Like an Entrepreneur</td>
<td>9 May</td>
<td>Business is all about people. Whether your staff, customers, investors or the governmental officials, you will need to communicate, communicate and communicate. This lecture will provide you with a framework for an effective communication that can use not only in business context, but also in your life at large.</td>
<td>2, 3, 4, 5, 6, 10, 12</td>
<td>Lecture</td>
</tr>
<tr>
<td>13</td>
<td>Entrepreneurship and Engineering: Building a Globally Competitive Engineering Services Business</td>
<td>16 May</td>
<td>Naguib Mohd Nor, the Founder and CEO of Strand Aerospace (Malaysia) speaks on building a globally competitive engineering services business. In his down to earth and engaging style, Naguib provides an account of the journey thus far of Strand Aerospace Malaysia, Malaysia’s leading aerospace engineering services company.</td>
<td>2, 3, 4, 5, 6, 10, 12</td>
<td>Guest Speaker Naguib Mohd Nor Strand</td>
</tr>
<tr>
<td>14</td>
<td>Business Plan</td>
<td>27 May</td>
<td>Business plans are how entrepreneurs communicate their ideas and plans of new ventures. A business plan is a document that outlines the venture’s potential including the business value, the customers’ segments, the resources needed and the expected profit.</td>
<td>1, 2, 3, 4, 5, 6, 10, 12</td>
<td>Lecture</td>
</tr>
</tbody>
</table>
| 15   | Behind the Scenes of Entrepreneurship: Challenges Faced by Entrepreneurs | 30 May | While Entrepreneurship is associated with changing the world in great ways, Entrepreneurs are often faced with difficult decisions to make, not to mention the long working hours. | 1, 2, 3, 5, 10, 12| Guest Speaker Paul Kids at SWiTCHE
<p>| 16 | <strong>Women Technopreneurs: Starting from the Ground Up</strong> | 3 June | Fu Ching Yee shares her entrepreneurial experience and the importance of inclusiveness and responsiveness to markets and customers needs. | 1,2,3,4,5,10,12 | Guest Speaker Fu Ching Yee, CEO Tricor Senedi |
| 17 | <strong>Market and Marketing</strong> | 6 June | This lecture discusses how to market a product or a service effectively as well as how to segment a market and how to penetrate new markets. | 1,2,3,4,5,6,10,12 | Lecture |
| 18 | <strong>Crowdsourcing</strong> | 10 June | Sam Shafie will discuss various aspects related to crowdsourcing and crowd funding drawing on his experience as a founder of PitchIn. | 1,2,3,4,5,6,10,12 | Guest Speaker Sam Shafie |
| 19 | <strong>Money in the Organisation</strong> | 13 June | This lecture will discuss various terminologies and concepts related to managing money within a business | 3,12 | Lecture |
| 20 | <strong>EPIC Homes</strong> | 17 June | Johnson Oei a Taylor’s alumnus shares his experience building homes for the needy | 4,6 | Guest Speaker Johnson Oei CEO EPIC |
| 21 | <strong>Return on Failure</strong> | 20 June | The lecture discusses the importance of failure as a pre-requisite for success. | 2,3 | Lecture |
| 22 | <strong>Project feedback and Revision</strong> | 24 June | We will work in a tutorial style to review what we have done and give feedback on the projects. | 6,6 | Tutorial |
| 23 | <strong>Entrepreneurship, Innovation and Social Change</strong> | 27 June | Kal will speak on his experiences as a social entrepreneur. | 4,6 | Guest Speaker Kal Joffers |
| 24 | <strong>Closure, Revision and Discussion</strong> | 1 July | A final discussion and feedback | 1,2,3,4,5,6,10,12 | Tutorial |</p>
<table>
<thead>
<tr>
<th>Assessment Details</th>
<th>Type</th>
<th>Details</th>
<th>Learning Domain</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quiz</td>
<td>Individual</td>
<td>Cognitive</td>
<td>10 %</td>
</tr>
<tr>
<td></td>
<td>Online Activities</td>
<td>Individual</td>
<td>Cognitive, Affective</td>
<td>4 %</td>
</tr>
<tr>
<td></td>
<td>Project Selection</td>
<td>Individual</td>
<td>Cognitive</td>
<td>10 %</td>
</tr>
<tr>
<td></td>
<td>Team Formation</td>
<td>Individual</td>
<td>Affective</td>
<td>10 %</td>
</tr>
<tr>
<td></td>
<td>Entrepreneurial Eco System</td>
<td>Individual</td>
<td>Cognitive</td>
<td>1 %</td>
</tr>
<tr>
<td></td>
<td>Crowd Funding Campaign</td>
<td>Individual</td>
<td>Affective</td>
<td>15 %</td>
</tr>
<tr>
<td></td>
<td>Final Exam</td>
<td>Individual</td>
<td>Cognitive</td>
<td>50 %</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td>100 %</td>
</tr>
</tbody>
</table>

### Assessment schedule:

<table>
<thead>
<tr>
<th>Assessment Methods</th>
<th>Week No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Quiz</td>
<td>X</td>
</tr>
<tr>
<td>Online Activities</td>
<td></td>
</tr>
<tr>
<td>Project Selection</td>
<td>X</td>
</tr>
<tr>
<td>Team Formation</td>
<td></td>
</tr>
<tr>
<td>Entrepreneurial Eco System</td>
<td></td>
</tr>
<tr>
<td>Crowd Funding Campaign</td>
<td></td>
</tr>
</tbody>
</table>

### LO-PO mapping:

<table>
<thead>
<tr>
<th>Programme Outcomes (POs)</th>
<th>PO 1</th>
<th>PO 2</th>
<th>PO 3</th>
<th>PO 4</th>
<th>PO 5</th>
<th>PO 6</th>
<th>PO 7</th>
<th>PO 8</th>
<th>PO 9</th>
<th>PO 10</th>
<th>PO 11</th>
<th>PO 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO 2</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO 3</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO 4</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO 5</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prepared By: Prof. Dr. Mushtak Al-Atabi

Checked & Approved By: (Program Director for CE / EE / ME)

Date:

Remarks:
1. The above plan is to be passed to the students on the first week of the Semester.
2. Any changes to the above plan shall be communicated (in writing) to the Program Director and all approved updated versions to be communicated to students.
<table>
<thead>
<tr>
<th>Assessments</th>
<th>Marks</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online progress (5%)</td>
<td>1m</td>
<td>Presentable profile picture of yourself</td>
</tr>
<tr>
<td></td>
<td>1m</td>
<td>Consistent Brain rewiring throughout the semester</td>
</tr>
<tr>
<td></td>
<td>2m</td>
<td>Percentage of Online Progress (Open Learning)</td>
</tr>
<tr>
<td></td>
<td>1m</td>
<td>Submission of Complete Ecosystem Assignment</td>
</tr>
<tr>
<td>Project selection (10%)</td>
<td>3m</td>
<td>Well-defined and differentiated value proposition targeting the correct customers’ segments</td>
</tr>
<tr>
<td>Module 3: Let’s Talk Crowd Funding</td>
<td>1m</td>
<td>Timeline: Realistic timeline. Campaign to end by 4 July, project value to be delivered by Nov 2014</td>
</tr>
<tr>
<td>Activity: Your Project</td>
<td>1m</td>
<td>Pozible Category: Correct categorization</td>
</tr>
<tr>
<td>Link: <a href="https://www.openlearning.com/courses/GlobalEntrepreneurship/Activities/YourProject/">https://www.openlearning.com/courses/GlobalEntrepreneurship/Activities/YourProject/</a></td>
<td></td>
<td>1. Your project should be within a category that is supported by Pozible.com</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. You need to correctly categorize your project</td>
</tr>
<tr>
<td></td>
<td>2m</td>
<td>Identify Top 3 Successful Projects (existing on Pozible within your category). Discuss the reasons for their success. This is intended for you to learn from the success of similar projects.</td>
</tr>
<tr>
<td></td>
<td>3m</td>
<td>State how do you plan to use similar strategies in your campaign to achieve success</td>
</tr>
<tr>
<td>Team formation (10%)</td>
<td>3m</td>
<td>Well-defined core competency which will help deliver the value proposition. Clearly connect the Core Competencies to the Value Proposition</td>
</tr>
<tr>
<td>Module 9: Building an Entrepreneurial Dream Team</td>
<td>4m</td>
<td>Well-defined roles, skills, attributes related to the project and delivering the value</td>
</tr>
<tr>
<td>Activity: Forming Your Team</td>
<td>3m</td>
<td>Three candidates (from the online community) and recruitment plan. Clearly state the basis on which you identified these individuals (how do you know they possess the required Skills and Attributes needed to develop the Core Competencies of your team)</td>
</tr>
<tr>
<td>Link: <a href="https://www.openlearning.com/courses/GlobalEntrepreneurship/Activities/FormingYourTeam">https://www.openlearning.com/courses/GlobalEntrepreneurship/Activities/FormingYourTeam</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campaign (15%)</td>
<td>1m</td>
<td>Identify the targeted customers and clearly and specifically state how will you reach them. For example: Target Customers: parents of autistic children below the age of 3. Where are they: Database of the ministry of health.</td>
</tr>
<tr>
<td>Module 3: Let’s Talk Crowd Funding</td>
<td>3m</td>
<td>Story of/behind the campaign, how the funds would be used, what are the challenges</td>
</tr>
<tr>
<td>Activity: Your Crowd Funding Campaign</td>
<td>1m</td>
<td>Clearly stating pictures/videos to be used in the project</td>
</tr>
<tr>
<td>Link: <a href="https://www.openlearning.com/courses/GlobalEntrepreneurship/Activities/YourCrowdFundingCampaign">https://www.openlearning.com/courses/GlobalEntrepreneurship/Activities/YourCrowdFundingCampaign</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1m</td>
<td>Suitable rewards for pledges received. The rewards should be directly connected to how the markets is segmented.</td>
</tr>
<tr>
<td>Module 3: Let’s Talk Crowd Funding</td>
<td>1m</td>
<td>Suitable target of campaign</td>
</tr>
<tr>
<td>Activity: Your Crowd Funding Campaign on Pozible</td>
<td>8m</td>
<td>High quality Pozible campaign</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Impactful and original video.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inspirational Language and error free English</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Attractive, innovative and differentiated rewards</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clear Strategy of how to market the campaign and drive traffic to the Pozible page</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Effective implementation of the marketing strategy</td>
</tr>
</tbody>
</table>
### Subject
Engineering Design & Innovations

### Subject Code
ENG2523

### Semester/year
4/2

### Date Prepared
07/02/2014

### Lecturer
Lim Chin Hong

### Credit Hours
3

### Period
24th March 2014 – 28th July 2014

### Subject Synopsis
This module equips engineering students with innovation techniques such as design thinking and TRIZ, sharpening their innovation skills. This will empower them to develop financially and economically sustainable solutions and enable them to play a key technical and economic role in activities ranging from creating jobs to addressing the Grand Challenges of the 21st Century.

### Contact hours
Lectures: 1 hour per week
Workshop: 1 hours per week (average)
Coursework project: 4.5 hours per week (average)

### Learning outcomes
On successful completion of this subject, students will be able to:
1. Identify a complex engineering challenge that has Business Value (C).
2. Design a system, with the aid of design tools and techniques, which solves a complex engineering challenge that has Business Value(D)
3. Explain the importance of IP rights as a legal instrument for commercial monopoly (IO).

### Evaluation
100% Continuous Assessment (No hurdle)

* Hurdle is defined as follows:

For modules which don’t have 100% continuous assessment and consist of a final exam component, a student enrolled in such a module would need to satisfy two conditions to progress on from the module.

1. The final exam mark must be equal to or more than 50%.
2. The overall assessment mark must be equal to or more than 50%

### Assessment Methods

<table>
<thead>
<tr>
<th>Assessment Methods</th>
<th>%</th>
<th>LO1</th>
<th>LO2</th>
<th>LO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Project Proposal</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presentation</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artefact Assessment</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portfolio</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering Fair</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Learning References
<table>
<thead>
<tr>
<th>Program Outcomes (Mechanical Engineering)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PO1</td>
</tr>
<tr>
<td>PO2</td>
</tr>
<tr>
<td>PO3</td>
</tr>
<tr>
<td>PO4</td>
</tr>
<tr>
<td>PO5</td>
</tr>
<tr>
<td>PO6</td>
</tr>
<tr>
<td>PO7</td>
</tr>
<tr>
<td>PO8</td>
</tr>
<tr>
<td>PO9</td>
</tr>
<tr>
<td>PO10</td>
</tr>
<tr>
<td>PO11</td>
</tr>
<tr>
<td>PO12</td>
</tr>
</tbody>
</table>
### Program Outcomes (Chemical Engineering)

1. **Apply the knowledge of mathematics, science, engineering practices, innovation techniques, entrepreneurship and human factors to provide value-adding solutions to complex Chemical Engineering challenges.**

2. **Identify, formulate, analyse and document complex engineering challenges to arrive at viable solutions and substantiated conclusions.**

3. **Conceive, Design, Implement and Operate solutions for complex engineering challenges that meet specified requirements with appropriate consideration for public health and safety, cultural, societal, environmental and economical considerations.**

4. **Conduct research and investigation into complex challenges using methods which include experiment design, analysis of data and synthesis of information to provide valid conclusions.**

5. **Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an awareness of the accompanying assumptions and limitations.**

6. **Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, economical and cultural issues and the consequent responsibilities relevant to professional engineering practice.**

7. **Explain the global impact of professional engineering solutions in societal, economical and environmental contexts and demonstrate knowledge of and need for sustainable development.**

8. **Apply professional and ethical responsibilities of engineering practice.**

9. **Effectively communicate complex engineering activities, both orally and in a written form, in both technical & non-technical contexts.**

10. **Function effectively as an individual and in multidisciplinary settings with the capacity to be a leader.**

11. **Recognise the importance of lifelong learning and engaging in continuous professional development activities in accordance with technological change.**

12. **Effectively manage projects in multidisciplinary environments and apply project management tools and techniques to one’s own work, as a member and leader in a team to satisfy stakeholders requirements.**
### Program Outcomes (Electrical & Electronic Engineering)

<table>
<thead>
<tr>
<th>PO1</th>
<th>Apply the knowledge of mathematics, science, engineering practices, innovation techniques, entrepreneurship and human factors to provide value-adding solutions to complex Electrical and Electronic engineering challenges.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PO2</td>
<td>Identify, formulate, analyse and document complex engineering challenges to arrive at viable solutions and substantiated conclusions.</td>
</tr>
<tr>
<td>PO3</td>
<td>Conceive, Design, Implement and Operate solutions for complex engineering challenges that meet specified requirements with appropriate consideration for public health and safety, cultural, societal, environmental and economical considerations.</td>
</tr>
<tr>
<td>PO4</td>
<td>Conduct research and investigation into complex challenges using methods which include experiment design, analysis of data and synthesis of information to provide valid conclusions.</td>
</tr>
<tr>
<td>PO5</td>
<td>Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an awareness of the accompanying assumptions and limitations.</td>
</tr>
<tr>
<td>PO6</td>
<td>Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, economical and cultural issues and the consequent responsibilities relevant to professional engineering practice.</td>
</tr>
<tr>
<td>PO7</td>
<td>Explain the global impact of professional engineering solutions in societal, economical and environmental contexts and demonstrate knowledge of and need for sustainable development.</td>
</tr>
<tr>
<td>PO8</td>
<td>Apply professional and ethical responsibilities of engineering practice.</td>
</tr>
<tr>
<td>PO9</td>
<td>Effectively communicate complex engineering activities, both orally and in a written form, in both technical &amp; non-technical contexts.</td>
</tr>
<tr>
<td>PO10</td>
<td>Function effectively as an individual and in multidisciplinary settings with the capacity to be a leader.</td>
</tr>
<tr>
<td>PO11</td>
<td>Recognise the importance of lifelong learning and engaging in continuous professional development activities in accordance with technological change.</td>
</tr>
<tr>
<td>PO12</td>
<td>Effectively manage projects in multidisciplinary environments and apply project management tools and techniques to one’s own work, as a member and leader in a team to satisfy stakeholders requirements.</td>
</tr>
<tr>
<td>No</td>
<td>Topic</td>
</tr>
<tr>
<td>----</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Module Introduction</td>
</tr>
<tr>
<td></td>
<td>Introduction 101</td>
</tr>
<tr>
<td></td>
<td>21st Century Grand Challenges</td>
</tr>
<tr>
<td></td>
<td>Brain Rewiring</td>
</tr>
<tr>
<td></td>
<td>Introduction to CDIO</td>
</tr>
<tr>
<td>2</td>
<td>Introduction to CDIO</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Design thinking</td>
</tr>
<tr>
<td></td>
<td>Business value</td>
</tr>
<tr>
<td>4</td>
<td>Design thinking</td>
</tr>
<tr>
<td>5</td>
<td>Introduction to TRIZ</td>
</tr>
<tr>
<td></td>
<td>TRIZ &amp; Contradiction</td>
</tr>
<tr>
<td></td>
<td>Trends Recognition</td>
</tr>
<tr>
<td></td>
<td>Recognition</td>
</tr>
<tr>
<td></td>
<td>Assessment Details</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>7</td>
<td>Exam</td>
</tr>
<tr>
<td>8</td>
<td>Design Project Proposal</td>
</tr>
<tr>
<td>9</td>
<td>Presentation</td>
</tr>
<tr>
<td>10</td>
<td>Artefact Assessment</td>
</tr>
<tr>
<td>11</td>
<td>Portfolio</td>
</tr>
<tr>
<td>12</td>
<td>Engineering Fair</td>
</tr>
<tr>
<td></td>
<td>Total</td>
</tr>
</tbody>
</table>

### Assessment schedule:

<table>
<thead>
<tr>
<th>Week No.</th>
</tr>
</thead>
</table>
### Assessment Methods

<table>
<thead>
<tr>
<th>Assessment Methods</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Project Proposal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artefact Assessment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portfolio</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering Fair</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### LO-PO(TGC) mapping:

<table>
<thead>
<tr>
<th>Programme Outcomes (POs) and Taylor’s Graduate Capabilities (TGC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PO 1</td>
</tr>
<tr>
<td>-------</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning Outcomes (LOs)</th>
<th>PO 1</th>
<th>PO 2</th>
<th>PO 3</th>
<th>PO 4</th>
<th>PO 5</th>
<th>PO 6</th>
<th>PO 7</th>
<th>PO 8</th>
<th>PO 9</th>
<th>PO 10</th>
<th>PO 11</th>
<th>PO 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO 1</td>
<td>×</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO 2</td>
<td></td>
<td>×</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LO 3</td>
<td></td>
<td></td>
<td>×</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prepared By: Lim Chin Hong

Checked & Approved By:

(Lecturer) (Program Director of CE) (Program Director of EE) (Program Director of ME)

Date: Date: Date: Date:

### Remarks:

1. The above plan is to be passed to the students on the first week of the Semester.
2. Any changes to the above plan shall be communicated (in writing) to the Program Director and all approved updated versions to be communicated to students.
Design Proposal (10%)

**Student Project:**

<table>
<thead>
<tr>
<th>Area</th>
<th>Band</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective or challenge of the project</td>
<td></td>
<td>4-5  Objective/Challenge of the project clearly stated with all the necessary background information.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0-3  Objective/Challenge somewhat described and certain details are either missing or unclear.</td>
</tr>
<tr>
<td>Concept or hypothesis</td>
<td></td>
<td>7-10 Concept(s) and/or hypothesis for the project are based on sound scientific principles and demonstrate element of critical thinking in their formulation. Technological feasibility, economic viability, and impacts on the environment and sustainability of the concept(s) and/or hypothesis have been thoroughly considered. The concept(s) and/or hypothesis for the project is also complied with the legal and ethical standards determined by the relevant authorities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4-6  Concept(s) and/or hypothesis for the project are based on relevant scientific principles and demonstrate low level of critical thinking in their formulation. Technological feasibility, economic viability, and impacts on the environment and sustainability of the concept(s) and/or hypothesis have been considered with varying degree of flaws. The concept(s) and/or hypothesis for the project did not take consideration of the legal and ethical standards determined by the relevant authorities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0-3  Concept(s) and/or hypothesis for the project are not based on any scientific principle and do not demonstrate element of critical thinking in their formulation. Technological feasibility, or/and economic viability, or/and impacts on the environment and sustainability of the concept(s) and/or hypothesis have not been considered. The concept(s) and/or hypothesis for the project did not comply with legal and ethical standards determined by the relevant authorities</td>
</tr>
<tr>
<td>Approach or Methodology</td>
<td></td>
<td>7-10 Suggested approach is based on sound scientific principles and demonstrates element of critical thinking in their formulation. The technology feasibility, economic viability and impacts on the environment and sustainability of the approach have been thoroughly considered. The suggested approach is complied with the legal and ethical standards determined by the relevant authorities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4-6  Suggested approach has varying degree of flaws or indicates a lack of critical thinking in their formulation. The technology feasibility, economic viability and impacts on the environment and sustainability of the approach have been considered with varying degree of flaws. The suggested approach did not take consideration of the legal and ethical standards determined by the relevant authorities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0-3  Suggested approach has weak basis and indicates minimum or no element of critical thinking in their formulation. Technology feasibility, or/and economic viability, or/and impacts on the environment and sustainability of the approach has not been considered. The suggested approach does not with the legal and ethical standards determined by the relevant authorities</td>
</tr>
<tr>
<td>Project management</td>
<td></td>
<td>7-10 Proposal details detail project-planning information such as budget breakdown, project timeline, linear responsibility chart, bill of materials (BOM), and other</td>
</tr>
</tbody>
</table>
project management matters that will ensure project success.

<table>
<thead>
<tr>
<th>Area</th>
<th>Band</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>4-6</td>
<td>Contain varying degree of project planning details such as budget breakdown, project timeline, linear responsibility chart, bill of materials (BOM), and other project management matters that will ensure project success.</td>
</tr>
<tr>
<td></td>
<td>0-3</td>
<td>Contain no details of project planning</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area</th>
<th>Band</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>4-5</td>
<td>The proposal is written accordingly to the content framework, with clear and concise English. Figures and tables are used effectively to illustrate the project outcome systematically</td>
</tr>
<tr>
<td></td>
<td>0-3</td>
<td>The proposal is written with or with loose content framework, with varying degree of flaws in English proficiency. Figures and tables are used in varying degree of flaws to illustrate the project proposal</td>
</tr>
</tbody>
</table>

Total mark for the module = (Total mark from each category)/40 x 10

Comments/Remarks
## Integrated Design Project
### Project Brief

<table>
<thead>
<tr>
<th>Module</th>
<th>ENG 2523: Engineering Design &amp; Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Outcomes</td>
<td>1. Identify a complex engineering challenge that has Business Value (C).</td>
</tr>
<tr>
<td></td>
<td>2. Design a system, with the aid of project management tools and techniques, which solves a complex engineering challenge that has Business Value (D).</td>
</tr>
<tr>
<td></td>
<td>3. Explain the importance of IP rights as a legal instrument for commercial monopoly (IO).</td>
</tr>
</tbody>
</table>

| Title Project           | Coupling Mechanism for Stirling Engine and air compressor |
| Integrated Project      | Stirling Air-conditioning unit |
| Research Group          | Environment Group |
| Grand Challenge         | Make solar energy affordable |
| Supervisor(s)           | Dr. Lim Chin Hong |
| No of Students          | 5 |
| Budget (RM)             | Air-conditioning unit- RM 1500.00 (from FYP project) |
|                         | Copper tubing- RM 100 |
|                         | Pressure valves- RM 200 |
|                         | Compressor unit- RM 200 |
| Date                    | 24th March 2014 |

### Project Description:
Air conditioning accounts for about 56% of the energy use in a typical tropical home and making the largest expense for most homes. Strategically harvesting the heat from the sun and transferring to the Stirling engine may generate cheap cooling air for household. This project focuses on developing a coupling mechanism, which effectively and efficiently transmit the mechanical torque from the stirling engine to a commercial air-conditioning unit.

<table>
<thead>
<tr>
<th>Project Deliverable</th>
<th>LO</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply thinking techniques to develop an effective coupling mechanism which connects the stirling drive shaft to the air compressor</td>
<td>1</td>
<td>Project proposal, Portfolio</td>
</tr>
<tr>
<td>Design and building the coupling mechanism</td>
<td>2</td>
<td>Artefact, Portfolio</td>
</tr>
<tr>
<td>Integrate into a commercial air conditioning unit and test on the performance</td>
<td>2</td>
<td>Portfolio</td>
</tr>
<tr>
<td>Demonstrate the functionalities and performance of the coupling mechanism in Engineering Fair &amp; Presentation &amp; artefact</td>
<td>3</td>
<td>Presentation, Artefact &amp; Engineering Fair</td>
</tr>
</tbody>
</table>

Approved by PJBL Committee
Signature of Project Supervisor | Date: 24th March 2014 |
Signature of Module Coordinator | Date: |