“Project Management: Fabricating real size formula-three styled vehicle as a transition for NYU’s automotive SAE club from Baja USA to International Formula Student Competition”

Introduction, Background information, Purpose, importance and project deliverables

GlobalFormulaStudentSeries(globallyhostedin11countries)isanInternationalFormulamotorsports event conducted by SAE (Society of Automotive Engineers, regulatory body) global consortium, considered as pioneer of motorsports events. The purpose of the competition is to promote the awareness of practical engineering experience and student innovation through creating a competitive International universities teamsalike.

- New York University’s automotive club has been actively participating in similar motorsports events such as Baja USA, an off-road vehicle dynamic event conducted by SAE, itself. During my undergrad, having served as a technical student engineer for two such automotive student competition (on-road/formula track) as a part of team Ojaswat, India which has been participating in formula student competition since previous 9 years. The project aims to highlight similarities and possible transition of NYU Baja USA to International Formula Student event, more specific event in terms of technical considerations and it would be the importance of theproject.
- I have also discussed with NYU automotive team members common procedures for both events, inventories, duration and methodologies involved in both the competition and along with that based on my experience, have created a complete timeline for thisproject.
- My Project on “Project Management for International Formula Student Competition”, can provide a general outlook of the complete

project planning of the formula student competition, starting from a scratch, cost flow, workflow including the project activities timeline of fabricating a formula three styled vehicle till testing and inspection. Based on that, budget planning and risk analysis was calculated.

· It can provide to have a brief outlook at various technical and other milestones, while synchronizing their work to meet the overall progress. Tools used in this project were: Project 365, MS Project, MS Excel(including Solver), MS word and SolidWorks. Also, one of the major objectives of this project is to cater for this need to develop multi-disciplinarycollaboration.

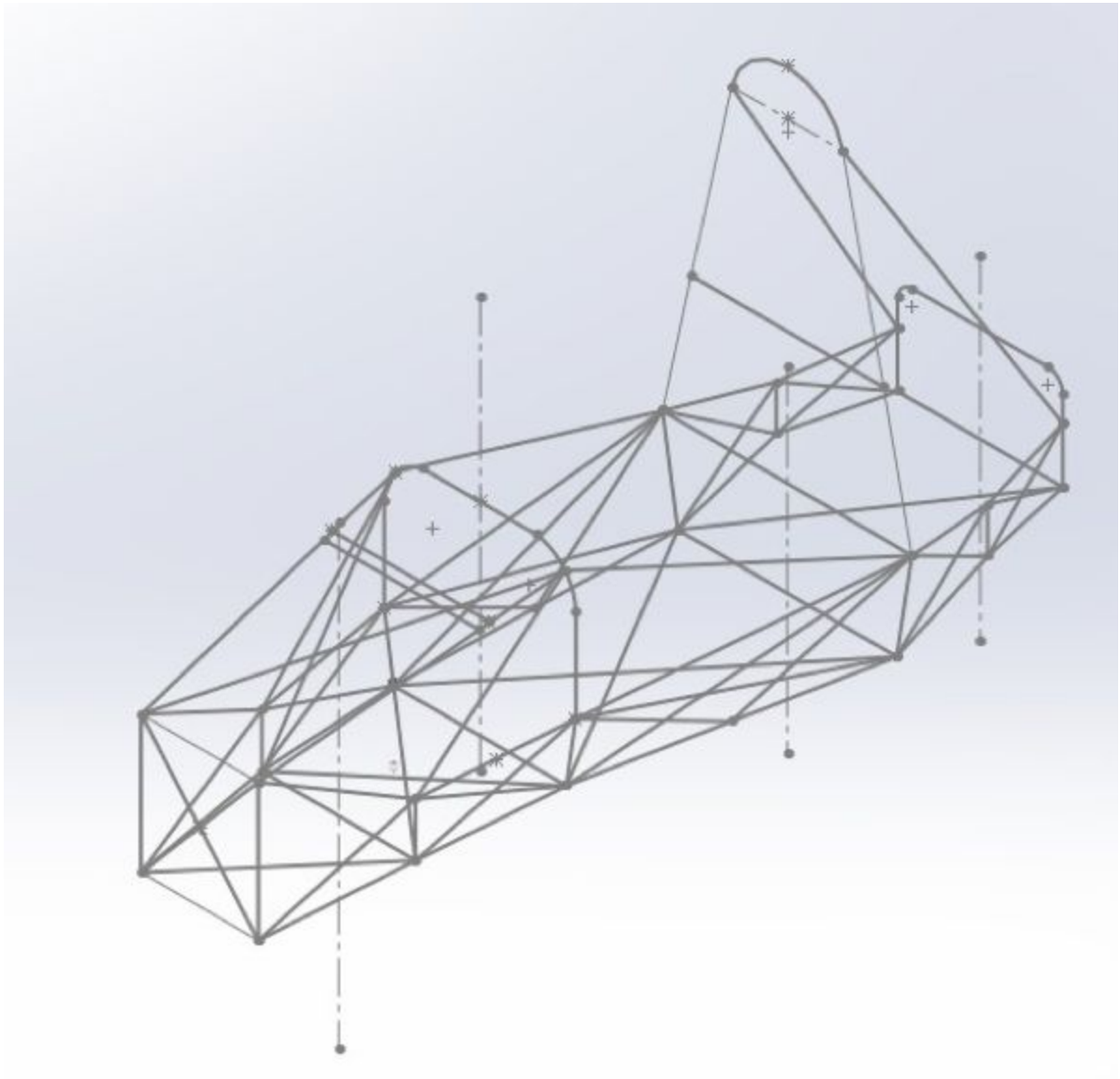
Brief Introduction of the incoming organization:

Team “Formula Violets” will be an upcoming formula student team from NYU, participating in Global Formula Student Series and will be governed and be a part of NYU Society of Automotive Engineers’ Club. The complete project, starting from scratch: stakeholders’ requirement gathering and designing to the complete manufacturing and inspection, will be conducted at NYU Makerspace Lab. Initial recruitment of the team is assumed to be before the initiation of the project and key stakeholders that can be a part of the decision can be adviser (faculties, NYU staff

members or consultants), hired team members and major sponsors based on its agreement. However, all the NYU students can be considered as its stakeholders, since it will official university FS team. All in all, Project Deliverable would be: Real Size- Formula three style vehicles for the purpose participation in international FScompetition.

General outlook of the process:

1. Design phase



on Ergonomics

(created using SolidWorks)

2. Analysis Phase

3. Fabrication andInspection

Project Activity Analysis

Setting up Key Goals, mission statement, Project Objectives, Problem Statement, past design

1.1 Analysis & Professional Consulting with the team

1.2 Setting up Key Goals and missionstatement

1.3 Analysis of Previous car versions and MarketAnalysis

1.4 Problem Definition, Project objectives andplanning

1.5 Professional Consulting with the team

1.6

Requirements gathering and freezing design specifications- constraints withstakeholders

2.1 Conceptual Design using SolidWorks- 3DModeling

2.2 Accessing Inventory & finalizing pre-selectedengine

2.3 Optimization as per SAEStandards

2.4 Alternative Design 1

2.5 Alternative Design 2

2.6 Material Analysis as perspecifications

2.7 Feasibility Assessment

2.8

Proposed Design & fixing withstakeholders

3.1 Analytical Analysis

3.2 Body Analysis

3.3 Side Pod Analysis

3.4 Ground EffectAnalysis

3.5 StructuralDesign

3.6

CostAnalysis

4.1 PrototypeConstruction

4.2 Description ofPrototype

4.3

Prototype CostAnalysis

5.1 Simulation and Evaluation

5.2 Finite ElementAnalysis

5.3

Computational Fluid Dynamics

6.1 Improvements of Design-Aerodynamics

6.2 Body Design & weight

6.3

DiffuserDesign

7.1 Gear, chains, exhaust muffler using CNC milling, grinding and bending, other machiningtools

8.1 Mold Creation

8.2

Frame creation, joint-fixtures andwelding

14.1 Intale-ExhaustAssembling

14.2

ImpactAttenuator

15.1 Carbon FiberLayering

15.2 Ergonomic and Driver safetyHarness

15.3
Safety and SAE Standardstesting

16.1 StaticTesting
16.2
Dynamic Testing

17.1 Performancetesting
17.2
Branding, advertising,promotion

18.1 Torque Control of Engine using ArtificialIntelligence
18.2 Improve ergonomics and drivercontrol
18.3 Finishing and aestheticwork
18.4 Experimental Testing and finalPacking

Green highlight indicates- Main activities
Without highlight indicates- Sub activities of Main activities

Time estimates- Optimistic, Most likely and Pessimistic for the selected main 18 activities are as follows. Those were calculated based on previous 9 years average time reports for various activities based on minimal and maximum duration for each activities, in common.

(snapshot of excel)

Work Breakdown Structure

Activity ID	Duration	Predecessors	Resources
1	6 days	-	Consultant, Technical team, Finance & Marketing team, Design and Analysis team, Inspection team
2	12 days	1	Technical team and Design Team
3	13 days	2	Design team, Analysis Team and Inventory members

4	5 days	3	Fabrication team & Finance team
5	6 days	3	Analysis team
6	5 days	4,5	Technical head, design and analysis team
7	8 days	6	Fabrication team
8	7 days	6	Fabrication team
9	5 days	7,8	Fabrication team
10	4 days	8	Electrical team
11	3 days	10	Technical team-fuel and fabrication team
12	2 days	10	Brake Department-Technical team

13	5 days	12	Suspension-Technical team and fabrication team
14	4 days	11	Fabrication team
15	4 days	11,12,13,14	Technical head and Inspection team
16	10 days	15	Inspection team and driver
17	7 days	15	Inspection team and Marketing team
18	7 days	16,17	Technical head, Project Manager, Electric team, Finance & Marketing head

TWO COST ESTIMATES-

1. COST OF EACH ACTIVITIES ANDSUBACTIVITIES
2. CRASH COST FOR EACHACTIVITIES

(Red highlight- critical activities, grey- non critical)

· Each activities' (including sub-activities) normal cost total, normal cost per day and crashed cost per day for activity acceleration has been mentionedbelow.
· Various cost and time estimates has been considered based on historical information from past 9 years record and proved practical experimentation, of previously associated formula student organizationOjaswat.
· Cost is estimated based on machining charge, fabrication process, energy sources, equipment cost and carcomponents.
· Charges for initial consultation are considered on hourly basis at 50$ per hour and 75$ per hour whenaccelerated.
· Cost notes section represents the charge information. Since, this project's initial section is based on research or iteration, accuracy in crash cost might be difficult, so certain values for crashed cost is assumed based on more utilization ofresources.
· Also, it is crucial to note that since the project is expected to be conducted at NYU Makerspace Lab, the facility charges, purchase cost of engine, labour charge per hour, etc. are exempted duringcalculations.

Project Scheduling Report

AON Network:

AON
Network
Diagram:
(1)—(2)—(3)
Red
indicates
critical
activities
Activities: 18
Project compeletion time: 81 days

AON Network in Project 365 : Based on Early Start Time created in Microsoft Project based on the initiation date July 7th, 2019
(1)
(2)

(3)

AON Network in Project 365: Based on Latest Start Time in Microsoft Project based on the initiation date July 7th, 2019

(1)
(2)
(3)

Following is the Gantt chart using Project 365

Gantt Chart based on Earliest Start Time

Gantt Chart Based on Latest Start Time

Gantt Chart based on Latest Start Time

- Critical activities are:1,2,3,5,6,8,10,11,12,13,14,15,16,18
- Project completion time: 81 (more than one critical activities)

Project RiskAnalysis

(snapshot MSExcel)

i. Probability that the project will take longer than 115% of its expected completion time: Expected completion time=81

115% of its expected completion time= 93.15

To calculate prob. of 115% or greater for the following data in normal distribution curve, probability of project competition within 115% of its expected completion time is calculated and the value is subtracted from 1.

std. dev= 3.05959

For that,

Using excel formula =1 - norm.dist(93.15,81,3.05959,True) = 0.00357685 %

ii. Probability that the project will take longer than 115% of its expected completion time: Expected completion time=mean=81

90% of its expected completion time= x = 93.15

To calculate prob. of 115% or greater for the following data in normal distribution curve, probability of project competition within 90% of its expected completion time is calculated using excel formula= norm.dist(93.15, 72.9, 3.05959, True)= 3.05959

std. dev= 3.05959

Project Budgeting Report

Detail Budget Report (includes sub activities)

Calculations:

Budgeted costs using Early Start time (daily, weekly & total)

(using MS Excel)

Budgeted costs using Latest Start Time (daily, weekly & total)

Project Acceleration Report

(Red highlight- critical activities, grey- non critical)

· Since there are more than one critical path in parallel, the sum of duration of critical activities would not provide with Project path. Total project duration has been calculated using AON network containing EST and LST and its value comes out to be- 81 time units(days).
· To reduce project by 15% of project completion time, 0.15*81 = 12.15, so project should be crashed by 12activities.

· Using AON network, it can be found that time for various activities:1—2—3—5—6—8—10—11—14—15—16—18 = 81
1—2—3—5—6—8—10—12—13—15—16—18 =
811—2—3—5—6—8—10—11—14—15—17—18 = 78
1—2—3—5—6—8—10—12—13—15—17—18 = 78
1—2—3—4—6—8—10—11—14—15—16—18 = 80
1—2—3—4—6—8—10—12—13—15—16—18 = 80
1—2—3—4—6—8—10—11—14—15—17—18 = 77
1—2—3—4—6—8—10—12—13—15—17—18 =77

Although activity 17 has lowest cost it cant be crashed since its on non-critical path and activity 4th cant be crashed by any unit even being on critical path. Based on the table, since activity 3 has minimum crash cost/ day in critical activities and its common in all so it can be crashed by only one unit time.

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days

· After crashing 3rd activity by one day, Using AON network, it can be found that time for various activities, timeduration-

1—2—3—5—6—8—10—11—14—15—16—18 =80
1—2—3—5—6—8—10—11—14—15—17—18 =77
1—2—3—4—6—8—10—11—14—15—16—18 =79
1—2—3—4—6—8—10—12—13—15—17—18 =76
1—2—3—4—6—8—10—12—13—15—16—18 =79
1—2—3—4—6—8—10—11—14—15—17—18 =76
1—2—3—5—6—8—10—12—13—15—17—18 =77
1—2—3—5—6—8—10—12—13—15—16—18 =80

Based on the table, activity 2 has minimum crash cost/ day among remaining critical activities so it can be crashed secondly by two units.

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n- 78
days

· After crashing 2nd activity by two days, using AON network, it can be found that time for various activities, timeduration-

1—2—3—5—6—8—10—11—14—15—16—18 =78
1—2—3—5—6—8—10—11—14—15—17—18 =75
1—2—3—4—6—8—10—11—14—15—16—18 =77
1—2—3—4—6—8—10—12—13—15—17—18 =74
1—2—3—4—6—8—10—12—13—15—16—18 =77
1—2—3—4—6—8—10—11—14—15—17—18 =74
1—2—3—5—6—8—10—12—13—15—17—18 =75
1—2—3—5—6—8—10—12—13—15—16—18 =78

Minimum crash cost per day comes out for activity activity 15 is crashed by one unit, 1st activity by 2 units,8th activity by 2 units and 10th by one unit. It is because all the four activities are common in critical path activities and can individually affect duration.

Update
d cost
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Activity
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n- 72

· After crashing 2nd activity by two days, using AON network, it can be found that time for various activities, timeduration

1—2—3—5—6—8—10—11—14—15—16—18 =72
1—2—3—5—6—8—10—11—14—15—17—18 =69
1—2—3—4—6—8—10—11—14—15—16—18 =71
1—2—3—4—6—8—10—12—13—15—17—18 =68
1—2—3—4—6—8—10—12—13—15—16—18 =71

1—2—3—4—6—8—10—11—14—15—17—18 =68
1—2—3—5—6—8—10—12—13—15—17—18 =69

1—2—3—5—6—8—10—12—13—15—16—18 =72

· From new critical paths, activities: 16 and 18 are in common, so it can be removed initially by 3 and 1 duration units, respectively. Updated cost becomes- $19,705 and net activity duration becomes- 68. And so there has been reduction of more than 15% total time duration by crashing 13activities.

· Additionally, having created simpler mathematical solver model for PM crashing activity, iteration for a complex models can be solved using Solveroptimization.