Multidisciplinary Senior Design
Project Readiness Package

Project Title:	RIT FSAE Composite Tube Winder
Project Number: (assigned by MSD)	P17221-1
Primary Customer: (provide name, phone number, and email)	RIT Formula SAE Team Jon Washington – Project Manager jlw4762@g.rit.edu (240-305-9218
Sponsor(s): (provide name, phone number, email, and amount of support)	RIT Formula SAE Team $2000 (See above)
Preferred Start Term:	e.g., Spring 2015
Faculty Champion: (provide name and email)	Dr. Alan Nye, ahneme@rit.edu
Other Support:	As applicable
Project Guide: (assigned by MSD)	

Prepared By Date

Received By Date

Items marked with a * are required, and items marked with a † are preferred if available, but we can work with the proposer on these.

Project Information

*** Overview:**
The RIT Formula SAE Team relies heavily on the use of composites to meet their goals of a lightweight competitive race car. The teams use of composites has earned it awards including the 2013 Audi award for "Best Ultralight Concept" and nominations for other awards including the BASF award for "Best used of Fiber Reinforced Polymers" and the Altair award for "Innovative Design"

Many of the composite structures on team's car utilize carbon composite tubes to realize their design. Subsystems that utilize composite tubes include the steering shaft, drive shafts, suspension arms and aero structure. In the past the team has fabricated these parts in house using hand layup techniques applied to prepreg unidirectional fabrics. However, the team has found that these techniques are not sufficient for producing robust parts that can handle the rigors of competition. After repeated failures of these tubes, the team has turned to buying premanufactured tubes to fulfill their needs

Buying premanufactured tubes has added significant cost to the team's budgets for the past few years. In addition to this, the tubes available on the market are typically much stronger than what the team needs and add additional weight to the vehicle that could be removed through a more optimized layup. The team would prefer to be able to bring the manufacturing of these tubes back in house to reduce the costs and to be able to control the design of the tubes. The team is seeking a solution that implements similar manufacturing techniques to the tubes that they currently purchase.

*** Preliminary Customer Requirements (CR):**
Safety – The machine shall protect users from hazards, both mechanical and chemical.
Part size – The team currently uses tubes up to 30" in length and 3" in diameter.
Flexibility – The team wishes to be able to use both pre-impregnated fiber and dry fiber in the design of their tubes
Simplicity = The team would like to be able to manufacture spare parts for the machine in house.
Rate – The machine would be able to produce enough tubes during their build season to satisfy both a full race set and at least a full set of spares

*** Preliminary Engineering Requirements (ER)**:
Include both metrics and specifications. Each ER should map to one or more CRs (see above).
Metrics:
Safety – Conform to current OSHA standards for machinery design
Operating Envelope – Maximum size the machine can handle
Wrapping tension – Tension that is applied to the fibers as they are placed.
Mandrel torque – Available torque to turn the mandrel.
Wrapping angle – Max angle that the fibers can be placed at.
Spool size – Machine would be able to accept standard tow spool sizes
Speed – Amount of fiber/hour that the machine can place

Specifications:
Wrapping tension – Minimum tensions would be at least 10lbs based off of data sheets of material that team currently has
Mandrel torque – Would be based off of maximum mandrel size and maximum tension the machine can output
Wrapping angle – At least +45 and -45 degrees for torsion tubes. Ideally would be able to place tows as near to a 0 Degree angle as possible for tension/compression tubes

[*] Constraints:
The team would be aiming to spend approximately $2000 on the project. Currently the team spends approximately this amount each year in purchasing

The finished machine would need to be able to stored either within the team's composite room or have a packaging solution to be able to place it in the team's long term storage solution (SeaVan Container)

[*] Project Deliverables:
Minimum requirements:
- All design documents (e.g., concepts, analysis, detailed drawings/schematics, BOM, test results)
- working prototype
- technical paper
- poster
- All teams finishing during the spring term are expected to participate in ImagineRIT

Additional required deliverables:
- First run parts that the team can test and assess
- Instructions on the setup and use of the machine for future team members

[†] Budget Information:
Major expected costs would be for the motors and motor controllers that would be necessary to complete the design.

[*] Intellectual Property:
No

Project Resources

† Required Resources (besides student staffing):
Describe the resources necessary for successful project completion. When the resource is secured, the responsible person should initial and date to acknowledge that they have agreed to provide this support. We assume that all teams with ME/ISE students will have access to the ME Machine Shop and all teams with EE students will have access to the EE Senior Design Lab, so it is not necessary to list these! Limit this list to specialized expertise, space, equipment, and materials.

Faculty Dr. Ghonheim as the most experience	**Initial/ date**
Environment (e.g., a specific lab with specialized equipment/facilities, space for very large or oily/greasy projects, space for projects that generate airborne debris or hazardous gases, specific electrical requirements such as 3-phase power)	**Initial/ date**
Equipment (specific computing, test, measurement, or construction equipment that the team will need to borrow, e.g., CMM, SEM,)	**Initial/ date**
Materials Carbon fiber and Resin – The team both has the materials and are able to procure them through donations if necessary	**Initial/ date**
Other	**Initial/ date**

† Anticipated Staffing By Discipline:
Indicate the requested staffing for each discipline, along with a brief explanation of the associated activities. "Other" includes students from any department on campus besides those explicitly listed. For example, we have done projects with students from Industrial Design, Business, Software Engineering, Civil Engineering Technology, and Information Technology. **If you have recruited students to work on this project (including student-initiated projects), include their names here, as well!**

Dept.	# Req.	Expected Activities
BME		
CE		
EE	1-2	Integrating motors with a GUI
ISE		
ME	4	Design of Machine elements, stress analysis, manufacturing, composite knowledge.

		Formula Team Members: Andrew Derhammer – ME Project Lead Matthew Hendler – ME Patrick Burke – ME Jon Washington - ME
Other		

* **Skills Checklist:**

Indicate the sills or knowledge that will be needed by students working on this project. Please use the following scale of importance:

1=must have
2=helpful, but not essential
3=either a very small part of the project, or relates to a "bonus" feature
blank = not applicable to this project

Mechanical Engineering

	ME Core Knowledge		**ME Elective Knowledge**
3	3D CAD	2	Finite element analysis
	Matlab programming	1	Heat transfer
3	Basic machining	3	Modeling of electromechanical & fluid systems
3	2D stress analysis	2	Fatigue and static failure criteria
2	2D static/dynamic analysis	3	Machine elements
	Thermodynamics		Aerodynamics
	Fluid dynamics (CV)		Computational fluid dynamics
2	LabView		Biomaterials
	Statistics		Vibrations
3	Materials selection		IC Engines
		2	GD&T
		2	Linear Controls
		3	Composites
			Robotics
			Other (specify)

Electrical Engineering

	EE Core Knowledge		**EE Elective Knowledge**
3	Circuit Design (AC/DC converters, regulators, amplifies, analog filter design, FPGA logic design, sensor bias/support circuitry)		Digital filter design and implementation
3	Power systems: selection, analysis, power budget		Digital signal processing
	System analysis: frequency analysis (Fourier, Laplace), stability, PID controllers, modulation schemes, VCO's & mixers, ADC selection	3	Microcontroller selection/application
2	Circuit build, test, debug (scope, DMM, function generator		Wireless: communication protocol, component selection
	Board layout		Antenna selection (simple design)
	Matlab		Communication system front end design
	PSpice		Algorithm design/simulation
2	Programming: C, Assembly	3	Embedded software design/implementation
2	Electromagnetics: shielding, interference		Other (specify)

Industrial & Systems Engineering

	ISE Core Knowledge		ISE Elective Knowledge
	Statistical analysis of data: regression		Design of Experiment
	Materials science		Systems design – product/process design
	Materials processing, machining lab		Data analysis, data mining
	Facilities planning: layout, mat'l handling		Manufacturing engineering
	Production systems design: cycle time, throughput, assembly line design, manufacturing process design		DFx: manufacturing, assembly, environment, sustainability
	Ergonomics: interface of people and equipment (procedures, training, maintenance)		Rapid prototyping
	Math modeling: OR (linear programming, simulation)		Safety engineering
	Project management		Other (specify)
	Engineering economy: Return on Investment		
	Quality tools: SPC		
	Production control: scheduling		
	Shop floor IE: methods, time studies		
	Computer tools: Excel, Access, AutoCAD		
	Programming (C++)		

Biomedical Engineering

	BME Core Knowledge		BME Elective Knowledge
	Matlab		Medical image processing
	Aseptic lab techniques		COMSOL software modeling
	Gel electrophoresis		Medical visualization software
	Linear signal analysis and processing		Biomaterial testing/evaluation
	Fluid mechanics		Tissue culture
	Biomaterials		Advanced microscopy
	Labview		Microfluidic device fabrication and measurement
	Simulation (Simulink)		Other (specify)
	System physiology		
	Biosystems process analysis (mass, energy balance)		
	Cell culture		
	Computer-based data acquisition		
	Probability & statistics		
	Numerical & statistical analysis		
	Biomechanics		
	Design of biomedical devices		

Computer Engineering

	CE Core Knowledge		CE Elective Knowledge
	Digital design (including HDL and FPGA)		Networking & network protocols
	Software for microcontrollers (including Linux and Windows)		Wireless networks
	Device programming (Assembly, C)		Robotics (guidance, navigation, vision, machine learning, control)
	Programming: Python, Java, C++		Concurrent and embedded software
	Basic analog design		Embedded and real-time systems
	Scientific computing (including C and Matlab)		Digital image processing

	CE Core Knowledge		CE Elective Knowledge
	Signal processing		Computer vision
	Interfacing transducers and actuators to microcontrollers		Network security
			Other (specify)