P10216 Robot Navigation Plant Platform Project Readiness Package

INTRODUCTION:

This document describes and serves as a template for preparation of a Project Readiness Package. The objective of the Project Readiness Package is to document customer needs and expectations, project deliverables (including time frame), budget, and personnel / organizations affiliated with the project. It will serve as the primary source of information for students necessary during Phase 0 (Planning) to develop a SD I plan and schedule including specific deliverables and due dates. The Project Readiness Package will also support Faculty evaluation of project suitability in terms of depth, scope, and student / faculty resources by discipline.

In this document, italicized text provides explanatory information regarding the desired content of the sections indicated by non-italicized, bold, capitalized headings. If a particular aspect of a section is not applicable for a given project, it is only necessary to indicate that by entering N/A (not applicable).

ADMINISTRATIVE INFORMATION:

Information regarding contacts, budgets, facilities, resources, regulatory or legal considerations, proprietary or specialized components, technologies or intellectual property associated with the project.

- Proposal Number: 1
- Project Name: Robot Navigation Plant Platform Project
- Project Number: P10216
- Track: Vehicle/ Robotics
- Start Term: 2009-1
- End Term: 2009-2
- Faculty Mentors: Dan Phillips; EE, Ferat Sahin; EE, Wayne Walter; ME, John Kaemmerien; ISE, Dr. Pratapa Reddy; CE.
- Faculty Guide: George Slack
- Technical Assistant: None.
- Customer organization and primary contacts - George Slack, Stan Rickel, Daniel Phillips.
  Funding organization – RIT Provost's Learning Innovations Grant
- Project Family Overview (*1 Paragraph that provides a general description of the project in terms of background, motivation(s), customer(s), and overall objective(s).*):
  The Wandering Campus Ambassador projects will develop a robot-like system to raise awareness of self-sustaining energy and showcase student's creative and technical abilities. The idea is to create curiosity through a robot like device with a living, growing and self-sustaining plant. It will wander around in a nice, slow, autonomous fashion, searching out the best sun, water, fellow plants and friendly passers-by. Act as a great (yet very quiet) spokesperson/plant for the KGCOE MSD, CC&IS Software Engineering Senior Projects, CIAS Industrial Design Senior Projects and even the new sustainability programs being created at RIT. Just think what a great news story or You-Tube episode it would make. If you think along the environmentally friendly side a little, you could consider some replenishable power sources for both the robotic-like device and its plant which is not only along-for-the-ride but may guide the robotics' autonomous decisions in search of being able to sustain the plant (i.e. water, sun, temperature, food).

  This project will deliver robot navigation portion of the robot. This team will work with the **P09215 Robot Locomotion and Plant Plant Platform Project** team who will deliver on the robot locomotion and plant functions. In the Winter quarter, both project teams will work with **P0921Y Integration and Field Testing team**.

  Team will prepare for design competitions such as RITs annual IEEE Design Competition, Circuit Cellar, Analog Devices and so on.

- Staffing Requirements:

Discipline (*number*)	Skills required (*concise*)
CE – 1	Wireless communications (Wifi connection) between Robot and remote server. Given three campus spots or locations for the robot to "wander", study algorithm needs associated the feasibility in implementing a successful solution. Consider and detail prototype and development platforms and tools. Work with EEs in defining electronics platform needs and architecture. Consult with the P09215 Locomotion and Plant Team on communication needs and a potential to integrate computing platforms. Software should consider future add-on processing capabilities to enable functions such as more advanced robot tracking schemes and sensors.
EE - 4	Review sensors and controls from P09207 Ground Scouts project. Evaluate obstacle avoidance using sensors such as sonar, IR, GPS, camera sensors. Hardware should consider future add-on processing capabilities to enable functions such as more advanced robot tracking schemes and additional navigation sensors such as location beacons. Integration of wiring, connectors and harnessing for a clean robot design.
Other tasks	Define developmental test stages from SD I prototyping through SD II campus test certification. Defining and delegating design competitions applications such as RITs annual IEEE Design Competition, Circuit Cellar, Analog Devices and so on.

- Continuation, Platform, or Building Block project information (*Include prior project number and title and to what extent previous results are being incorporated*):
  P09207 Ground Scouts Robots Project

DETAILED PROJECT DESCRIPTION:

Since the mission of the project mission is to raise campus awareness of self-sustainability energy, the robot's portion of the project can act as a guardian to support the plant's growth needs as well as its own needs. That is, make maximum use of natural campus conditions by navigation to manage sun, shade, temperature, rain, and watering to allow the plant to grow and thrive and robot power to self-sustain.

The following customer needs are organized by conceptual clusters for navigation portion of the project: Motion/ Territory, Pedestrian Interactions and Communications.

Motion/ Territory

1. There will be three designated areas for the robot to wander within. The area should enable sun and shade, be close to people but limited away from pedestrian walk areas. If the determined space is circular, the area should be at least a three feet radius or if rectangular, the area should be at least two by five feet. Team is free to challenge shape and size.
2. Movement is primarily needed to support the plant's photo-synthesis, rain and temperature needs and be noticed on campus.
3. Periodic "wandering" motion is also needed to the capture the attention of pedestrians while ensuring the plant's photo-synthesis and robot power needs are being met.
4. Robot will detect and maneuver in such as way as to minimize the opportunity of becoming trapped or lodged. As an example, steering may rotate on a near zero radius and/ or consider reverse drive.
5. Suggested Travel Speed: Maximum speed of 10 inches per minute to support a wandering motion needs. Since the robot will be delivered to and returned home, the robot with a leash will need to move at human walking speeds.

Pedestrian Interactions:

1. See Pedestrian Safety description in P09215 Robot Locomotion and Plant Platform PRP on EDGE .
2. Periodic "wandering" motion is also needed to the capture the attention of pedestrians while ensuring the plant's photo-synthesis and robot power needs are being met.

Communications:

1. Robot will be able to summon for help. Robot will maintain wireless communications for a number of reasons listed in this document.
2. Device will have a back-up communication scheme such as a beacon when in peril due to a number of reasons such as plant parameters are out of range, low robot power or need for service.

- Customer deliverables (*Customer requested milestones, progress reports, and expected product*):
  Customer: As per MSD design documentation requirements as listed on MyCourses. Files and documents will be storage on EDGE team site and SVN to manage file version control.
  Since this may be an on-going project, detailed CAD, software architecture, software comments, schematics, critical component specifications are critical.

- Customer and Sponsor Involvement (*Describe role of customer and sponsor in the project, planned participation in design and project reviews, etc.*):
  - Sponsors are Dr. Phillips, Prof. Slack and Prof. Rickel and their involvement will be to review formal and informal documents and presentations. They will be available at any time via emails with any specific questions.
  - Guide: Prof. Slack. At a minimum there will be Friday weekly team meetings when all team members are available. Midweek team meetings should be used for planning, status and progress updates which will drive team and individual plans. Midweek individual development should be planned as well as development on Fridays.

- Regulatory requirements (*i.e. UL, IEEE, FDA, FCC, RIT*):
  RIT Campus Security.

- Project Budget and Special Procurement Processes (*Provide all budget details and processes associated with expenditures*):

  Since the finished project must perform reliably, major components should be integrated and not designed from scratch. The budget takes this assumption into account.

  The total robot grant is for $5,000 for supporting three team projects. Two teams starting in the Fall and one starting in the Winter. Therefore, approximately $1,700 expenses for each team. There are typically 20% early prototyping component expenditures for component tryouts ($350) and 20% unanticipated expenses for redesign and components not anticipated in the Bill of Materials ($350). This leaves approximately $1,000 for the "official build" Bill of Materials which the team should not exceed. Given that, many teams purchase from their BOM prior to the end of MSD I (Fall Quarter) and this is encouraged. Since this is a rule of thumb your design expenses are certainly negotiable if you can prove engineering value and/or negotiate the removal certain requirements. Therefore the team will need to manage budget limitations.

- Intellectual property (IP) considerations (*Describe any IP concerns or limitations associated with the project*):
  None. Student(s) interest and discretion.

- Other (*Describe potential benefits and liabilities, known project risks, etc.*):
  On-going world needs for sustainable energy solutions.
  This project may offer resume bullet points and interviewing discussion points.

DETAILED COURSE DELIVERABLES:

From the Course Deliverables document, extract general and discipline specific deliverables that are appropriate to the project. This should provide clear guidance to the students on what it expected.

- Review the course (located on MSD I MyCourses) deliverables (Grading Rubric) document and MSD I Timeline document. These are located on MyCourses/ Content under the Getting Started header. As needed, modify the proposed timeline to meet project needs.

- Establish discipline specific plans and then individual plans (including schedules, milestones and critical risks). Compile the discipline specific plans up to the Team Plan and evaluate for critical internal hand-off points and readjust the plan as needed. These plans will be maintained and updated as new information and any issues rise. A good Project Plan is usually outdated as soon as it is compiled so frequent adjustments are expected as the team's knowledge and experiences grow. Once there is a good working plan, the updates occur with relative ease and will serve as a critical device to recognize and then reconcile looming issues. A good engineering rule of thumb is that most technical tasks will take three times the effort as initially planned.

- Since the major effort is to integrate major components, early selection of devices may be achievable to aid in gaining hardware experiences and enable sufficient debug during MSD II. That is, completion of all MSD I technical tasks as soon as possible knowing that significant knowledge and experience is gained during early prototyping and lab debugging.

PRELIMINARY WORK BREAKDOWN:

Describe the anticipated distribution of general tasks to be accomplished by project participants based on perceived skill set requirements. This should justify the requested skills and number of students from each discipline.

See **DETAILED PROJECT DESCRIPTION** previously listed in this document. Though each category is functionally organized, team members can apply to their discipline during the concept selection process. The following are preliminary areas or tasks of recommended investigation.

- Review the course deliverables and deliverables timeline on MyCourses. Customize the timeline for team needs.
- Capture engineering specifications in one concise document. Use SVN as a change control mechanism and to enable ALL team members to update key documents in a real time manner. Communicate changes to team members via email.
- Navigation scenario definition and selection.
- Navigation sensors reviewed.
- Evaluate levels of robot autonomy versus reliability and safety.

GRADING AND ASSESSMENT SCHEME:

Describe how the grading rubric relates to expectations and deliverables. The impact of project enhancements and improvements from baseline should be clearly articulated.

Review Grading Rubric spreadsheet on MSD I MyCourses. The following offers a global view specific to this project. Please feel free to discuss specifics with your Guide well prior to grading of deliverable. This applies to team and individual tasks. Remember there is a 16% (two letter grade) team member differentiation. If there is a team member issue, then 16% differentiation does not apply and the team member will be consulted.

Review Grading Rubric spreadsheet on MSD I MyCourses. The following offers a global view specific to this project. Please feel free to discuss specifics with your Guide well prior to grading of deliverable. This applies to team and individual tasks. Remember there is a 16% (two letter grade) team member differentiation. If there is a team member issue, then 16% differentiation does not apply and the team member will be consulted.

D/ F. – Minimal concept development or key customer needs unaddressed, reliance on only a few ideas; evaluation process not defined or followed. Superficial understanding of the design is evident at either the system or subsystem level. Rationale for specific design decisions and tradeoffs is poorly understood, if at all. Many questions remain as to whether needs and specs will be met. Design Review was not held or was poorly executed: key subsystems were not reviewed, key issues were not addressed, little/no preparation or documentation.

C. - Key customer needs and specs were addressed but many were left unaddressed, or evaluation process was not followed. Component benchmarking was sketchy. General comprehension of the design is evident but rationale for decisions is not solid and tradeoffs are not well understood. Technologies and devices were defined but limited or no prototypes of subsystems were built to evaluate customer-oriented criteria and competing products. Project was not fully functional. The built, debugged and tested (evaluated) was complete with marginal data and results. Design Review execution was acceptable but was weak in one or more areas: breadth of participants, preparation, thoroughness, or documentation. Team generally did not iteratively review and update of their previous design activities and documents for the purpose of maturing their knowledge and design. Team processes and documents were not evergreen or thus not updated.

B. - Demonstrate robot navigation platform captures critical engineering specifications and customer needs. Valid concepts were developed. Concepts were generated, reviewed with faculty and refined. Good investigation of devices for and interfaces, devices used and component benchmarking was complete. Technologies and devices were defined and good prototype was built and evaluated against customer-oriented criteria and competing devices during MSD I. Knowledgeable understanding is evident to your peers and faculty (verbal and written during weekly meetings and more formal sessions) of the design and rationale for design decisions and tradeoffs. Team can elaborate on its attributes during design reviews and execution was acceptable in all areas: breadth of participants, preparation, thoroughness, or documentation.
Bill of materials suitable for ordering all development materials and tools for multiple device build at or before the end of MSD I.
Throughout the life of the project, key analytical processes (i.e. Concept Review and various Design Reviews, Guide status meetings) were planned and executed with appropriate attendees. Team iterated their design based on growing team knowledge and reviews to reflect current design. This may require concurrent updates to more than one engineering document. Most project design elements were addressed and documented key issues, notes, risk assessment and action items.
Project successfully built, debugged and tested (evaluated) in MSD II. Team demonstrated that most customer needs and design specs were met. A tested and proven acceptably reliable operation as defined in the Customer Needs and Specifications.
Good hypothesis on how future additional functionality (added hardware and software functions) that can be added without a redesign. Also propose detailed requirements to influence next project (P10217 Robot Integration and Field Testing) design and may enable future device functions.

A. - Demonstrate Robot Locomotion and Plant platform captures critical engineering specifications and customer needs. Valid concepts were developed. Creative concepts were generated, reviewed with faculty and refined early in the project development. Excellent investigation of analog devices used in musical devices and component benchmarking was complete.
Technologies and devices were defined and excellent prototypes were built and evaluated against customer-oriented criteria and competing products during MSD I. Thorough and in-depth knowledgeable understanding is evident to your peers and faculty (verbal and written during weekly meetings and more formal sessions) of the design and rationale for design decisions and tradeoffs. Team can easily elaborate on its attributes during design reviews and execution was acceptable in all areas: breadth of participants, preparation, thoroughness, or documentation.
A complete bill of materials suitable for ordering all development materials and tools for multiple device build at or before the end of MSD I.
Throughout the life of the project, key analytical processes (i.e. Concept Review and various Design Reviews, Guide status meetings) were very well planned and executed with appropriate attendees. Team consistently and timely iterated their design based on growing team knowledge and reviews to reflect current design. This may

require concurrent updates to more than one engineering document. All project design elements were clearly documented key issues, notes, risk assessment and action items.
Project successfully built, debugged and tested (evaluated) in MSD II. Team demonstrated that customer needs and design specs were met. A tested and proven excellent reliable operation as defined in the Customer Needs and Specifications.
Excellent hypothesis of how future functionality (added hardware and software functions) that can be added without a redesign. Also propose detailed requirements to influence next project (P10217 Roboy Integration and Field Testing) design and may enable future device functions.

THREE WEEK SDI SCHEDULE:

List expected activities in the first three weeks. Highlight any project specific activities that may not be part of the generic course syllabus (e.g. customer visits).
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Week 1: Enter MSD I MyCourses. Select **Content**, then documents within "**Getting Started**" and "**Week 1"** deliverables. Under "**Getting Started**" review Course Schedule for week 1. Take notes in your Logbook.

Meet **P10215 Robot Locomotion and Plant and P10216 Navigation team members** for better understand needs and abilities. Using Staffing Requirements section in this document as a guide, assign team members. This may change as the team gains knowledge.

By end of day Friday, review Week 2 MSD I Course Schedule and plan to meet early in week 2.

If not already, review team's EDGE website. See EDGE instructions on MSD I MyCourses. Plan to learn Wiki edit and SVN for document repository and version control for EDGE repository needs.

Establish and concur to team member expectations (see Values and Norms on MSD I MyCourses):

- As an example, effort of 12 to 16 hours per week for preparation for Friday and Friday's activities is normal and expected. This is a "lab" course with very limited lecture requirements and homework. Your completion of engineering design activities and associated documentation should be considered equivalent to homework and lab reports.

- After the first few initial seminar and meetings, effort moves from team planning to more individual accountability and development. However, as the team's knowledge increases, be flexible to move into or out of tasks to balance work needs. That is, you may not predict task complexity or time involvement from initial planning but as your knowledge and experience grows, a more accurate prediction can be made. Volunteer to help other team members and please don't wait to be asked by the team lead.

- All issues both technical and personal must be raised immediately to the team and Guide. Make full use of emails and don't wait until the next meeting to raise an issue. Teams and individuals cannot make up for lost ground as in other courses.

- By end of Week 1 review MSD I MyCourses use "**Week 2"** deliverables. Each team member should understand Week 2 course requirements and mid-week completion expectations and team status.

Week 2: Enter MSD I MyCourses. Select **Content.** Within "**Getting Started**" review Course Schedule for week 2. Then review documents within "**Week 2"** deliverables.

Gain an understanding of what is expected of this team collectively and each member individually. As an example, get into the routine of progressing during the week. Develop and be prepared to present at the start of Friday.

Meet with Guide and your discipline consultants to better understand needs and abilities.

Begin benchmarking or comparing robot or subsystem devices that may be available.

Finalize customer needs and review both teams' specifications to determine which robot functions are well understood.

This is an opportunity to co-share with the other two robotic teams in the build and debug activities. This will offer a rapid understanding of the design.

Finalize customer needs, determine what types of robot and platform features that are needed, and begin compiling design specifications. This will prove be a critical and essential engineering document and as your knowledge and experience grows. The development will cause the team to revisit to ensure it matches your design plans. Continue robot benchmarking. Search technologies to be used in the final design. Remember, this is an integration project and minimizing "clean sheet" designs is recommended where possible. This does not minimize the need to clearly comprehend detailed specifications since these are needed for device selections.

Begin creating specifications from a perspective of robot integration and implementing field testing. Integration will be the process of taking the navigation technologies and merging with the robot locomotion platforms into a cohesive package in terms of visual appeal, clean mechanical attachments and brackets, well displayed and protected electronics, clean harnessing and all subsystem functioning together and reliability. This is also an opportunity to partially or completely redesign subsystems that may not perform to specifications. This determination will be better understood at that starting of the Winter Quarter of this project.

By end of Week 2 review MSD I MyCourses use "**Week 3"** deliverables.

<u>Week 3:</u> Generate and document design concepts for each of the different key components of the design. Hand sketched concepts should be captured in your individual project notebooks. These sketches will be referred to throughout the project. Concepts and ideas will grow as the team's knowledge grows.

Each team member should understand Week 3 course requirements. This same routine should be used throughout the quarter. Leave time to review team and individual plans update as needed. These may be changing significantly at the subsystem level so be sure the full team understands your updates since this may impact their design.

Review your plans and update as needed given your knowledge is rapidly growing. Review needs and specifications with your sponsoring team (Prof. Slack, Prof. Rickel and Dr. Phillips). Be prepared to narrow your concepts to one or two per subsystem and system. Select design concepts for each of the different key components of the design. Again, the concepts should be captured in your individual project notebooks. Scan in and share with team even though they are in a different discipline. By now each team member should be totally versed in EDGE and SVN. Make full use of EDGE for document repository. For reliability of final design determine a "purchase" versus "design" of subsystems. If not already, propose the purchase or borrowing of **<u>prototype hardware and software</u>**. This early hardware and software will aid in proving the feasibility of your concepts. Setup a meeting with your Guide and Consultants to gain approval on these preliminary purchases. See Project Budget above for more details.

REQUIRED FACULTY / ENVIRONMENT / EQUIPMENT:

Describe resources necessary to support successful Development, Implementation and Utilization of the project. This would include specific faculty expertise for consulting, required laboratory space and equipment, outside services, customer facilities, etc. Indicate if required resources are available.

Category	Source	Description	Resource Available (*mark with X*)
George Slack	**EE**	**Guide.** *Will work closely with the team on an on-going basis to facilitate success.*	**X**
Pratapa Reddy	**CE**	**Consultant.** *Will provide CE discipline technical support on as needed basis.*	**X**
Ferat Sahin	**EE**	**Consultant.** *Will provide EE discipline technical support on as needed basis.*	**?**
Wayne Walter	**ME**	**Consultant.** *Will provide ME robotics discipline technical support on as needed basis.*	**X**
Environment	**EE/ CE**	**EE Senior Design Lab and 4th Floor – Senior Design Area.**	**X**
	ME	**4th Floor – Senior Design Area.**	**X**
	ID	**4th Floor – Senior Design Area.**	
Equipment			
	Test Equipment	**EE Senior Design Lab**	**X**
	Machining	***Contact Dr. Walters.***	
Materials			
Other			