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 the Planning phase 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.

- Project Name (tentative): **Projected Image Prototyping System**
- Project Number:
- Project Track: **Printing Systems**
- Project Family:
- Start Term: **Winter, 2010**
- End Term: **Spring, 2011**
- Faculty Guide *(project mentor)*: **Denis Cormier**
- Faculty Consultants *(disciplinary subject matter experts)*: **Marcos Esterman (hopefully)**
- Customer organization and primary contact (name, phone, e-mail):

  Denis Cormier, Industrial and Systems Engineering, 475-2713, drceie@rit.edu

- Principle sponsor or sponsoring organization: (*provider of financial support)*

  Denis Cormier – Brinkman Endowment

- Project Overview (*1-2 paragrapsh that provide a general description of the project: background, motivation(s), customer(s), and overall objective(s).*):

  The aim of this project is to design and fabricate a projected image photopolymer curing R&D platform. The system will use a Texas Instruments digital light projector (DLP) development system to project black and white ultraviolet (UV) light images onto a film of UV curable photopolymer in order to selectively cure/harden the polymer. Students will therefore design and construct a liquid resin spreading system, an optics system capable of transmitting and focusing a suitably powered UV light source, and the software needed to slice a 3D CAD model into the individual black and white images to be cured.

- Staffing Requirements: (*use WBS and associated resource estimates to summarize <u>anticipated</u> staffing needs)*

Discipline (*number*)	Skills required (*concise*)
EE (0)	
ME (3)	Machine design (enclosure, resin spreader, optical projection system, etc), motion control

CE (1)	Computer graphics – need to slice 3D solid models into 2D black and white slice images that can be projected.
ISE (1)	Fabrication, project management
Other	

- Continuation, Platform, or Building Block project information (*Include prior project number and title and to what extent previous results are being incorporated*): **N/A**.

DETAILED PROJECT DESCRIPTION:

- Customer needs:

  I need a projected light photopolymer curing system that is sufficiently flexible to allow process research and development involving (for example) different light sources, different optics, different photopolymers, etc.

- Customer deliverables (*Customer requested milestones, progress reports, and expected product*):
  - **Liquid resin spreading sub-system**
    - **Expected Product: A detailed design and implementation of a sub-system capable of spreading a thin layer of liquid resin to a specified thickness onto a platform upon which the part is being built.**
    - **Milestones:**
      - **Customer Requirements and Product Specifications**
        - **The team will determine the customer needs and will create a specifications document from those customer needs**
      - **Conceptual design**
        - **The team will research and document existing approaches and will brainstorm new approaches**
        - **The team will conduct a competitive benchmark of the approaches with respect to the specifications**
        - **Students will mock up simple spreading systems to assist with their understanding and evaluation of the different approaches**
        - **Students will report on which concept they've selected and why**
      - **Detailed design**
        - **Students will create a detailed design of the selected concept that includes CAD models that are appropriately dimensioned and annotated.**
        - **Students will create detailed parts lists for both "buy" and "make" items. For purchased items, the supplier, part numbers, quantities, unit prices, and extended prices will be provided.**
      - **Implementation**

- **Students will construct a functioning resin spreading sub-system along with operating details that include the interface with the systems level control (e.g. what is required to drive stepper or servo motors, interface with the E-Stop, etc).**

- **UV image projection sub-system**
  - **Expected Product: A sub-system that will project a focused binary (black and white) ultra-violet light image onto a layer of photocurable resin at a specified distance. Due to lead times and expenses involved with this sub-system, a Texas Instruments Digital Light Processing (DLP) projection development kit has been purchased and is already available. Students will be required to use this as the basis for their mask projection system. The DLP development kit allows developers to use their own light sources and optics and to control the projected image via external triggers.**
  - **Milestones:**
    - **Customer Requirements and Product Specifications**
      - **The team will determine the customer needs (feature sizes, cure times, etc) and will create a specifications document from those customer needs**
    - **Conceptual design**
      - **The team will research and document available UV light sources and UV transparent optics.**
      - **The team will conduct a competitive benchmark of the available technologies with respect to the specifications**
      - **If there are resources already available or available at low cost, students will mock up prototype projection configurations and will experiment with them in order to gain a better understanding of the problem they are trying to solve.**
      - **Students will report on which configuration they've selected and why**
    - **Detailed design**
      - **Students will create a detailed design of the selected concept that includes CAD models that are appropriately dimensioned and annotated.**
      - **Students will create detailed parts lists for both "buy" and "make" items. For purchased items, the supplier, part numbers, quantities, unit prices, and extended prices will be provided.**
    - **Implementation**
      - **Students will construct a functioning optical projection sub-system and will demonstration its use.**

- **Enclosure – A UV safe enclosure that houses the resin spreader, the UV projection system, and any other elements (power supplies, motion control boards, etc).**

- **Control System**
  - **Expected Product: Software that allows a user to load a 3D CAD model, slice it into black and white images to be projected, and all required GUI elements to control the system hardware. Source code must be provided that allows future students to modify and enhance the system.**

- **Milestones:**
  - **Customer Requirements and Product Specifications**
    - **The team will determine the customer needs (feature sizes, cure times, etc) and will create a specifications document from those customer needs**
  - **Conceptual design**
    - **The team will research rapid prototyping control software for other systems in order to understand basic features and functionality.**
    - **The team will mock up some GUI's for evaluation.**
    - **Students will report on which configuration they've selected and why.**
  - **Implemented Control Software**
    - **Students will deliver very well organized and commented control system source code capable of slicing CAD models, generating images at the user specified resolution(s), and then controlling the hardware.**

- Customer and Sponsor Involvement (*Describe role of customer and sponsor in the project, planned participation in design and project reviews, etc.*):

  I'm a faculty member working in the area of additive manufacturing. I will lead project reviews and will ensure that the students are on track. Dr. Esterman is also involved in 3D printing and has an interest in this topic.

- Regulatory requirements (*i.e. UL, IEEE, FDA, FCC, RIT*): **Students will need to be aware of the fact that the system enclosure must block harmful UV radiation, and it must have a safety interconnect that cuts power to the light source if the enclosure is opened. Photopolymers must also be handled and disposed of according to manufacturer's guidelines (i.e. gloves, eye protection, cure resin prior to disposal, etc).**

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

  The DLP development system has already been purchased. I will pay for the other system elements from the Brinkman endowment. Students will need my approval prior to any purchases, and all purchases must be processed by me to ensure that the available funds are not exceeded.

- Intellectual property (IP) considerations (*Describe any IP concerns or limitations associated with the project*): **N/A**

- Other (*Describe potential benefits and liabilities, known project risks, etc.*):

  I'm confident that this project is 100% technologically feasible, but the students will have to work hard right from the start of the project.

  This project has considerable potential to result in a long stream of future MSD projects that focus on topics such as improvement of the initial deposition system, development of novel material combinations with enhanced function, design and fabrication of multi-material devices that take advantage of the unique system capabilities.

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.
That is covered reasonably well in a preceding section.

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.

The distribution of tasks follows from the deliverables section. Mechanical Engineering students will have responsibility for mechanical design of the resin spreader sub-system, the overall enclosure with power supplies and safety interlocks, the optical projection sub-system, and all associated motion control. The Industrial Engineering student will be responsible for component fabrication in the Brinkman Lab and overall project management. The Computer Engineering student will be responsible for developing the software sub-system that slices a 3D CAD model and generates the black and white images for projection. He/she will also be responsible for the control system GUI.

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.
Grading and assessment will follow from the rubric. Each student will be responsible for specific sub-systems, and their sub-systems will be assessed per the rubric guidelines.

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).
In addition to the standard SDI topics, students will work with Dr. Cormier in the lab to get familiar with how RP systems and their software operate. They will conduct some simple photopolymerization experiments to get a feel for what we are after with this particular system.

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*)
Faculty			
Cormier	**ISE**	**Can provide the bulk of project guidance. Other involvement is welcomed though if interest exists from other departments.**	**X**
Environment			
Brinkman Lab	**ISE**	**Fabrication of parts, and location of the system itself**	**X**
Equipment			
		Components and materials will be purchased as needed by Dr. Cormier	**X**
Materials			
Other			

***Project Tracks**: Assistive Devices & Biotechnology, Aerospace Systems & Technologies, Vehicle Systems & Technologies, Systems & Controls, Sustainable Design & Product Development, Printing & Imaging Systems, Entrepreneurship & Business Development, Unknown.*

***Project Family**: a group of closely related (or interdependent) projects.*