

AC 2007-2386: DEVELOPMENT OF INTEGRATED PROJECT TRACKS FOR A COLLEGE-WIDE MULTIDISCIPLINARY ENGINEERING DESIGN PROGRAM AT RIT

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Development of Integrated Project Tracks for a College-Wide Multidisciplinary Engineering Design Program at RIT

Abstract

Since 2002, the Kate Gleason College of Engineering (KGCOE) at the Rochester Institute of Technology (RIT) has seen its Multidisciplinary Senior Design (MSD) program grow from a small pilot project into a college-wide initiative involving four departments and almost 400 students annually. While subtle adjustments have been made each year, a major redesign effort was undertaken prior to the 2006 academic year to improve program alignment with departmental objectives, to improve delivery efficiency and effectiveness, and to improve student and faculty satisfaction. Coordination of related projects and sharing of information between approximately 60 design teams in a given year, and preserving continuity of information from one year to the next has proven to be a challenging hurdle. This paper addresses the project definition process, which was overhauled to focus on the definition of related projects within a set of disciplinary “tracks,” consistent with academic programs and faculty interests. Emphasis was placed on the development of reusable and scalable platforms to lay the foundation for future project extensions, and to encourage cross-project and cross-department collaboration. The process by which project tracks, project families and individual projects were identified, screened, modified and ultimately selected will be discussed. The integral relationship between the Design Project Management course, which trains the future project managers and technical leaders of the multidisciplinary project teams, and the project definition process will be illustrated. The development of the Aerospace Systems and Technology Track, with particular emphasis on the Microsystems Engineering and Technology for the Future Exploration of Outer Space Regions (METEOR) family of projects will be used as a case example to illustrate the process.

Introduction

Project-based “capstone” design has become an integral component of the undergraduate engineering experience. As noted by Dym, et al.¹, this has been the standard academic response to address the need to produce engineering graduates able to practice in industry. The Multidisciplinary Senior Design (MSD) program at the Rochester Institute of Technology (RIT) arose from departmental capstone design experiences within Mechanical, Industrial, and Electrical Engineering². Since its inception in 2002, the program has grown from a small pilot effort into a college-wide initiative involving four departments and almost 400 students annually. In addition to the three original departments, Computer Engineering joined the program in 2004, although the department continues to offer a discipline-specific capstone course sequence. Students from other colleges at RIT are encouraged to participate in MSD and have done so sporadically (especially from Business and Industrial Design), but broader participation remains a long term goal deserving greater attention. Components of the current MSD program include a two-quarter course sequence entitled “Multidisciplinary Senior Design (MSD) I&II,” which constitutes the “design-build” core of the program; a third course entitled “Design Project Management (DPM),” which trains selected students for project management roles in MSD I&II

and facilitates early-stage planning and documentation. MSD I is primarily focused on planning and designing, while MSD II is dedicated to realizing and testing a prototype of the design.

Subtle adjustments to the MSD program have been made each year since its inception in 2002, however a major redesign effort was undertaken prior to the 2006 academic year to improve program alignment with departmental objectives, to improve delivery efficiency and effectiveness, and to improve student and faculty satisfaction. A working group consisting of department heads and key faculty spent the summer of 2006 reexamining strategic objectives, identifying critical issues, formulating solutions, and developing an integrated plan for launching a redesigned program in the 2006-07 academic year. Sub-teams focused on project selection, course content, and course delivery and logistics. The paper will focus on the project selection process. For a more detailed account of the course redesign and the activities of the other sub-teams, refer to Walter et al.³ and Bailey and DeBartolo⁴.

While it is clear that at the heart of the MSD capstone experience is the project, the project also represents an opportunity to accomplish objectives that transcend the MSD program. It is this opportunity that drove the development of project tracks, a set of related projects consistent with academic programs and faculty interests. Emphasis was placed on the development of reusable and scalable platforms to lay the foundation for future project extensions, and to encourage cross-project and cross-department collaboration. The remainder of this paper will discuss the needs and issues addressed by these tracks, summarize the process by which the tracks and projects are developed, illustrate an example track and conclude with a discussion of the benefits and implementation recommendations for other programs.

Background

A. Literature Review

Howe and Wilbarger⁵ surveyed over 400 programs and showed that only a very small number of programs offer a capstone experience that do not involve a project. While an overwhelming majority of these project teams were organized within a department, there was a significant increase from 1994 to 2005 in interdepartmental (i.e. multidisciplinary) project teams. This trend is not surprising given the desire to produce graduates that can practice in industry. Dym et al.¹ have highlighted additional benefits associated with project-based learning (PBL). These benefits include the development of engineering intuition resulting from the shift between divergent and convergent thinking modes which arises while working on a hands-on project, the ability to extend what has been learned in one context into another context, improved communication skills, and increased team cooperation skills.

While the benefits of PBL are clear, relatively little attention has been placed on the project selection process, nor on the strategic role that projects play within and beyond the capstone program. Amon et al.⁶ describe the process of identifying, selecting and implementing sponsored multidisciplinary projects at Carnegie Mellon University; Brackin and Gibson⁷ discuss the selection of appropriate industry projects at Rose-Hulman; a set of “do’s and don’ts” are summarized by Visiwanathan and Evans⁸ from their experiences with successful projects at National University; Bachnak et al.⁹ describe some of the project improvements due to changes

in the course structure at Texas A&M University – Corpus Christi. Some of the common and/or important themes that emerged are summarized below:

- Projects need to be appropriately scoped to allow for timely completion and a positive experience for the students – projects should be “fun”
- Projects should not be on the critical path of the sponsoring organization; however the results should be meaningful to them and a stakeholder needs to interface with the team
- Objectives of the project need to be clearly defined prior to the start of the project
- The project needs to be a design problem and not an analysis problem
- The project needs to be such that students manage the project, they need to be given the “freedom to fail”⁷
- The project needs to be diverse and complex enough to engage all members of the multidisciplinary team

These themes provide valuable insights into the project selection criteria, but they are tactical in nature.

B. Historical MSD Project Issues

In the past, MSD projects were proposed primarily by industrial sponsors. The projects were of interest to the sponsors, but typically they were not critical to the immediate success of the organization. Often, they were projects that were “on the back burner” due to a lack of personnel or resources. Despite considerable time and effort spent by the MSD director in the summer months to develop an adequate pool of projects for the fall quarter, sponsors often waited until the start of the fall quarter to propose projects, leading to project start-up issues and delays.

Project Definition Process

In order to give the MSD program team more strategic control over the interaction between projects and faculty research, to spread the effort more evenly throughout the academic year and to get an immediate start on the project once the quarter began, a new process was defined. This process will be discussed below.

A. Project Definition Paradigm

It is useful to preface the discussion on project definition by drawing analogies to fishing, hunting, and farming to describe the various means by which projects are identified. In the fishing scenario, some bait is put in the water (projects are solicited); we wait for the fish to bite (projects to come); finally we reel them in (try to make the project fit our skills, capabilities, and resources). In the hunting scenario, we identify target areas (select focus areas for projects); we pursue one or more targets (identify potential sponsors with common interests); lastly we bag the catch (try to make the project fit our skills, capabilities, and resources). In the farming scenario, we establish a farm (form a base foundation of skills, capabilities, and resources in support of one or more focus areas); we grow the crops (work with existing sponsors to build upon success); finally we harvest the crops (on a relatively predictable schedule, complete projects of increasing complexity). The issues that were identified above are partially due to the

reactive nature of being in the fishing and hunting paradigms where one has to adapt to the projects that come.

The idea of project tracks naturally aligns with the farming paradigm. Project tracks will help us to farm a concept -- to plant the early seeds of a technology in MSD, and then water those seeds with additional resources and talents, so that new technologies can emerge from RIT. Most people feel fulfilled when they are part of something larger than themselves. These tracks will help students understand where their project came from, and where it will be going after they leave.

More formally, a "track" is a general category of projects to which a student project may belong. Tracks are helpful for students seeking project membership in that they provide a way to look for a project in an area without knowing what the specific projects necessarily are. Tracks of projects are generally correlated with the various concentrations and options offered through the departments in the Kate Gleason College of Engineering at RIT.

Some of the key learning objectives of the MSD program that the projects most contribute to include the: (2) Ability to perform a critical analysis of requirements, engineering specifications, and the relationship between them. (3) Ability to integrate theory from a broad range of courses, laboratory exercises and co-op experiences to the solution of an engineering design problem. (4) Ability to employ a rigorous design process that includes ideation, analysis, synthesis, prototype implementation, and test against engineering specifications. (7) Ability to work effectively in a diverse team environment. (8) Ability to communicate and make tradeoffs, within and across disciplines, to meet project requirements. (9) Ability to explain the impact of project schedule, critical paths and budgetary constraints on the effective execution of an engineering design. Note, numbering matches course syllabus.

B. Project Selection Process

An overview of the project selection process is summarized in Figure 1. There are four feeders into the project pool: Industry-sponsored, faculty research, student initiated and the Design Project Management class. These project feeder streams will be discussed in greater detail below.

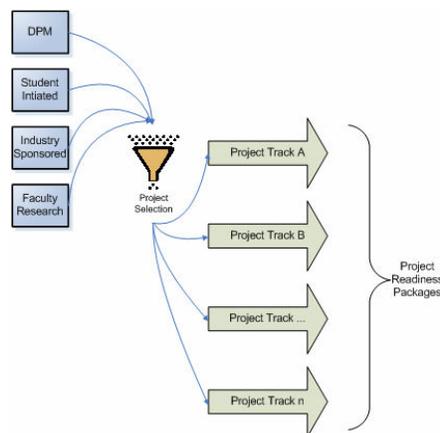


Figure 1: Project Selection Process

B.1. Project Feeder Streams

The first type of feeder is the industry sponsored projects. These include projects that may come from a company, a not-for-profit or external individual, to name a few. The main distinction in this case is that the MSD program is being directly engaged by the sponsoring company and some sort of sponsorship fee is typically involved. A second category of project feeder is faculty research. There are two main scenarios of project sponsorship in this case: (1) a faculty member has sponsored research that they wish to engage the MSD program for. (2) There is a new research stream or area that the faculty member wishes to investigate, and the MSD program can help enable that. In either case, the MSD project team may be delivering an outcome to support the research or they may be directly enabling the research. A third class of project feeder is student initiated. The intent here is two-fold. One of the objectives of the MSD program is to foster entrepreneurship. If properly defined, an entrepreneurial project can be one of the most motivating for students to work on and can lead to some of the most spectacular results.

The DPM feeder stream is primarily a project proposal development stream. In a previous paper Hensel and Stiebitz¹⁰, describe the development and implementation of the Design Project Management course at RIT. This course has two top-level objectives: (1) to build skills in leadership, project planning, problem definition, concept development, concept selection, and performance validation; and (2) to lay the foundation of the project assigned to them in preparation for the MSD team who will undertake the project in a subsequent quarter². It is this latter objective that is relevant here. By the end of the 10-week quarter, the DPM team will have produced the Product Readiness Package (PRP) that is expected of all project proposals.

It should be noted that while the PRP is generated with the guidance of MSD faculty, the PRP still undergoes the same review process as all of the other PRP's before becoming a formal project. Another interesting observation is that the national trend has been an increase in the number of industry sponsored capstone projects⁴, the bulk of MSD projects are from faculty sponsored research for the AY '06-'07. Having said that, the majority of the sponsored research does have industry backing, but it is the faculty member guiding the project.

B.2. Project Definition Process

Although the project definition process is still evolving, the criteria and the process that the MSD program is aspiring to is summarized below.

Project acceptance criteria:

1. *Committed sponsor*: There needs to be a clear stakeholder identified from the sponsoring organization that has a vested interest in success of the project and that is available on a fairly frequent basis. In addition, there needs to be a project sponsor that is responsible for providing financial support. These may or may not be the same person.
2. *Fully funded*: It is not the intention of the MSD Program to put project teams in a position to barter, acquire materials from auction web-sites, or use any of many creative material acquisition techniques. Instead, it is a goal to prepare them for industry and to expose them to standard processes of getting quotes, generating purchase orders and planning for the risks

introduced by the sourcing process. It is important that the needed funds be in place and that any materials, hardware, software, and services needed by project team be available.

3. *Fits into a defined track*: It is important that the projects tie into faculty research interests and/or educational thrusts. Since a goal of a track is to have a set of interrelated projects, the likelihood of generating future projects is another important consideration. The MSD program team may define a new track if the project is determined to be of strategic value.
4. *Must not prohibit students from meeting academic requirements*: information dissemination should not be restricted by the sponsor, intellectual property belongs to the students, timing must agree with course schedule, etc. While not a requirement, freedom from confidentiality constraints and intellectual property constraints are more desirable.
5. *RIT Champion identified*: faculty, student, or staff member interested and willing to provide internal support, particularly during the approval process (e.g. completed PRP). Ideally, the RIT champion is the project guide, but they may also be a DPM student, the project sponsor, an associate or liaison to the industrial sponsor, or the track Guide (same role as Guide, but over the entire project track).
6. *PRP approved by MSD Project Review Team*: The MSD program goal is to have a standing sub-team to review projects on an on-going basis as defined below. In addition to the criteria mentioned above, the review team will also consider the following.
 - The RIT expected resources need to be available. An important consideration is ensuring that the number of expected students matches the expected needs of the project. If a project is going to affect that mix, it may need to be postponed.
 - Ensure that the project will be multidisciplinary in nature and have a high degree of confidence that it will result in a positive experience for students.
 - All projects need to be in place before the start of the quarter.

The proposed review process is summarized below.

Project review process:

1. PRP draft prepared by sponsor, DPM student, or faculty/staff member.
2. PRP draft is submitted to the DPM instructor, MSD Program or Director for initial review.
3. PRP draft goes to review team and is assessed against acceptance criteria 1-4. It is at this stage that if the RIT champion is also identified if the project is not going to be rejected. Possible outcomes are (a) rejection, (b) postponement, or (c) identification of RIT champion to complete PRP.
4. If the RIT champion is not the project Guide, a project Guide is assigned.
5. PRP reviewed by project Guide. The Guide is responsible for securing reviewers from other departments and gaining approval from those reviews. The Guide is also responsible for any final changes needed before releasing the PRP to students.
6. Guide submits recommendation to MSD Leadership Team for final disposition: “accept”, “reject”, or “postpone”.

Again, it should be stressed that the program is still evolving and what is discussed above is what we are aspiring to. However, we have made great progress and expect to be in this state by the beginning of the next academic year.

B.3. Faculty Roles and Responsibilities

In the new MSD system, faculty members act as either “Guides” or “Consultants.” A Guide is a faculty member who is the primary mentor for the project. They are the most intimately involved with the entire process, and remain with the team for both quarters of MSD. Ideally the Guide is also an expert in the field of the project’s subject matter and the one championing the PRP. Upon project approval, they meet with their team weekly to help resolve technical issues and help resolve project execution issues. They are instrumental getting the team up to speed during the all-day workshops at the beginning of the MSD course and ultimately grade the team.

Technical issues beyond the expertise of the Guide can be referred to a Consultant. There are often many Consultants for each team, and consist of other faculty members, teaching assistants, or people in industry. The Consultants will usually have expertise or important knowledge in specific areas of the project. Ideally, they complement the Guide, and are usually from another academic discipline. The consultants will often give the Guide input on grading the team.

B.4. Current Project Tracks

Table 1 summarizes the tracks that are currently available. Note for example, the Sustainable Design and Product Development Track. Both the Industrial and Systems Engineering and the Mechanical Engineering Departments have academic programs in sustainability, as well as a Master of Science Degree that is currently under development. As an example of how a track can be used to develop a strategic objective, consider the Printing and Imaging Systems Track. At RIT, the College of Imaging Science has long been recognized as an international leader in the printing and imaging sector. By developing projects that are of mutual interest to both Colleges, we have fostered a more formal relationship between the two colleges.

Table 1: Summary of Project Tracks at RIT

| Track | Description |
|---|--|
| <i>Assistive Devices and Bioengineering Track</i> | Of interest to students in the bioengineering or biomedical options within their departments, or with an interest in applying engineering upon the foundation of the biological sciences. |
| <i>Aerospace Systems and Technologies Track</i> | Of interest to students in the Aerospace option, or with an interest in aeronautical systems, aircraft design, spacecraft design, launch and recovery vehicles, and space exploration. These craft may overlap with other vehicle systems, but have unique flight-related aspects. |
| <i>Vehicle Systems Technology Track</i> | Of interest to students in the Automotive option. This track includes water craft, underwater craft, trucks, cars, trains, inter-modal transportation and logistics, materials handling, etc. Also includes are IC engines, Fuel Cells, dynamometry, suspension systems, etc. |
| <i>Systems and Controls Technology Track</i> | These cross-cutting projects deal with the hardware and software of systems, modeling, controls, sensors, actuators, algorithms, etc. Students in this track may also have an interest in one of the other applications oriented tracks. Systems and controls generally include projects which are intended to have applications across the other tracks. |
| <i>Sustainable Design and Product Development Track</i> | Of interest to students in the Energy and Environment Option in Mechanical Engineering, students in the Sustainable Design minor, or taking the public policy minor from the College of Liberal Arts. Projects include small and large scale energy production and utilization systems including alternate energy systems, applications in under developed countries, or projects focused on product stewardship issues, e.g. recycling and reuse. |
| <i>Printing and Imaging Systems Technologies Track</i> | Of interest to students doing a minor in Imaging Science, or with an interest in imaging and printing systems. This track consists of projects that involve the development of printer or imaging systems or subsystems, hardware that supports the development of these systems, or projects that support hardware development for use in imaging and color science. |

Aerospace Systems and Technologies Track

Table 2 summarizes the projects that are currently in the Aerospace Systems and Technologies Track. Note that within each track, there are three distinct families of projects: the Microsystems Engineering and Technology for the Future Exploration of Outer Space Regions (METEOR) family of projects, the Micro Air Vehicle family of projects and the Modular, Open Architecture Unmanned Air Vehicle Platform (UAV) family of projects. All of these projects clearly align with the aerospace systems theme and they also align with ongoing research activities at RIT. Also note that while not shown, there are dependencies between tracks. For example, some of the electronics and control systems for the Aerospace Systems and Technologies Track will come from the Systems and Controls Technologies Track. So not only will there be coordination tasks within a track, there will be some across tracks as well.

Table 2: Aerospace Systems and Technologies Track

| P07100 | METEOR - Family of Projects | Start | End |
|---------------|--|--------------|------------|
| P07102 | METEOR Space Environment Test Stand | 06-1 | 06-2 |
| P07103 | METEOR Instrumentation Platform | 06-1 | 06-3 |
| P07104 | METEOR RITSAT1 Satellite | 06-1 | 06-3 |
| P07105 | METEOR Launch Vehicle | 06-2 | 06-3 |
| P07106 | METEOR Inertial Navigation and Guidance | 06-2 | 06-3 |
| P07107 | METEOR Mission Control Procedures | 06-2 | 06-3 |
| P07108 | METEOR Gliding Instrumentation Platform | 06-2 | 06-3 |
| P07109 | METEOR Rocket | 06-2 | 06-3 |
| P07110 | METEOR Test Stand | 06-2 | 06-3 |
| P07111 | METEOR Destruct system | 06-2 | 06-3 |
| P07120 | Micro Air Vehicle - Family of Projects | Start | End |
| P07121 | MAV Project | 06-2 | 06-3 |
| P07122 | Modular, Scalable, Autonomous Lighter-Than-Air Flight Vehicle | 06-2 | 06-3 |
| P08140 | Modular, Open Architecture Unmanned Air Vehicle Platform (UAV) - Family of Projects | Start | End |
| P08141 | UAV Airframe and Flight Controls | 07-1 | 07-2 |
| P08142 | UAV Fuselage Payload Interface and Release | 07-2 | 07-3 |
| P08143 | UAV Underwing Payload Interface and Release | 07-2 | 07-3 |
| P08144 | UAV Fuselage to Picosat Interface | 07-1 | 07-2 |

The remainder of this section will focus on the METEOR Project Family. This family is sponsored by Harris Corporation and is the first, university-based multidisciplinary project in the world whose ultimate goal is to launch and place small payloads on or near earth asteroids and lunar surfaces. While student groups at many universities have designed, built and operated small satellites for more than two decades, a complete launch system has never been attempted within academia. Furthermore, the challenge of developing technology for space exploration is a strong and appealing motive for students. Figure 2 illustrates a schematic representation of the system, which consists of: (1) Balloon, (2) Tether, (3) Parachute, (4) Stabilization Tethers, (5) Instrumentation Platform, (6) Rocket Suspension Lines, and (7) Rocket With Pico-Satellite Payload.

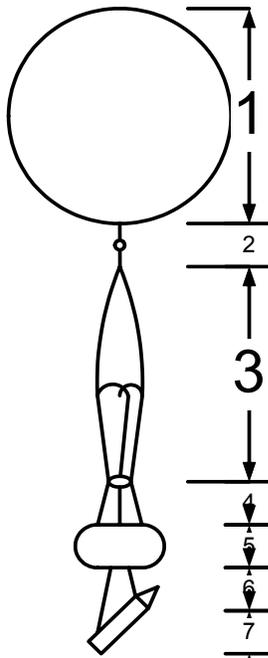


Figure 2: Launch System Block Diagram

The METEOR project has been in existence for over three years and the central focus of the project is the launching of a series of small payloads into low earth orbit, the low earth orbit re-launch and control of these payloads toward the moon or near earth asteroids, the landing of these payloads on the surfaces and the data acquisition and remote control of these payloads during the scientific research phase of each mission. This project will provide the students and faculty at RIT, and the scientific community at large, the opportunity to obtain small payload volumes for conducting micro-systems and other scientific experiments in outer space. METEOR will accommodate and promote these multi-disciplinary collaborations.

Table 3 summarizes the project plan associated with the successful launch of the system. As can be seen, this is multi-year effort involving many sub-projects for its successful execution. Each MSD team completes an original design or improves upon prior design of different subsystems of the launch system. The last column of Table 3 maps the projects from Table 2. Where generic project names are used it is because these are projects from previous years.

As a summary of progress to date, the first team started with the design of the instrumentation platform. Their work was continued and improved by the second team, which has successfully launched the instrumentation platform twice, without a rocket attached to it. This past year a third team further customized the instrumentation platform to lower its weight and volume. In parallel, a fourth team designed a rocket engine test stand and the fourth stage of the rocket. Starting this academic year, there are eleven multidisciplinary senior design teams associated with this project as is summarized in Table 2.

Clearly this family of projects can be continued almost indefinitely. As technology advances there will be opportunities to build a better and cheaper system. Furthermore, a major milestone will be achieved once the first pico-satellite can be placed in orbit. From that point on, the teams of each year will be able to see their work fly, which will be an unmatched incentive to get their implementation completed.

Table 3: Project Activities for the METEOR Project

| Phase | Activity | Objectives | Duration / Status | Students Involved |
|-------|--|---|--|---|
| 1 | Instrumentation Platform design and testing. | Design, implementation and testing of a high altitude balloon tethered instrumentation platform for use in Phase 4. | Started in Fall 2003 – on going | Platform Team 1 – 7 Platform Team 2 – 2 Platform Team 3 – 5 P07103 P07108 |
| 2 | Rocket design and testing. | Design, implementation and ground testing of a hybrid propellant rocket. | Started in Spring 2005 with the design of the 4 th stage, ~ 5 kg – on going | P07102 P07102 P07105 P07106 P07109 P07110 P07111 |

| Phase | Activity | Objectives | Duration / Status | Students Involved |
|-------|---|--|--|---|
| 3 | Pico-Satellite design, construction and testing. | Design, implementation and ground testing of the Pico-Satellite, to include a radio beacon. | Started in Spring 2004 – on going | Satellite Team 1 – 4 P07104 |
| 4 | Sub-orbital test flight of one rocket stage. | Test stage and guidance system | Summer 2007 – tentative date | |
| 5 | Complete Launch System testing. | The airborne testing of the complete launch system with the launch of an earth remote sensing Pico-Satellite. | Pending successful completion of previous stages | P07107 |
| 6 | Launch System improvements and upgrades / Pico-Satellite developments | Improve and upgrade the Launch System with state-of-the-art technologies / Develop Pico-Satellites tailored for scientific space experiments | Indefinitely | Platform Team ~ 6 Rocket Team ~ 6 Satellite Team ~6 |

Discussion

A. Advantages

An important advantage of the new track structure is that it can be tailored to departmental expertise and interest. At the same time, it promotes the leveraging of resources. For example, by aligning projects with faculty interests, faculty members become more engaged because they have a vested interest in the project outcome. This eliminates the problem of faculty who view guiding a project team as an additional burden for which they get no recognition. The students have a strong motivation to succeed because they know that not only are they part of a larger effort, there is an interested stakeholder eagerly awaiting the outcome.

The track system also provides the ability to continue projects over several years. Students do not have to reinvent the wheel but can leverage past project work, giving them important context in which to design. Faculty and the College also benefit as “the sum of the parts will be greater than the whole”. As noted earlier, an important objective is to allow the emergence of new technologies from RIT, and this system will enable that if a series of projects is properly defined, as the METEOR project has done.

Given the closer ties to faculty interest, more collaboration opportunities will arise; not only between faculty, but between students, as well as between faculty and students of different disciplines. As noted in the Printing and Imaging Track example, this has been a proven mechanism to promote and accelerate these collaboration opportunities.

Another advantage of the track system is the flexibility that it can provide. Consider a proposed project that has a scope that will not fit into the 22-week constraint of the two quarters. It can still be accomplished by wise partitioning of the effort within the same MSD cycle or over several MSD cycles. Projects can also be scaled so that a deliverable may be the first design iteration that is then passed to the subsequent MSD team to refine the design. This provides yet another mechanism for the students to feel a sense of accomplishment for their contribution.

B. Words of Advice to Other Programs

A strong leadership team that is committed to success is absolutely essential. The work involved to define the project tracks, manage the workshops, handle student logistics, etc., is not trivial. It

is not something that can be accomplished in a haphazard manner and needs a great deal of focused attention not only from a leadership team, but an individual who acts as a point of focus. At RIT we are fortunate that we have a strong program manager as the program director and that we have strong support from the Dean of the College.

Faculty buy-in and support are also essential to the success of the program as well as to ensure a positive student experience. The key to achieving this buy-in comes in the recognition that the MSD platform can be used to enhance faculty's ability to perform scholarly research. If the MSD project is viewed as one of many mechanisms that can be used to perform research, it can be effectively integrated into an overall strategy that yields good results. As examples, graduate students can be cultivated by working as part of the MSD project that is related to current faculty research; key research instrumentation can be developed and improved over several cycles of MSD projects; the outcomes of the MSD projects can feed summer internships and summer graduate work.

Cross departmental communication is always important. Students will be working across disciplines and it is important that they are receiving a united message concerning expectations and deliverables. Equipment use may also be an issue depending on the facilities structure of the departments and colleges.

C. Closing Remarks

At this point the data is only anecdotal, but the track structure has received good reviews from the faculty and the students. As the assessment data are collected, the program will be in a better position to assess the benefits of this structure and can report these findings in a future paper.

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