

**AC 2010-2032: THE COACH'S GUIDE: BEST PRACTICES FOR
FACULTY-MENTORED MULTIDISCIPLINARY PRODUCT DESIGN TEAMS**

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The Coach's Guide: Best Practices for Faculty-mentored Multidisciplinary Product Design Teams

Abstract

Faculty mentors, also known as *coaches*, have two overarching roles when mentoring industrially sponsored capstone design projects: (1) ensure the team achieves the academic goals of the course, and (2) keep the team focused on the design project goals.

The Integrated Product and Process Design (IPPD) program at the University of Florida is a fully institutionalized experiential educational course sequence. Through weekly classes held over two semesters (eight months), students from various engineering and business disciplines are taught how to design products and processes. Then working in small multidisciplinary teams the students design and build authentic industrial products under the guidance of faculty coaches and industrial liaison engineers representing the sponsoring companies.

Over a fourteen-year period, spanning more than 340 industry-sponsored design projects, a wide variety of interaction patterns have been observed between project teams and their coaches. With help from the best faculty coaches, and guidance from published literature on team dynamics and “coaching for success,” a “how-to” guide was developed as a resource for faculty project coaches. This guide includes elements such as an overview of the IPPD program, roles and responsibilities for various stakeholders, a collection of best practices for mentoring and conflict management, and a frequently-asked-questions section. Since the IPPD program is multidisciplinary, an appendix with a set of expectations for each participating undergraduate discipline was developed.

The *IPPD Coach Guide* is intended to be a framework for capturing and sharing with the capstone design community a set of best practices for team mentoring.

Introduction

The Integrated Product and Process Design (IPPD) program¹⁻⁴ is an innovative educational initiative at the College of Engineering of the University of Florida. In weekly classes spanning two consecutive academic semesters, (eight months), students from various engineering and business disciplines are taught how to design products and processes. Then, working in small multidisciplinary teams under the guidance of faculty coaches and industrial liaison engineers, the students design and build an industrial product or design a manufacturing process to specifications established in collaboration with the sponsoring company.

The IPPD program is institutionalized at the University of Florida and since its launch in 1995, over 340 industry-sponsored multidisciplinary projects have been completed, with the participation of more than 1900 students and 50 faculty coaches, and hundreds of company sponsor liaison engineers. While the IPPD development process is well defined and 90% of the projects are deemed successful, there is wide variability in the patterns of the interactions between the faculty coaches and their student teams.

Participating faculty coaches are compensated for their work with the project teams through teaching load relief, summer salary, or graduate-student funding support. Further, each coach is considered the principal investigator for the sponsored design project. While these incentives may be enticing, it is apparent that most coaches truly enjoy working with the student teams and contributing to the development of these emerging young engineers. The management style of the coaches ranges from hands-off, to equal-among-peers, to autocratic.

Each year brings new projects, new students, and many new challenges (logistical, managerial, technical, and financial) for the coaches to deal with. Further, coaches for student teams in multidisciplinary capstone design courses frequently lack teaching paradigms that can be called upon to serve as a guide when making pedagogical and team-management decisions. In other words, few faculty experienced multidisciplinary capstone courses in their own education and simply do not have those pedagogical patterns available to apply to capstone teaching. Anecdotally, we have observed that some coaches have proven to lead successful projects year in and year out, regardless of the technical and emotional maturity of their teams, while other coaches only deliver strong results if their team is exceptionally strong. A how-to guide was envisioned to effectively capture and concisely present the best coaching practices and make these available to all coaches. The guide would provide a framework for establishing expectations for new coaches as well as providing a written resource for new and experienced coaches.

The IPPD program had acquired experience in preparing a how-to guide for a different class of users, namely the industry-liaison engineers who represent their companies in the student-led design activities. A faculty retreat was held in May 2008 to develop an outline for that guide. The faculty nominated exemplary liaison engineers, and best practices were gathered from a description of these engineers' modes of operation, and consolidated into the *IPPD Liaison Engineer Guide Document*⁵⁻⁶. To supplement the guide, a comprehensive set of university resources were identified and made available to the liaison engineers. These resources include library privileges, university e-mail accounts, and access to certain campus software licenses (note: football and basketball tickets were *not* available).

To initiate the creation of the coach guide, an IPPD faculty retreat was held in May 2009. Four challenge questions were posed to the faculty coaches. Brain Writing⁷, a small-group idea generation technique, was used by teams of faculty to generate content to be incorporated into the guide. The faculty then developed Affinity Groups⁸ from the concepts. These affinity groups became the chapter headings for the guide, and the concepts within the groups were transformed into an outline for each chapter. Arif Mohsin, a graduate student, produced the first draft of the guide from the outline and the concepts contributed by the coaches. Arif researched a variety of mentoring and management concepts that were folded into the guide. A working draft, *IPPD Coach Guide: A Resource for Mentoring Project Teams*⁹, was made available in August 2009 for use in the 2009-2010 IPPD program.

Motivation

The IPPD Advisory Board strongly endorsed the concept of creating guides for the stakeholders in the program. This endorsement grew out of concern for improving the overall effectiveness of the IPPD program in meeting educational goals and for maintaining long-lasting relationships

with sponsoring companies. The *New Engineers Training Manual*¹⁰ defining all the program deliverables was developed in the first year of IPPD activity. This guide establishes expectations for the students. Over the years, administrative assistants for the IPPD program have developed “how to” guides for processing team travel, purchasing, and event planning. In 2008, a guide was developed for the liaison engineers at the sponsoring companies. The *Liaison Engineer Guide Document* clearly defines the liaison’s role and provides best practices captured from past liaisons for interacting with the student teams. The coach guide was the only missing piece of the “how to” document for the IPPD stakeholders.

It is important to note that the coaches are *enlisted* rather than *assigned* for participation in the IPPD program. The IPPD director recruits faculty coaches based upon how well their expertise aligns with a given project’s technical expectations and how interested they are in mentoring students. New coaches have to be convinced this endeavor is something they have time for and that they would enjoy. A frequently asked question during the recruiting process is “what is expected of me?” This question led to many lengthy and unstructured conversations. The *IPPD Coach Guide* has provided the director with a comprehensive and systematic tool for informing new faculty coaches about the program’s performance expectations.^a

Lastly, few of our faculty members experienced an intensive multidisciplinary capstone design course in their undergraduate education. All have experienced more traditional lecture-based courses that follow a text or set of prepared notes, involve homework assignments created by the instructor or taken from a text, and measurement of student achievement through examinations. When faced with preparing and teaching such a traditional course, faculty are often fortunate to have taken such a course as an undergraduate, and draw upon personal experience (and perhaps course notes, homework assignments, and tests). Mentoring likely plays a smaller role in the traditional course, whereas in a capstone course, mentoring plays a major role. Project-based learning in a multidisciplinary capstone environment requires dealing with team management issues, meeting technical goals from an external client, and balancing satisfaction of ABET outcomes for academic disciplines where one may not have firsthand knowledge. The *IPPD Coach Guide* has provided a framework of tools for faculty coaches to address these and other pedagogical challenges faced in mentoring multidisciplinary capstone project teams.

Liaison Guide

The *Liaison Engineer Guide Document* was published in 2008⁵⁻⁶. It serves the main purpose of informing liaison engineers of their role and shares best practices from past outstanding liaison engineers and faculty coaches. The liaison guide has been adopted by another university for its capstone program.^b

Coach Evaluations

Students evaluate their coach at least twice per semester. The evaluations assess the following aspects of the faculty member’s performance:

^a One might be concerned that too much information about expectations could have the opposite effect—discouraging well-qualified faculty (“you want me to do all that?”)

^b University of Colorado-Boulder

- Most valuable thing learned from the coach
- Balance of direction and independence
- Availability
- Overall rating
- Comments for improvement

Numerical ratings are provided for the Availability and Overall ratings. The data for Fall 2008 and Fall 2009 indicate that most students rate highly their coach’s availability and overall effectiveness. See Table 1. Note that the pre-guide (Fall 2008) and post-guide (Fall 2009) ratings are nearly identical for each measure. One could conclude that the coach guide has had no measurable impact on the students’ ratings of faculty coach availability and overall effectiveness. This could mean that the guide was not utilized or that the coaches were already using the best practices anyway. Feedback from liaison engineers in Spring 2009 indicated that after reading through the liaison guide during Fall 2008, many had forgotten all about the guide and did not proceed to consult it.^c

Table 1 Student ratings of faculty coach availability and overall effectiveness

Statistic	Availability		Overall	
	Fall 2008	Fall 2009	Fall 2008	Fall 2009
mean	4.45	4.45	4.53	4.52
mode	5	5	5	5
median	5	5	5	5
std dev	0.72	0.73	0.67	0.67
N	218	186	218	186

where low = 0 and high = 5

Policies and best practices

The *IPPD Coach Guide* provides a place to capture policies and best practices for managing teams, working with sponsors, assigning grades, and dealing with difficult situations. Team management includes considerations such as frequency of meetings, formality of meeting practices (announcements, agendas, and minutes), and the establishment of roles within the team. Faculty coaches must work with the sponsors to balance educational objectives with design project objectives. Further, the weekly interactions with sponsors may be quite demanding for faculty used to a more typical hands-off approach from their funding sources. Grade assignment is based primarily on the coach’s assessment of the student’s performance. The grading policy was documented in the *IPPD Coach Guide* to ensure consistency across the distributed project teams. Difficult situations include handling non-responsive team members, liaison engineers, and suppliers. Since students apply to participate in the program and in addition have opportunities

^c If this were a reading assignment, perhaps a quiz could be administered!

for enrolling in alternative discipline-specific capstone courses, removal of a student from an IPPD project team is a possible option that can be exercised by the coaches.

IPPD Coach Guide Elements

The creation of the guide included a definition of the writing style, and a selection of the topics that populated each section. Details of some of these elements are given below.

Writing Style

The *IPPD Coach Guide* is organized in thirteen sections that extend a length of 32 pages. To facilitate access to the contents, each section is written using a structure based on numbered paragraphs and subparagraphs and bullets, deliberately avoiding lengthy narratives.

In most sections an overview of the topic covered is presented in a brief numbered subsection entitled *Preamble*. For example, the first line of Section 2 appears as “2.1 Preamble”. Rather than emphasizing a list of contents, the Preambles are written to provide motivation that highlights the importance of the topic of the section. For example, the Preamble for the section entitled *Conflict Management* is as follows:

“Everyone in a team is a human with different cultural and social backgrounds and experiences, and it is then only natural to have differences in opinion among team members. These differences can often lead to conflicts that can be destructive and hinder the realization of the full potential of the team. Alternatively, a situation of conflict can be positive, helping in the development of new ideas, open up opportunities to gain new information, bring creative alternatives to the table and encourage team building. The team leaders, members and the coaches should acknowledge from the beginning that conflicts are inevitable, and reach a consensus at the initial meetings on ways to deal with conflicts to realize its positive potential and avoid its derogatory consequences.”

Note that the Preamble does not list the ensuing subsections, which are entitled *Intervention*, *How to Identify Problems in a Team*, etc. The focus is instead placed on the reasons why conflict occurs, and on the benefits of proactively addressing the issue of conflict on the early-term team meeting. Our intention was to provide a contextual framework that would motivate the target audience, essentially current or prospective faculty coaches, to engage in the reading of the ensuing subsections given the created anticipation of the benefits to be gained from a mastery of the material.

Overview

The *IPPD Coach Guide* begins with a message from the IPPD director outlining in brief the expectations for the coaches. An overview of the IPPD process follows. Next, the roles of the players are defined. The players are the IPPD stakeholders and include the IPPD director, IPPD advisory board, coaches, liaison engineers, and the students. A set of job titles within the project team, such as team leader, facilitator, finance and travel minister, web master, and research librarian are specified. Available administrative support is discussed next. This section includes job descriptions of the IPPD program assistant and IPPD systems administrator, as well as an

overview of the IPPD facilities, travel and purchasing procedures, and computer resources dedicated to the program.

The next five sections are devoted to best practice management materials gathered from the most successful IPPD project coaches and from published literature. A bulleted list of do's and don'ts leads this group of topics. A section devoted to guiding coach behavior follows. This chapter establishes detailed expectations for a coach, and provides tips on being a good motivator and communicator. Management concepts, including team start-up practices, tips for organizing and planning, and techniques for selecting and managing the team leader, are introduced next. A chapter devoted to conflict management provides guidelines for intervention, ways to identify team problems, and procedures for firing people (explained in the next subsection of this paper) and dealing with inactive sponsors. The final chapter in this grouping provides guidance on student performance and grading.

The last sections of the guide include frequently asked questions, an appendix defining expected skills and capabilities of the various student disciplines that participate in IPPD (for instance, an industrial engineering major can be expected to develop a project plan, a detailed business case, a facility layout, the quality and manufacturing plan, and a decision support application). A glossary of terms and a bibliography provide the final elements of the *IPPD Coach Guide*.

Terminating Students

A unique feature of the IPPD program is that when a conflict becomes irresolvable after reasonable intervention approaches have been conducted, then the coach may proceed to terminate (effectively fire) one or more team members. Termination amounts to removal of the offending team members from the team. In the case that no other team is available to incorporate the terminated individual in a fashion that is conducive to improved overall benefits to the program and the students, then the terminated student will be asked to stop participating in all program activities and will be assigned a non-passing grade in that semester. The reason why a termination procedure is made available to the coach is that the persistence of some irresolvable conflict effectively threatens the success of the project and leads to the development of an unacceptable learning environment for students in the program.

The *IPPD Coach Guide* provides the coaches with a list of reasons that may lead them to initiate a termination process. These includes conflicts arising from an individual's repeated failure to carry a fair share of workload or to deliver work of acceptable quality, for failures to attend workshops, or for acts of insubordination towards the coach or team leader in a fashion that compromises the timely progress, the quality, or the success of the project.

The guide also provides for a termination procedure to be followed. After having exhausted all reasonable intervention methods, the coach can call for a termination meeting, where all team members discuss the adverse impact of the individual's unacceptable performance or behavior, and provide an opinion on whether a termination is due. The coach then makes a decision of whether to proceed to terminate the individual in question, ensuring that all the university by-laws regarding the assignment of failing grades are followed.

Assessment Plans

A preliminary assessment of the *IPPD Coach Guide*'s impact on student perceptions of the coach's performance, as mentioned earlier was inconclusive. This assessment approach will likely not provide much insight into utility of the document. We propose instead to approach assessment from two main perspectives. First, we will seek out those faculty who have either declined offers to coach or have expressed an interest in coaching, but have yet to participate, and lastly, those faculty who have not coached projects in the previous five years. From this cohort, we will explore their comments to questions related to the following:

How did the content of the IPPD Coach Guide assist you in making a decision about joining or declining to join the IPPD faculty?

The second assessment group will consist of faculty that are current, active coaches. From this cohort, we wish to gather specific feedback on the content of the *IPPD Coach Guide* and its utility. Questions for this group will focus on the following veins:

Did the IPPD Coach Guide provide information to empower you to take corrective action with your project team? If so, in what way?

What elements from the IPPD Coach Guide have you incorporated into your coaching style and what impact have these changes made on (1) the performance of the project team, (2) the sponsor's satisfaction with the project results, and (3) your overall assessment of the success of the project?

Assessment from the capstone design education community will be sought after the guide has completed a second year of use and revisions based on internal evaluation have been incorporated.

Conclusion

A working version of *IPPD Coach Guide* was introduced to the IPPD coaches in August 2009. The document is structured in a bulleted format so coaches can quickly identify resources and tips for handling specific project team and team member management issues and situations. A major revision is underway to add content and simplify the ease of navigation. Assessment of the guide's effectiveness will be completed in April 2010. This assessment will provide feedback from potential and former IPPD coaches on how the content of the guide will influence their decision regarding future participation as an IPPD coach. Feedback from current, active coaches will be used to determine how useful the guide is in practice. The results of these assessments will guide further revisions. Ultimately, review and adoption of the *IPPD Coach Guide* by the capstone education community will be sought.

Acknowledgments

The authors acknowledge the efforts of the entire IPPD faculty for providing the best practices that form the foundation of the *IPPD Coach Guide*. The IPPD program acknowledges the generous support of the National Science Foundation and the SUCCEED Coalition for providing seed funding to help establish the IPPD program.

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