Enhancing the Coach's Performance: Effective Propagation of Pedagogical Techniques, Resources, and Know-how

R. Keith Stanfill and Oscar D. Crisalle
University of Florida

A common challenge faced by faculty serving as coaches for student teams in multidisciplinary capstone design courses is the lack of teaching paradigms that can be called upon to serve as a guide when making pedagogical and team-management decisions. We have addressed this challenge by creating a document entitled *IPPD Coach Guide: A Resource for Mentoring Project Teams* that compiles a set of best practices and catalogs available program resources with the goal of enhancing the coach's effectiveness in directing the evolution of the design project and assisting the students in reaching all learning objectives. The guide serves as a tool that enables the propagation of pedagogical techniques, identifies all available administrative and material resources, and archives the program's historically acquired know-how basis. This paper describes the mechanics followed to arrive at the generation of the guide, including the methodology used for harvesting collective knowledge from the most experienced faculty coaches, using techniques ranging from a directed faculty-retreat event to systematic idea mapping and management approaches such as a challenge-question environment and the adoption of affinity-group analysis. The guide also serves to recruit and train new coaches, to establish policies, and to serve as a contextual framework for extramural program reviews. A brief overview of the contents of the guide is provided including succinct representative examples of the material included. The guide may serve as an example tool that could be of utility to other capstone design courses interested in promoting improved uniformity in quality of pedagogical delivery and increased coach effectiveness.

Introduction

The University of Florida offers the Integrated Product and Process Design (IPPD) program[1-4] as an undergraduate capstone design course. The program lasts for two consecutive semesters (for a total of eight months), and the students work in small multidisciplinary teams directed by a faculty member serving as design *Coach*. The design project is proposed and financially sponsored by an industrial partner recruited from a diverse commercial pool that includes the chemical processing industries, the parts-manufacturing industries, microelectronics, pharmaceutical, aerospace, defense, and food industries, among many others. The coach leads his or her team through the design and build of a unique product and an accompanying manufacturing process. Hence, the projects vary widely in terms of the types of engineering knowledge that is required to execute the requested design.

Not only is the nature of the design projects very different every year, but also the composition of the student team assigned to a given coach changes in a significant fashion. The team typically consists of five to six students recruited from chemical, electrical, mechanical and aerospace, industrial, civil, and environmental engineering, as well as from materials, packaging and computer sciences and business majors. Each multidisciplinary team is formed in a fashion that best fits the requirements of a specific design project, and as a consequence every year the coach may find himself or herself working with a team of vastly different curricular backgrounds. The coach interacts with a team via weekly workshops rather than through standard lectures, and is hence constrained to adopt a less traditional venue for pedagogical delivery to suit the course format.

The diversity of projects and student teams pose a challenge to the coach's ability to perform his or her pedagogical duties with efficacy. For example, the coach's pedagogical and management techniques that may have led to the successful design of a new chemical-sensor in the preceding academic year may not be easily adaptable for deployment with a new team of students working on the design of fuel-cell power generator in the current year. In addition, in a preceding year the coach may have led a team composed of students with skills closely aligned with electrical and industrial engineering curricular topics, while in the current year the students may have no such academic preparation and yet be well trained to address topics more typical of the chemical and material science curricula. The coach is then faced with the need to modify his or her pedagogical approach to appropriately suit the abilities of the current team of students, a

process that often involves an inefficient, and potentially ineffective, trial-and-error approach.

When teaching a course that follows the more standard paradigm of teaching and learning through the use of lectures, homework assignments, quizzes and exams, most faculty can easily make decisions on what they may anticipate to be an effective pedagogical strategy. Such decisions can be based on their own experience as undergraduate students, when they enrolled in many conventional-format courses. That experiential reference frame can be used by the instructor to decide to teach as his or her own teachers taught. More important, the personal experience can reliably guide the introduction of subtle improvements based on what they perceived as particularly efficacious and the rejection of what they perceived to be of lower pedagogical value.

Unfortunately for the coach, the IPPD capstone course at the University of Florida does not include homework assignments or exams, because the deliverables that comprise the design project take their place. In addition, the coaches do not participate in the lecture component of the course. Given that most faculty members did not have the opportunity to enroll as a student in courses with a similar structure, there is a complete absence of a paradigm that the coach can emulate and refine.

The pedagogical literature addressing the needs of instructors leading capstone courses is vigorously growing in content and accessibility, but it nevertheless remains relatively small in scope and generality. Note that an instructor involved in the teaching of a standard course may easily learn and quickly implement pedagogical techniques well known for their effectiveness, such as cooperative-learning exercises, guided learning, mastery-progress (also known as self-paced learning), *etc.*[5]. In contrast, a coach in the IPPD course finds that those standard techniques are not easily extrapolated for application under the constraints of a design-driven teaching environment, where many of these methodologies are simply ill suited for adoption.

The IPPD program holds weekly coaches' meetings, where pedagogical techniques of particular value to the workshop mode of instruction are discussed. This effort, however, is only of limited impact for several reasons. First, the meetings need to address course-management issues that reduce the available time for discussion of other topics. Second, some repeat-participant coaches do not find it constructive to be redundantly exposed to a particular topic when the beneficiary may be only a first-time coach. And finally, some coaches find it impossible to attend all the meetings and may therefore deny themselves the opportunity to become familiar with a best practice that could be of particular usefulness for his or her current design project circumstances.

In summary, a coach faces pedagogical challenges that emerge as a consequence of radical changes made on an annual basis to the nature of the design problem and to the skill set of the student team. The coach is inhibited in his or her ability to overcome these challenges in an effective and efficient fashion because of the lack of a reference teaching paradigm readily available for emulation, and because of the relative scarcity of specific literature references. We address these challenges through the creation of a document entitled *IPPD Coach Guide*[6] that is designed to provide a coach with rapid access to a set of best practices that can be adopted to respond to a variety of pedagogical scenarios that are in some sense unique to the capstone course constraints. The intention is to provide the coach with a tool that can assist in enhancing his or her ability to deliver a more effective pedagogical experience.

The creation of the *IPPD Coach Guide* is also motivated by other objectives. These include providing the coach with lists of all relevant program and university resources available to support the teaching mission, assisting the IPPD director in recruiting new coaches who need to be informed about the expectations of the program, and to serve as a guide that can assist extramural reviewers in conducting a meaningful analysis of the program.

Mechanics for Generation of the Guide

The creation of the guide involved the following steps: (*i*) the compilation of a list of best practices, (*ii*) the organization of the best practices into logical groups, and (*iii*) the creation of a final document. We approached each step using systematic methodologies, as discussed below.

An IPPD faculty retreat was held in May 2009 to initiate the capture of a set of best practices. Additional goals of the retreat included fostering teamwork amongst the faculty (we must practice what we preach) and generating in the faculty a feeling of ownership in the *IPPD Coach Guide*.

A graduate student who did not have any prior experience with the IPPD program was present during the retreat and was charged with producing a first draft of the guide from the outline and the concepts collected by the coaches' efforts. His official role during the meeting was that of *Scribe*, with the responsibility of recording all findings.

Approximately 15 faculty members and staff participated in the May 2009 IPPD retreat. Some of the most experienced IPPD coaches were present, providing an excellent opportunity to capture best practices directly from the practitioners. Two groups of 5 to 6 began the process of generating ideas using the Brain

Writing[7] technique. Participants wrote coach guide ideas on Post-it Notes™ which were then posted on 11 inch by 17 inch paper. After 2 minutes, the participants passed their idea sheets to the right and received a sheet with new posted ideas. During the next 2 minutes, the participants reacted to the new ideas or continued to contribute ideas. The process of ideating and swapping continued for about 10 minutes, after which ideas were exchanged between tables. After four or five rounds of ideating and swapping, about 40 topic ideas were recorded.

To arrange the ideas into logical collections, each table was asked to use the Affinity Group[8] process. After grouping the ideas, the table participants were asked to create category names for each grouping and then arrange these names and ideas into a table of contents for the guide. Each work group presented their table of contents on a flipchart. The flipcharts and raw ideas became the basis for the *IPPD Coach Guide*.

In the last thirty minutes of the retreat a small group of faculty volunteered to create a more comprehensive table of contents for the *IPPD Coach Guide*. This working group presented the table of contents for the other retreat participants and included on-the-spot modifications based on the group's input.

After the retreat event the Scribe's role was changed to that of *Draft Editor*, with the assignment to write the retreat findings into an initial document and to include into that draft literature citations to a variety of mentoring and management techniques that were identified during the retreat. The Draft Editor asked for editorial contributions from all IPPD faculty, a process implemented using *Google Docs*[9], an Internet-hosted editing system, to store the document work-in-process. This approach eliminated the practice of e-mailing drafts and provided the team with an always up-to-date file for review. A working draft of the *IPPD Coach Guide: A Resource for Mentoring Project Teams* was made available in August 2009 for use in the 2009-2010 academic year.

Overview of the Guide's Contents

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 program follows. Next, the roles of all IPPD stakeholders are defined, including the IPPD Director, IPPD Advisory Board, coaches, liaison engineers, and the students. A set of job titles within a student team, such as team leader, facilitator, finance and travel minister, webmaster, and research librarian, are specified. The available administrative support is discussed next, including 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-practices materials regarding student-team management. A bulleted list of do's and don'ts leads this group of topics. A section devoted to guiding coach behavior and expectations follows, including in addition a series of tips on how to be 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 coach intervention for positive problem resolution, techniques to identify team problems, and procedures for firing team members and dealing with inactive industrial sponsors. The final chapter in this grouping provides guidance on assessment of 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, a 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*.

Uses for the Guide

The following list includes the primary uses we envision for the *IPPD Coach Guide*, where we anticipate that the guide contents can serve as strong leverage:

1. as a training resource for new coaches
2. as a repository for standards of practice
3. as a uniform collection of policies and procedures
4. as a tool for recruiting new coaches
5. as a reference framework for producing meaningful and useful program assessments by external reviewers

The *IPPD Coach Guide* provides a way for the IPPD Director to train new faculty through the "Teach-the-Teacher" paradigm. Faculty time is in short supply and the guide provides an efficient structure for educating our coaches.

Uniform standards of practice address such items as how often should the coach meet with the team, how should the team be organized, and how should the coach provide feedback to the team. The standards of practice establish a minimum set of expectations for the coach to meet.

Uniform policies and procedures address items such as how to provide grades to the team and to individuals, how to escalate issues to the IPPD Director (for example, what to do if the sponsor becomes inactive),

and how to deal with low performing or disruptive team members. A procedure for firing a disruptive or otherwise counterproductive team member is documented.

Potential coaches need to know what is expected of them before they commit their time, energy and talent to the IPPD program. The guide provides a structural support for an efficient discussion between the recruited coach and the IPPD Director, clearly identifying the expectations for the coach.

The *IPPD Coach Guide* will also provide external reviewers with a set of standards upon which to produce meaningful and useful program assessments. We expect the guide to be an invaluable resource during the 2012 ABET assessment at the University of Florida.

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 and team-member management issues. 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 promoted.

Acknowledgments

The authors acknowledge the efforts of the entire IPPD faculty, with special thanks to Dr. Suleyman Tufekci and Dr. Carl Crane III who served with the authors on the *IPPD Coach Guide* working group. Our Scribe and Draft Editor, Arif Mohsin, did an outstanding job gathering references and developing the initial draft 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 program.

References

1. Stanfill, R.K., Wiens, G.J., Lear, W.E., Whitney, E D., "Institutionalized University and Industry Partnership in Multidisciplinary Design and Build: Product and Process Realization," Proceedings of the 2001 ASME International Mechanical Engineering Congress and Exposition, November 11-16, 2001, New York, NY, 11 pp. (CD-ROM, Book No. I00517).
2. Stanfill, R.K., Crisalle, O.D., "Recruiting Industry-Sponsored Multidisciplinary Projects for Capstone Design," Proceedings of the American Society for Engineering Education Southeastern Section 2003 Annual Meeting, Macon, GA, April 6-8, 2003, 12 pp. (CD-ROM).
3. Fitz-Coy, N., Mikolaitis, D.W., Stanfill, R.K., Vu-Quoc, L., "Maintaining Industry Partnerships in Integrated Product and Process Design Education," Proceedings of the American Society for Engineering Education 2002 Annual Conference & Exposition, Montreal, QC, June 16-19, 2002, 13 pp. (CD-ROM).
4. Stanfill, R.K., Wiens, G.J., Eisenstadt, W.R., Crisalle, O.D., "Lessons Learned in Integrated Product and Process Design Education," Proceedings of the American Society for Engineering Education Southeastern Section 2002 Annual Meeting, Gainesville, FL, April 7-9, 2002, 14 pp. (CD-ROM).
5. Wankat, Phillip C., *The Effective, Efficient Professor: Teaching Scholarship and Service*, Allyn and Bacon, MA: Boston, 2002.
6. Mohsin, A., Stanfill, R.K., "IPPD Coach Guide: A Resource for Mentoring Project Teams," The University of Florida, 2009.
7. Ritter, D., Brassard, M., "Brain Writing 6-3-5," The Creativity Tools Memory Jogger™, 1 ed., GOAL/QPC, Salem, NH, ©1998, p. 21-30.
8. Brassard, M., Ritter, D., "Affinity Diagram," The Memory Jogger™ II, 1 ed., GOAL/QPC, Salem, NH, ©1994, p. 12-18.
9. Google Inc., Google Docs [Software]. Available from http://www.google.com, 2009.
10. Fridrich, H., Stanfill, R.K., *New Engineer's Training Manual*, The University of Florida, 1995-2010.
11. Rajkumar, T., Stanfill, R.K., "IPPD Liaison Engineer Document," The University of Florida, 2008.
12. Stanfill, R.K., Rajkumar, T., "The Liaison Engineer's Guide: A Resource for Capstone Design Project Industrial Sponsors and Faculty Mentors," *Proceedings of the American Society for Engineering Education 2009 Annual Conference and Exposition*, Austin, TX, June 14-17, 2009, 15 pp. (CD-ROM).