The Professional Guide: A Resource for Preparing Capstone Design Students to Function Effectively on Industry-sponsored Project Teams

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Abstract

Completion of a capstone design project typically occurs in the final year of study in U.S. engineering schools. Capstone design projects are often completed by teams of students charged with designing and implementing solutions to real-world problems. Many programs feature projects that are sought from industrial sponsors. These industry-supported projects require that the student teams interact regularly with their off-campus clients. While lectures focus heavily on teaching technical skills, professional skills are often overlooked due to limited classroom time. Providing professional training to senior engineering students will help them work more effectively with their industry sponsors and project team, as well as make them competitive candidates for positions upon graduation.

This paper describes a training and reference guide developed for capstone design students at University of Florida (UF) enrolled in the Integrated Product and Process Design (IPPD) Program. The Professional Guide communicates key project research and legal elements, establishes expectations for professional conduct, and defines business procedures that must be followed. Rather than devote classroom time to these topics, the guide and associated training elements essentially constitute a self-paced new-hire professional orientation program for capstone design students. Experience at UF suggests that the Professional Guide provides an efficient vehicle for delivering important training that might otherwise be neglected.

The Professional Guide’s project research and legal elements cover essential intellectual property, non-disclosure, and export controls aspects. The expectations for professional conduct areas covered include sexual harassment prevention, identification of at-risk students, basic laboratory safety, and over two dozen ethics mini-case studies developed from real IPPD experiences. Items lumped into the business procedures include training for the IPPD collaboration and project management tools, lab and classroom rules, effective meeting strategies, and procedures for purchasing and travel. Many of the training elements require creation of web-based elements for students to prove they have mastered the materials. Students also receive certificates for the Preventing Sexual Harassment and At-Risk Student training courses. As an incentive to complete the required training, each team’s laboratory access is withheld until all team members complete the assignments.

Introduction

The Integrated Product and Process Design (IPPD) Program\textsuperscript{1-4} is an innovative educational initiative at the College of Engineering of the University of Florida (UF). 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.
IPPD is institutionalized at UF and since its launch in 1995, over 400 industry-sponsored multidisciplinary projects have been completed, with the participation of more than 2,000 students and 50 faculty coaches, and hundreds of company sponsor liaison engineers. IPPD was designed from day one to be an outstanding experiential education program that would span the classroom, laboratory and industrial workplace. The educational goals include learning how to:

- design, build and test a real product following industry best practices
- function in a multidisciplinary team
- complete projects on time and within budget

While the IPPD Program’s 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, their student teams, industry liaisons, and IPPD staff.

Each year brings new projects, new students, and many new challenges (logistical, managerial, technical, and financial) for the IPPD stakeholders to deal with. A series of guides have been developed by IPPD to improve the outcomes for each of the stakeholders. A project coaching guide was developed to aid faculty project mentors in managing student teams. For liaison engineers, a guide was developed to provide tips for successful interactions with the student teams. A training manual was developed in year one of the IPPD Program to define required project technical deliverables and technical expectations for the student teams. The scope of the training manual has been updated annually to include new process elements, such as the incorporation of software development deliverables, and clarifying earlier content, such as the proper organization of a project risk summary table.

The training manual originally included content describing financial and travel procedures. The procedures predated UF’s adoption of the PeopleSoft Enterprise Resource Management (ERM) system. As the ERM system was rolled out over many years, UF financial, fiscal, travel, grant, human resources, and other core business processes were completely reengineered. Further, the new ERM-enabled business processes were accompanied by increased level of compliance by all stakeholders to consistent practices. As a consequence, the IPPD financial and travel procedures were removed from the training manual and replaced with a series of how-to presentations delivered during IPPD class time.

Since its inception in 1995, the IPPD Program has always included a lecture component. The lectures traditionally only focused on technical topics relevant to product development. Feedback gathered from sponsoring companies and faculty mentors indicated there were weaknesses in student team project management, effective meetings, and presentation skills. Industry-led seminars were incorporated to address shortcomings in these so-called “soft” skill/professionalism areas.

While the liaison engineer and faculty coach guides captured lessons learned discovered over the years for effectively interacting with the student project teams, it was incumbent upon these
mentors to pass along this knowledge to the students. As an example, the coach guide devotes a section to dealing with difficult students and problem teams. The guide defines a process to terminate problem students that do not respond to a series of defined intervention steps. Other than an overview of this termination process in the course syllabus, there was no training or reference guide provided to the students defining acceptable team behaviors, how to resolve conflicts, or who to go to seek help in resolving team problems.

A new how-to reference, IPPD Professional Guide, was created as a result of the following circumstances occurring in the Fall of 2011:

- the class meeting structure was changed from 3 one-hour meetings a week to one 3-hour meeting a week
- additional active learning opportunities were incorporated into class time to reinforce core IPPD technical elements
- the number of lectures were reduced, as were the length of the lectures

With less class time available, it was determined that certain technical and professional learning activities would have to be accomplished outside of regular class time. Further, through observation of student engagement during lectures, feedback on various course management surveys, and usage patterns of various web-based collaboration and document management tools, it was found that delivering certain professionalism training content in class lectures was ineffective. Inevitably, each team had already appointed certain team members to specific tasks (one member responsible for purchasing, one for travel, one for managing the team wiki, and so forth), resulting in other team members not paying attention to process details during class. Moreover, students were not taking ownership of their participation in the overall project scope (“that’s not my job, I’m an _______ engineer”). As a result, teams were hindered when, for instance, they needed to submit a travel request, but their designated travel team member was not available to show the others how. A key outcome designed into the IPPD Program is for students to develop capabilities outside of their discipline boundaries to support their professional skills and engineering technical skills. The IPPD Professional Guide was developed to address professional, non-technical elements needed by all project teams for successful project outcomes.

This paper will discuss the motivation behind creating the Professional Guide, the development process used to create the Guide, key elements and features, and current limitations and improvements planned.

**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. Students have always been a central stakeholder, yet no professional practice guide had ever been provided as a reference for effective interactions with IPPD. A guide was needed to span the IPPD interactions inside and outside the classroom, such as Loui
notes in student reflections, a student “would be a professional “both on and off the clock” because being a professional is integral to a person’s identity”11.

Streamline procedural, professional, and legal information into one document

Previously, many elements of IPPD were being delivered to students through lectures scattered throughout the academic year. This caused problems because students needed to know certain information (such as how to do update the team Trac Wiki12) several weeks before it was taught in a lecture, but due to a large amount of material that needed to be covered and limited classroom time during which to deliver it, this was not possible.

Maximize/optimize classroom and out-of-class time

The IPPD pedagogy spans inside and outside of the classroom. By implementing a Professional Guide that students would complete at their own pace, instructors could optimize available IPPD time by teaching technical skills and allowing for team project meetings during class, while enabling students to read about professional skills out of class and apply them in multiple situations.

Provide a framework for emerging engineers to understand professional conduct

While nothing can replace hands-on, real-world experience, elements of the Guide—such as case studies—can prepare young engineers for diverse situations before any mishaps occur during interactions with Faculty Coaches, Liaison Engineers, or Sponsors. A Professionalism Committee has been established to intervene with students and teams struggling with professionalism issues. Professionalism Committee provides corrective action steps and monitors progress. In the event behaviors are not corrected, the Termination Committee convenes to remove the bad actors.

Supply an up-to-date guide for students to reference throughout the year

Policies and procedures change often within IPPD, so an up-to-date repository was needed for this information. The Professional Guide fulfills this need for a single source of information related to project professionalism.

Development process

To develop the Professional Guide, IPPD staff members worked together to streamline information and instructions that previously had been presented to students in multiple lectures spread throughout the semester. Staff also called upon prior experience with IPPD students to write mini-case studies relevant to teaching appropriate professional and ethical conduct for different situations.

Throughout the course, peer assessment surveys and faculty coach surveys are conducted several times—at the beginning, middle, and end of each semester. Information from the Likert scale and qualitative questions inform the IPPD Program on students’ mastery of some of the qualities presented in the Guide’s Professionalism Competency Model. During the course of the projects and looking back at the peer assessment surveys, projects that had lower outcomes also had low
peer assessment scores. After reviewing feedback from past surveys, it became clear that more accountability for professionalism needed to be added to the course.

Table 1 shows a sample peer feedback summary for a student who was great in contributing ideas for the project, but needed to add value to the project in other ways—such as doing more work and helping out teammates. The coach would need to provide more professional guidance to this student to curb behaviors that if practiced in an industry setting would warrant a job placement change or firing.

Table 1. Sample peer assessment of a bright student that lacks a professional attitude. The scale is poor = 0 to excellent = 4

<table>
<thead>
<tr>
<th>#</th>
<th>Question</th>
<th>Poor</th>
<th>Fair</th>
<th>Average</th>
<th>Good</th>
<th>Excellent</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Participation time and effort with group</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1.80</td>
</tr>
<tr>
<td>2</td>
<td>Team player, peacemaker, consensus builder</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1.40</td>
</tr>
<tr>
<td>3</td>
<td>Perceived expertise or competence (whether it is used or not)</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td>4.00</td>
</tr>
<tr>
<td>4</td>
<td>Willingness to help others on the team with their needs</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1.60</td>
</tr>
<tr>
<td>5</td>
<td>Amount of work accomplished</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2.60</td>
</tr>
<tr>
<td>6</td>
<td>Demonstrated leadership skills</td>
<td>2</td>
<td></td>
<td>2</td>
<td></td>
<td>1</td>
<td>1.60</td>
</tr>
<tr>
<td>7</td>
<td>Overall evaluation of team member's performance</td>
<td></td>
<td>2</td>
<td></td>
<td>2</td>
<td>1</td>
<td>2.40</td>
</tr>
</tbody>
</table>

Similar to the peer assessment surveys, course evaluations consist of a Likert scale and qualitative questions. Feedback from these surveys made it obvious that the delivery of the course material needed to change, which led to the streamlining of professionalism lecture material into one Professional Guide.

Staff are an essential part of the IPPD education team. They are present for class lectures and lab meetings, and often offer guidance and assistance to students; therefore, they are the eyes and ears that often detect team and individual performance issues. Because of this, at least once a year, after IPPD is finished, the Faculty Coaches and Staff meet to do a lessons learned workshop. These workshops have covered topics such as

- Incidences that go against Student Code of Honor or Conduct
- Grading rubrics
- Weekly schedule of course material
• Streamlining business processes
• Course materials and accreditation processes
• Professionalism

The lessons learned workshop helped in roadmapping the different changes and priorities that were needed not only for the course, but also for the Guide.

After each semester, the Director and staff gather feedback and review material, and the Professional Guide continuously evolves. Table 2 shows a timeline of iterations of the Guide.

**Table 2. IPPD Professional Guide development timeline**

<table>
<thead>
<tr>
<th>Year</th>
<th>Guide elements added</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>baseline guide created and partially prototyped in the Spring semester and then officially rolled out in Fall 2011: trac wiki, svn, myIPPD, inventory, ITAR/EAR, Design Station Rules, materials and supplies request, travel requests, making meetings work, sexual harassment training; certification quiz</td>
</tr>
<tr>
<td>2012</td>
<td>added: intellectual property, engineering notebooks, at-risk students, ethics case studies; deleted: quiz</td>
</tr>
<tr>
<td>2013</td>
<td>added: safety, professional model</td>
</tr>
</tbody>
</table>

**Guide elements/features**

The Fall 2013 version of the Professional Guide is a 115-page PDF made available to students on the first day of class via the IPPD e-Learning online course management system.

At the beginning of the semester, students are required to read the Professional Guide, complete web-based modules, and think critically about mini-case studies to show understanding of procedures and policies essential to professionalism. This process equates to a self-paced new-hire orientation, and students are encouraged to use the Guide as a reference resource throughout the academic year.

As incentive to complete the training, each team’s laboratory access is withheld until every member has read the Professional Guide and completed its corresponding assignments. Figure 1 shows a sample assignment that each student must complete.

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*a The idea to use authentic IPPD past experiences as case studies was an outcome from the 2012 Capstone Design Conference panel session on working with industry project sponsors*
Complete this Trac Assignment

- Create a personal home page on your team’s Trac wiki

1. Log in to my.ippd.ufl.edu
2. Click on Team Wikis
3. Go to your team’s wiki
4. Create a page by typing the following URL: https://my.ippd.ufl.edu/trac/teams/<your team>/wiki/FirstLast (use your name for FirstLast)
5. Click OK to create the page
6. Attach a short “Elevator Pitch.” Pretend you’re pitching yourself to a potential employer; why should they hire you? Write just a few sentences—something that can be said in about 30 seconds.

Figure 1. Trac wiki assignment example

The Guide contains a table of contents consisting of 17 topics. Content is grouped into three categories at the author’s level: project research and legal elements, expectations for professional conduct, business procedures. Figure 2 shows the table of contents for the Guide.
Project research and legal elements (ethics)

Conducting project research is a crucial part of a capstone design course. The Professional Guide includes information on what project details to include in an Engineering Notebook to track project research and progress, and it also includes a tutorial on how to maintain one. Navigating legal elements can be challenging for any new engineer, so this section of the Guide describes pertinent export control laws\(^b\) that could hinder the progress of their project, and what the consequences of breaking these laws are. A copy of the standard Non-Disclosure Agreement each student must sign for the program is included for their reference.

Emerging engineers benefit from conducting project research and understanding legal elements. Intellectual property, ITAR and EAR laws, regulations, policies, and consequences are an important aspect to a professional in training. When working on a project, keeping a well-defined Engineering Notebook is essential to tracking detailed information on project progress and could be used eventually to obtain patents. IPPD teams are not allowed to post project work on non-secure web sites. Repositories to share project documents with all project stakeholders are

\(^{b}\) International Traffic in Arms Regulations (ITAR) [http://www.pmddtc.state.gov/regulations_laws/itar.html](http://www.pmddtc.state.gov/regulations_laws/itar.html) and Export Administration Regulations (EAR) [http://www.bis.doc.gov/index.php/regulations/export-administration-regulations-ear](http://www.bis.doc.gov/index.php/regulations/export-administration-regulations-ear)
expected to be stored on the team Trac Wiki, SVN, and E-learning/Sakai access-controlled web portals. This server uploading process is done differently in Trac Wiki, SVN, and E-learning/Sakai, which creates real-time learning and document management experience. MyIPPD is the portal to Trac Wiki and SVN, as well as the storage of team member agreed upon non-disclosure agreement.

Examples

MyIPPD portal each student electronically signs a nondisclosure agreement on intellectual property. Below is an example of what IPPD students might have to deal with in their ethics decision making skills.

[Case Study 19] You’re walking with a friend who is not an IPPD student, and you remember you need to pick up an item from your team’s locker in the IPP lab. It’ll only take a minute, and there’s no one else in the lab. What do you do?

  a. Do not invite your friend inside the IPPD lab, even if it’s only for a few minutes. Anyone not on the approved list is never allowed inside the IPPD lab.

  b. In the UF Non-Disclosure paperwork, allowing someone to be privy to information in the lab is breaking the non-disclosure agreement.

  c. Remember, some sponsors have additional non-disclosure agreements.

Project management requires documentation of project progress. The use of the Trac Wiki, SVN, and E-learning/Sakai requires students to maintain documents. The example below shows a situation in which a student is in fear of turning in something that is still in progress.

[Case Study 26] The IPPD Director asks you to turn in your Preliminary Design Report, but you’ve only spent an hour on it, and it’s nowhere near where you want it to be. It’s not the best representation of what you’re capable of. What do you do?

  a. Hand it in, even if it’s a work in progress. IPPD just wants to see where you are in the process. When you don’t hand it in, it looks like you’re not doing any work at all—which is worse.

Expectations for professional conduct

In this section, engineering students are able to study and apply the IPPD pedagogy to real-world situations using expectations for professional conduct. Whether presenting design work in class or optimizing meetings, professional competencies are a must for both engineers in training and

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\(^\text{c}\) Subversion, also known as SVN, is a web-based software source control (versioning) repository system that has been adapted for use as a document repository system. SVN allows users to checkout a document (or source code) from a centralized data repository to a local PC where it can be modified a new version committed to the central repository. Unwanted versions can be rolled back to previous versions. Reference 12 provides details on how SVN and Trac are used in the IPPD Program.
professional engineers. Learning how to articulate what is appropriate to include in the Engineering Design Notebook is important to communicate the process and products of their design.

Students are required to participate in Sexual Harassment Prevention Training and At-Risk Training and receive a certificate to show mastery of the courses. During these web-based trainings, students participate in simulations of real-world situations that could occur, and they are able to choose an action and immediately see the outcome. After the trainings, these principles and more are further reinforced in the written case studies, which present scenarios that have happened previously in IPPD and ask the student to think critically about what they would do in that situation; the appropriate reaction and the reasoning behind it is then presented after. Professionalism and Termination Committees uphold the Professional Competency Models and handle any situations in which a team member may be behaving in an unprofessional way.

Examples

Teaching classroom etiquette is important for emerging engineers because this lays the groundwork for how they will operate in a workplace setting. Below is an example of a student who is not optimizing their class time.

[Case Study 8] During class, you and your team are asked to work on an activity. Your teammate John refuses to work on the activity, and he simply sits back and lets the rest of the team do all of the work. This becomes a repetitive problem, and your other teammates constantly complain about it, but they have never said anything to John. What do you do?

   a. Confront John about it and remind him that the IPPD class is centered around working in a team environment--just the way it will be in the professional engineering world.

   b. If it continues to be a problem, notify an IPPD staff member and the Director.

Building off of the Sexual Harassment Prevention Training and At-Risk Training, the case study below encourages students to think critically about how to anticipate behavioral changes in team members, and in the future, coworkers.

[Case Study 13] You notice a change in behavior in one of your teammates lately. They haven’t been getting along well with the team, and they’re constantly showing aggressive/irritable behavior (slamming things, refusing to talk to people, etc.) They won’t tell anyone what’s going on. What do you do?

   a. Talk to your Coach and/or the Director, and let them know what’s been happening with the team member. Let the Coach and Director handle the situation.

   b. Don’t ignore the problem, even if you aren’t sure what to do to help, someone else might. There may be something deeper and more serious going on in your teammate’s life.
Business procedures

Rounding out the competencies of a professional engineer is the ability to manage business procedures. This section of the Professional Guide covers everyday business procedures such as recording information on a project in an Engineering Notebook and preparing to travel to a sponsor company with a travel request. The Business Procedures section covers many procedures that are too lengthy to cover in class, but are needed in order for the student to successfully complete the program. Working with material and supplies requests, conducting research, managing a budget, and waiting for ordering approval enforce project management skills. Learning about IPPD classroom and lab rules helps students understand how to operate in the workplace, as they must collaborate in a shared facility with many teams working at the same time. Lastly, MyIPPD provides a crucial HR element, as students must give confidential feedback on peers, superiors, and on the IPPD Program in general.

Examples

Managing project purchases is both a business skill and technical skill. Figure 3 shows an example from the Guide illustrating different levels of justifications that are acceptable for purchase approval.

![Figure 3. Example of unacceptable, marginal and acceptable justifications for project team purchasing requests](image)

The IPPD classroom lab space is an open floor plan that has surveillance video. The classroom and lab rules remind the students that this is a place of work, a shared facility, with many teams working at the same time. Below is an example of how the student will learn how to be more business minded in the classroom and in their future workplace.
[Case Study 9] One of your teammates constantly talks about non-IPPD related topics (relationships, sports, gossip, etc.) when your team meets in the classroom. It is distracting you and your other teammates, but so far no one has said anything. You feel uncomfortable because you want to get along well with all of your team, but you also want to do well on your project. What do you do? Remember, the whole classroom lab can hear you. It is an open space.

a. Kindly remind your teammate that the classroom lab is a place to learn new concepts, practice professionalism, and work to solve real-world engineering problems by collaborating with your team on your project.

b. The classroom lab is not a place to vent about relationships or gossip about classmates, IPPD staff, or professors. (Again, remember everyone can hear you.)

c. There’s nothing wrong with trying to be conversational/social and maybe getting off topic for a few minutes; just remember this is a professional meeting, so don’t talk about non-IPPD related topics for too long.

d. If your teammate continues to be distracting, even after you’ve explained this to them, please notify your team’s coach.

e. If it still doesn’t change, notify an IPPD staff member and the Director.

Assessment of Guide impact

Specific assessment tools were not designed prior to releasing the Guide, so metrics defining the effectiveness of the Guide are not explicitly available. The impact of implementing the Guide can be measured in the following ways:

1. reduced in-class lecture time devoted to Guide topics
2. increased usage of the SVN project data repositories by teams
3. reduced student “how do I do ________” emails and personal inquiries with staff
4. increased student critical thinking related Guide elements questions
5. reduced project purchasing mistakes
6. increased staff productivity
7. reduced negative feedback in course management surveys

Lecture time reduction

As noted previously, the IPPD class transitioned in the Fall of 2011 from a three-day-per-week lecture structure to a three-period, one-day-per-week structure. With increased emphasis on
active learning activities in class and less reliance on traditional lectures, it was imperative to free up lecture time. In the weekly schedule for the 2009-10 IPPD Program, 9 50-minute class periods were devoted to topics covered in the Guide. In the 2013-14 weekly schedule, approximately one class period was devoted to Guide. A total of 8 class periods were freed up due to the guide implementation.

**SVN usage increase**

IPPD project teams use SVN as repository for code and documents. Each time new or revised code or document elements are committed to the SVN repository, a new revision number is issued. Table 3 shows a summary of how the project teams increased their usage of SVN for project data repository purposes. Note the increase in the minimum number of revisions that occurred between program years 2010-11 (10 revisions) and 2011-12 (86 revisions). Although use of SVN was trending upward since 2008, the dramatic increase in usage did not occur until after the implementation of the Guide. Prior to the 2011, there were many teams with members that did not use SVN and either relied upon others to do it for them, or simply did not back up their work. It is possible to gather additional statistics regarding each individual user’s usage of SVN, but this data was not collected for this paper.

**Table 3. Summary of project team SVN revisions committed by program year.**

<table>
<thead>
<tr>
<th>Program Year</th>
<th>2008-09</th>
<th>2009-10</th>
<th>2010-11</th>
<th>2011-12</th>
<th>2012-13</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of teams</td>
<td>23</td>
<td>24</td>
<td>21</td>
<td>22</td>
<td>21</td>
</tr>
<tr>
<td>Maximum no. of revisions</td>
<td>469</td>
<td>1336</td>
<td>1230</td>
<td>1263</td>
<td>1569</td>
</tr>
<tr>
<td>Minimum no. of revisions</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>86</td>
<td>97</td>
</tr>
<tr>
<td>Mean revisions</td>
<td>150.5</td>
<td>350.1</td>
<td>429.2</td>
<td>406.4</td>
<td>538.5</td>
</tr>
<tr>
<td>Median revisions</td>
<td>69</td>
<td>232.5</td>
<td>378</td>
<td>351.5</td>
<td>428</td>
</tr>
<tr>
<td>Teams with &lt;5 revisions</td>
<td>8</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**How-do-I questioning decrease**

Staff interviews indicated a reduction in the number of “how-do-I” questions from IPPD students. These questions included the following:

- *How do I open my locker?*
- *How do I get lab access?*
- *How do I request travel?*
How do I purchase stuff?

How do I get reimbursed for project purchases?

For the few times these questions were asked, the standard reply was “what does it say in the Professional Manual?” After a while, these simple questions began to occur far less frequently.

Critical thinking question quality increase

As discussed previously, the implementation of the Guide provided more time for in-class active learning activities where students work in teams to complete tasks that require critical thinking and decision-making. The IPPD staff interviews indicated that as the “how-do-I” questions decreased in frequency, the questions based upon critical thinking increased. The following are examples of the types of critical-thinking-based questions that have become more frequent:

- I need to get help from an outside supplier to design an element of my project. Under what circumstances would I need to have the supplier sign a non-disclosure agreement?
- I am concerned that my teammate is not pulling his weight. How do you recommend that I address this issue?
- Can you review our project team agenda? I have never run such a meeting before and I really don’t know if the time allocated is sufficient or if I just have too many topics.

Based on the increased critical-thinking-based questions coupled with the decrease in simple “how-do-I” questions, the staff believes the Guide to be effective. The Guide has also proved to be a useful reference tool for the staff.

Purchasing mistakes decrease

Based upon IPPD past experience, project materials purchasing mistakes have often been attributable to poor item need justifications provided by the student team. Without relevant back-up material that can be found in properly prepared requests, too frequently the wrong part was ordered and expensive returns and stressful project delays were required. Prior to implementing the Guide, justification content was held to low standard. The first version of the Guide did not include examples of poor, acceptable and excellent purchase justifications. In the 2011-12 IPPD Program, 18 project teams made 504 purchase requests—of which 86 (or 4.8 per team) requests were rejected and revised due to inadequate purchasing justifications. The 2012-13 version of the Guide did include examples of poor, acceptable and excellent purchase justifications. In the 2012-13 IPPD Program, 17 project teams made 447 purchase requests—of which 43 (or 2.5 per team) requests were rejected and revised due to inadequate purchasing justifications. Therefore, after implementing the examples of acceptable and unacceptable purchasing justifications, the number of rejected purchasing requests was effectively cut in half.

Staff productivity increase

Staff interviews indicated that with less time spent answering trivial questions and rejecting purchasing requests, their productivity increased. Further, the staff commented that more of the
students have begun to engage with them from the perspective of a partner in completing their projects, rather than a barrier person that they must avoid.

**Negative course feedback comment decrease**

Four times over the course of any given program year students are surveyed for their feedback on the management of the IPPD Program. The survey consists of six questions with a 5-choice Likert scale (rating the program materials/resources, communication with faculty and industry, organization of team meetings, pace of the program, and overall program) and the following open-ended comment requests:

- Improvements you would like to see
- Problems you have encountered
- Experiences you particularly like

Data for these surveys is available in electronic format going back at least 5 years. It is possible to code the open-ended comment requests to identify elements covered by the Guide and then compile statistics on the effectiveness. Coding over 2000 surveys; however, is not practical.

Overall, the indirect measures suggest that the Guide has a positive effect on the adoption of best practices by the individual student participants and project teams.

**Guide limitations and improvement opportunities**

The Professional Guide consolidates information gathered over many years and from multiple sources. The initial versions of the Guide were delivered under significant time constraints, so the emphasis was to be roughly right and fast. While the Professional Guide is a significant advancement in IPPD professionalism training, there are a number of limitations and opportunities for improvement.

Table 4, found in the Appendix, shows the table of contents of the Guide, how each topic is delivered, and a qualitative assessment of the effectiveness of the content. The delivery column describes such content elements, including things like email templates, links to training courses, learning assessments, deliverables, and how-to instructions. Content effectiveness is rated qualitatively as Low (students commonly have errors and the concepts are not reinforced), Medium (students frequently need reminders, but reinforcement of content occurs regularly), and High (content is reinforced frequently and students are held to a high standard of accountability). Of the 17 Guide topics, 7 are rated High, 8 Medium, and 2 Low. Overall, the Guide effectiveness would be rated Medium-High.

**Limitations**

Consolidating lessons learned and training in a document provides a handy resource, but it cannot replace the experience of applying the concepts in the real world. Although case studies can simulate potential situations students might encounter, it is rarely possible to immerse these often passive learners in the appropriate context of emotions, stresses, and knowledge about a
given circumstance to provide an impactful learning outcome. Shuman, Besterfield-Sacre and McGourty, define fidelity as “the similarity of the training situation to the student’s present and future working conditions.” Higher fidelity training translates most closely to the actual working environment. The authors further define complexity in terms of task interdependence and cognitive effort. Given the time constraints and resources available, the Professional Guide provides moderate fidelity and moderate complexity training exercises.

The current assessment process provides minimal feedback on whether the students have read, understood, and mastered the material. Several verifiable learning checkpoints are required, such as the following:

- creation of a trac wiki page
- upload of a resume to the SVN document repository
- completion of a Preventing Sexual Harassment certificate
- completion of an At-Risk Student certificate

These checkpoints cover only a small subset of the training. A short in-class quiz was implemented in Fall 2011 to provide a further assessment element. The quiz was found to be ineffective. It was designed to take about 10 minutes to complete and be easy to grade. As a result, common sense coupled with a brief glance-through of the material could garner one a passing grade. Time constraints have precluded the development of an online assessment through the e-Learning system. The quiz was dropped. Note that this was the first time a quiz or test had ever been administered in IPPD.

The final limitation of the Guide is purely structural. The guide was created in PowerPoint so that existing training presentation elements could be quickly incorporated, graphical elements could be easily added, and the default landscape page orientation would fill a typical computer screen to minimize the need for scrolling. Creating a table of contents for PowerPoint documents is a tedious manual process and providing a document index is not practical. As a result, once the PowerPoint is converted to an Adobe PDF format, using the guide as a reference document to locate procedure details is suboptimal. As a work-around, the PDF search tools can be used, but this is limited if one does not know the keyword to look for—while one can always scan through an index to find related words.

**Improvements**

The Guide introduces the students to the IPPD Professional Competency Model. This model was adapted from the UF Leadership Model. The Guide includes a breakdown of each area of competency, but this barely scratches the surface. In future iterations, the Guide would benefit by going into greater detail on leadership qualities and professional competencies; furthermore, case
studies developed around these competencies would be helpful in order for students to gain deeper understanding.\(^d\)

The Professional Guide is frequently updated and the version control has been informal. The future releases will include a formal set of version control conventions to insure that at a glance, the consumer will know the effectivity dates of the material. In parallel, an index system for a quick topic and reference search should be implemented. It would also be extremely useful if direct links to specific Guide topics, such as how to plan project travel or how to purchase project materials, could be referenced from outside of the document. The implementation of these usability elements may warrant implementation of the Guide in a document format other than PowerPoint and PDF. There may be an e-book technology that will suffice.

In an effort to make the Guide more dynamic and engaging, the authors have begun to explore different interactive elements that can be integrated. For example, the ability to include quiz questions after each case study that, depending upon the answer chosen, would lead the student to a certain outcome, would be helpful in deepening the student’s understanding by showing them the consequences of their actions. Other interactive elements could include discussion questions, videos, and animations.

Lastly, collaboration with experts in the following would add tremendous utility to the Guide and increase student engagement:

- content subject matter
- content delivery
- assessment

Conclusion

The IPPD Professional Guide was developed to address professionalism elements vital for successful capstone project execution. The contents of the Guide were either previously provided during normal classroom lecture time, or accessed from a variety of sources. The net positive effectiveness of the Guide has been measured indirectly via the reduction in required class time, improved student usage of the SVN document repository, staff productivity increases due to not answering trivial questions and redoing purchasing requests, and the observed accountability of students participating in IPPD.

The Guide is a work-in-process. Collaborators are sought to improve the utility of the subject matter, content delivery, and assessment methods. The authors invite the capstone design community to comment and make use of the guide. The Guide is available for download at the UF Institutional Repository, [http://ufdc.ufl.edu/IR00003855/00001](http://ufdc.ufl.edu/IR00003855/00001). Guide elements that are specific to UF have been left as placeholders so that other institutions can provide customized content. If you adopt elements of the Guide for your institution, the authors request that the

\(^d\) Note that the UF Leadership Model involves four 8-hour live instruction training modules.
following statement be included on the cover page: “Adapted from the University of Florida IPPD Professional Guide © 2014.”

Acknowledgments

The authors thank the reviewers for their suggestions on improving the paper by including details on the effectiveness of the Guide.

Bibliography

Appendix

Table 4. Professional Manual topics, delivery methods, and content effectiveness. The scale is Low = not reinforced and students commonly have errors, Medium = reinforced and students frequently need reminders, and High = reinforced and students held to a high standard and are accountable.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Delivery</th>
<th>Effectiveness</th>
</tr>
</thead>
</table>
| myIPPD              | • Screenshots  
• Overview of what is in myIPPD: news, calendar, project information, sponsor information, inventory, evaluations, survey, assessments, Wiki&SVN portal, your information | Medium. The screenshots were helpful, but would benefit from more detailed captions and instructions. |
| Engineering Notebooks | • List of requirements  
• Link to Google wiki tutorial on best practices | Low. The process is not reinforced uniformly by faculty project mentors and sponsors. |
| Intellectual property | • Overview of what is IP  
• Defines requirements for protecting IP when seeking outside help on project  
• Describes standard IPPD Non-Disclosure agreement  
• Understanding penalties | High. Intellectual property laws are streamlined, making it easy for students to grasp IP in use, what they agreed upon, and understanding penalties. |
| ITAR & EAR          | • Overview of ITAR and EAR for team project needs  
• Overview of Project STOP | High. Also has a companion in-class seminar. |
| In Class            | • Overview of:  
  o participation  
  o attendance  
  o uploading to e-learning  
  o emails from class | Medium. A lot of information is condensed onto one page. This section would benefit with links to the appropriate e-learning materials on how to do what the section asks students to do. |
| E-learning          | • Overview of what is in e-learning class website  
  o syllabus  
  o resources  
  o drop box  
  o emails  
  o grades  
• Email procedures in e-learning | Medium. Many e-Learning tutorials are available to the students directly through the e-Learning system. |
| Wiki                | • Overview of wiki and how to use it  
• Assignment check | High. All students create Wiki pages. |
| SVN                 | • Overview of SVN and how to use it  
• Assignment check | High. All students upload documents to the SVN repository which has increased the SVN use. |
<table>
<thead>
<tr>
<th>Topic</th>
<th>Delivery</th>
<th>Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom Lab</td>
<td>- Tips on wireless, tool safety, shipping</td>
<td>High. An online safety course became available in mid-Fall 2013 and will be incorporated for future Guide offerings. Safety is reinforced in the classroom through 2 lectures and “safety moment” discussions to lead off each class session.</td>
</tr>
<tr>
<td></td>
<td>- Safety: non life threatening vs. life-threatening and reporting property damage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- How to deal with a fire</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Classroom lab rules</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Conference room reservations</td>
<td></td>
</tr>
<tr>
<td>Equipment Use Policy &amp; Inventory</td>
<td>- Overview of equipment use policy &amp; inventory</td>
<td>Low. By the time equipment is needed, students seem to forget the process and staff have to refer teams back to the training frequently.</td>
</tr>
<tr>
<td></td>
<td>- How to order from the Inventory</td>
<td></td>
</tr>
<tr>
<td>Making Meetings Work</td>
<td>- Overview of how to organize a meeting</td>
<td>Medium. Meeting minutes has improved yet uploading to Wiki’s is not always done.</td>
</tr>
<tr>
<td></td>
<td>- Tips on capture meeting minutes, professionalism, things not to do</td>
<td></td>
</tr>
<tr>
<td>Preventing Sexual Harassment</td>
<td>- Link to online high-quality online training course developed for UF. Includes post-course assessment and certificate.</td>
<td>High. Effective in providing the standard sexual harassment training elements in an online fashion. Certificate is the same that is issued to UF employees upon successful completion</td>
</tr>
<tr>
<td>At-Risk</td>
<td>- Link to online high-quality, avatar-based online training course developed for UF. Includes post-course assessment and certificate.</td>
<td>Medium. More students report issues/concerns in real time instead of waiting until the end of the project or a year later.</td>
</tr>
<tr>
<td>Material &amp; Supplies Request</td>
<td>- Overview of process</td>
<td>High. Email template is not followed and staff have to refer teams back to the training frequently. Number of phone calls and emails for problem orders has been reduced.</td>
</tr>
<tr>
<td></td>
<td>- Email template</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Examples of justifications</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- How to check online for order details</td>
<td></td>
</tr>
<tr>
<td>Travel Request</td>
<td>- Overview of why travel is necessary</td>
<td>Medium. Email template is not followed and staff have to refer teams back to the training frequently. Annual project team travel requirements vary considerably.</td>
</tr>
<tr>
<td></td>
<td>- Email template</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Overview of travel reimbursements and process</td>
<td></td>
</tr>
<tr>
<td>Professionalism and Termination Committees</td>
<td>- Overview of each committee</td>
<td>Medium. This is a new area for IPPD. It is thought that establishing the processes and defining the expectations has reduced the need to invoke the committees. More data is needed.</td>
</tr>
<tr>
<td></td>
<td>- Professional Competency Model diagram</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Tables detailing each competency</td>
<td></td>
</tr>
<tr>
<td>Topic</td>
<td>Delivery</td>
<td>Effectiveness</td>
</tr>
<tr>
<td>------------</td>
<td>---------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Case Studies | • Case studies for different elements of the guide are presented, and students are asked to think through what they would do in each situation  
              • Appropriate responses to situations are then presented | Medium. Students refer to these when reporting At-risk issues or concerns and in jest to help ease their stress. Case studies need to be categorized for quick reference. Incorporating a few case studies for in-class discussion on best practices. |