TRANSITIONING PROJECTS BETWEEN STUDENT TEAMS

Cameron C. Jones, Clifford R. Weiss, Soumyadipta Acharya

JOHNS HOPKINS UNIVERSITY

ABSTRACT

The Center for Bioengineering, Innovation and Design (CBID) program at Johns Hopkins University is directing undergraduate and Master's level students in core principles of the needs-based innovation model. In a one-year period, students develop highly innovative products that have traditionally attracted great interest and various levels of follow-on funding. Often these projects are passed along from previous teams as students graduate and leave the university. While a transition between project managers is not uncommon in business, such a shift at the nascent stage of innovation invites new challenges. These projects—typically just a year or two old—are still evolutionary: prototypes, intellectual property, and business models are continually adapting with the influx of new data and fresh ideas. In this paper we discuss many of the pitfalls that may arise as projects undergo team turnover, offer some recommendations to mitigate these challenges, and present an illustrative case study.

Introduction

The Center for Bioengineering, Innovation and Design (CBID) program at Johns Hopkins University is directing undergraduate and Master's level students in core principles of the needs-based innovation model. Our students spend a year immersed in a staged, iterative approach to biodesign strategy, and benefit from strong collaboration with the Johns Hopkins healthcare system, local entrepreneurs, regulatory and legal advisors, and industry giants (Yazdi and Acharya 2013). With the support of these partners, many teams develop highly innovative products for both advanced and resource-limited global markets, including drug delivery devices and monitoring, diagnostic, and surgical tools. These projects often receive funding from foundation partnerships (Laerdal Global Health, Jhpiego, and the Johns Hopkins-Wallace H. Coulter Foundation), as well as several Maryland technology development initiatives. With the continued support of CBID, many designs carry on as either multi-year projects or transition into startup ventures. It is not uncommon during project maturation for there to be some turnover in core team members, which can create interesting challenges. There are three principal types of restructuring that can occur: 1) a reduction in existing members; 2) integration of new members; and 3) complete hand-off of the project to a new student team. While each of these transitions presents its own unique set of difficulties, the focus of this paper will be the complete transition from one team of students to another.

A transfer between project managers in business is an unwelcome event, but can be handled with a strategic course of action that minimizes overall risk. In the academic setting, the demands of business are emulated in many ways, but projects may still be evolutionary in both scope and design and consist of members who are learning the commercialization track in tandem. Studies of the success rate of tech companies in the US and European countries

found that over the last decade, 60–70% of businesses were either challenged (over-budget, late, or reduced product function/features) or failed (Standish Group 2013, 1–3). Executive support and project management were recognized as two of the five most significant factors for success. Therefore the involvement of the PI and good project management practices should be emphasized in the education model of medtech innovation, since poor implementation will likely manifest itself at pivotal periods in the project lifecycle.

This article will investigate challenges and pitfalls that may be encountered during project transitions, and present a case study to illustrate these points. We will make the argument for designating a project manager as part of student teams, as well as specific criteria that should be addressed during the development process. A summary of common pitfalls, with respective recommendations, is provided in Table 1.

Internal Conflicts

Projects undergoing a change in core members may vary in degrees of maturity, from those with only an identified unmet need to others with commercially viable solutions. During this transition period, internal friction is more likely to arise if the project has matured to some degree of novelty or commercial viability (i.e., presence of intellectual property or technical validation). Much of the conflict between incoming and outgoing members stems from an unclear delineation of authority when pivotal decisions must be made regarding the direction of a project. This may occur when new data modifies prior assumptions, or when changes in regulatory strategy or funding status necessitate adjustments to the commercialization plan. Time spent in confrontation over the decisions to be made (or more specifically, by whom—whether it is the outgoing team that conceived elements of the project, or the new team directing its efforts forward) results in a significant loss of project focus. Without proper project management, there is weak control over how changes in scope are proposed and enacted.

Unfortunately, students tend to favor groupthink, where, in an effort to prioritize harmony, decisions are made collectively and contributions are spread evenly (Kerr and Tindale 2004, 640). While collaborative team participation is encouraged and valuable, an affinity for groupthink versus a management organization with an adopted protocol for critical examination of key issues will lead to greater challenges later in the life of the project. Instead, teams should develop a balanced power structure at the proposal stage of the project lifecycle, where one member is designated the project manager, having most authority in the management structure, but where other students exercise an important voice in specific areas of responsibility, with all members participating in strategic decisions. The management organization should be continually updated as core membership or responsibilities change.

Projects vary also in the degree of restructuring, depending on whether there is partial or complete student turnover. Independent of post-transition team dynamics, when the project is still in the academic setting the faculty PI should mentor and validate the agreed-upon organizational structure of the new team. If there is a change in authority at the project level (e.g., project manager to project manager), PIs should help establish this new organizational structure, especially early on when outgoing students (who may have an interested stake in the success of the project) challenge decisions of the new team. If unable to effectively lead, a new project manager can have difficulty maintaining project focus, as meetings can become disorderly and rifts form between members. For instance, if no management structure is maintained and there is no procedure in place for approving changes in project scope, current and past teams may

develop "us versus them" mentalities. These divisions can be exacerbated as more hands come and go that have a vested interest in the project success.

Pitfalls: Internal Conflict

1. Lack of clearly designated project leader (groupthink)

2. Failure to recognize the authority of new project managers (role conflict)

Logistical Challenges

As a new student team assumes direction of an existing project, the greatest resource to maintaining momentum is a well-kept design history file and accompanying documents. Reports from clinical observations, discussions with subject matter experts, project assumptions, and technical studies conducted should provide the shoulders on which the new team stands. It is the role of the outgoing project manager to offer clarity about any documentation and give insight into the project status, such as constraints on budget, time, or resources. While it may be difficult to predict an overlap in project managers, a handoff from a PI or sponsor to a new project manager represents a risk of losing vital project memory.

Teams often struggle to effectively communicate critical project details. This is particularly dangerous, as a failure to convey all aspects of the project scope will almost certainly weaken project momentum and could potentially misdirect future efforts away from a vetted solution. Updated and organized documentation, which may include laboratory notebooks, full documentation of lab meetings, or even video or audio recordings of key discussions or decisions, will assist in knowledge transfer, especially when the project transition involves a complete hand-off to a new team. While design history files generally address major shifts in design, a failure to document the decisions behind key justifications poses a potentially dangerous misstep. Even good-willed team members can impede a project if shortcuts and cleverness create leaps in decisions, or if anomalies in data are casually dismissed. Without full documentation of decision-making processes, the loss of these team members during a transition can lead to a serious failure in project knowledge transfer, which can result in time spent rediscovering *known* answers.

In addition, rigorous documentation practices help guard against a situation where one (or more) member(s) become overly important to the project. For example, there may be teams with only one member fluent in electronics, or another with particular acumen in a specific area of business, medicine, or engineering. If a former member's expertise was particularly essential while other members filled complementary roles, the project may suffer if attempts to retrace the decision process are impeded by inadequate documentation. For newly formed teams that are attempting to advance the work of their predecessors, understanding the project's history can be essential to the success of the venture.

Projects that continue under new management may also lose traction if there is not a clearly defined project scope to help a new team make informed decisions. A well-defined scope successfully expresses the project's vision, specific criteria for success, and tracks progress towards goals/milestones. Often only long-term objectives have been expressed, but these can lack depth simply because there are too many unknowns with an evolving device design. Other times, students may formulate a business case for an innovation, but stop short of defining the realization (value) of the deliverables, and only define the deliverables that "enable" a particular business case. This is a common oversight seen with projects that require a specialized software code. For example, a team may develop a business case around a device with an integrated smartphone app to improve patient monitoring, but neglect

to write the code or fully anticipate the time, resources, or regulatory aspects required to develop the software.

A poorly articulated project scope may be one of the most frustrating aspects inherited by a new team, since it may be difficult to address project requirements, technical and business priorities, potential risks, or manage expectations. Renewed projects are generally accompanied by much optimism, and it is easy for expectations to be inflated to unrealistic levels. This sometimes occurs when project proposals (such as those presented at business plan competitions) convey a hyperbolic message rather than a realistic one, leading to expectations that a project will actually follow such an idealistic trajectory when follow-on funding is obtained.

A good business case should not only clearly articulate the project vision and path to realization, but should have enough granularity that progress can be measured almost in real-time. Expectations can be better managed when projects are broken down into smaller phases with frequent milestones (e.g., 1–2 weeks between deliverables). Smaller steps provide greater visibility in project scope, can expose potential hurdles, and give opportunities to disseminate questions and concerns from advisors or sponsors. For example, if a team wishes to test a new biodegradable bone cement in vitro, their proposal should include a study protocol, facilities and equipment, and key personnel that are needed to prepare, analyze, and scientifically validate respective portions of the study. Vaguely proposing an in vitro study to provide technical validation to the project without characterizing details of the study leads to missed deadlines, variable measures of progress, and the potential to overlook important study parameters. Furthermore, if the project is passed to a new team prior to execution of the planned study, there is a risk that the new team lacks key proficiencies required to implement the proposed study.

An important element of a business case is to identify risks, including those that affect meeting project milestones. At the student level, where project transitions between members can occur frequently, contingency plans should be drafted for possible project hand-off (whether intended or not) and loss of key personnel at critical times. This might include defining metrics for assessing progress of a project during a transitional period, or the organizational structure and responsibilities of all members (old and new) who are expected to advance a project to commercialization. It may also be helpful to brainstorm mitigation strategies with other teams with similar projects who have undergone team turnover, and the challenges they've faced. Building a business plan that anticipates project turnover will facilitate the transition if/when it comes, and will strengthen good project management practices.

Pitfalls: Logistical Challenges

1. Loss of project knowledge through poor documentation and/or communication

2. Poorly defined project scope

Silent Dangers

Students coming into an ongoing project have a steep learning curve in order to familiarize themselves with all aspects of their new project. These include the clinical need and design statement, the technical details of the project, and work already accomplished. A brief period of overlap between teams with direct guidance and insight from the outgoing project manager helps ensure a smooth transition. While this has many advantages, there is a tendency for new students to completely stand on previous work and merely to continue the previously determined course of action. If the motivation of the new team is still primarily academic, that is, to be educated in the process of innovation, then students taking over existing projects are susceptible to adopting "fixed innovation" due to external voices (i.e., prior team members and mentors)

who may advocate their already established direction of progress, thereby omitting any innovative contribution on the part of the new students. Therefore, new project managers and teams should be encouraged to practice a brief period of independent review—without any bias, judiciously using the outgoing team only for clarifications. Teams should critically evaluate existing data and test prototypes, assumptions, and any variables that helped form the basis of major project goals. Not only will this encourage innovative discovery and pride on the part of the new team member(s), it will allow for additional perspectives and new ideas.

Sometimes when a project has attained a certain level of credibility, such as external interest in a particular design or process, there is the possibility that stakeholders (e.g., former students, sponsors, PIs, mentors, etc.) may develop a sense of loyalty to an individual solution. Unintentionally, new project managers may be directed toward micro-level design iterations (i.e., same solution, different technical constraints), and be discouraged from macro design changes. Former members may be resistant to deviations from original ideas, "brand image," or changes that would create adjustments in proposed commercialization strategy. However, it is not uncommon for projects originating from condensed academic exercises to have incomplete functional and feasibility validation, since some decisions may have had previous unknowns incorporated into decisions or projections. Therefore, it is critical that as data becomes available that may influence technical, clinical, commercial, or organizational understanding, team members revisit their project's solution landscape to verify that the chosen design is still the optimal one. Just as students are taught the importance of not building solutions into a needs statement, they must not violate its derivative: that a new solution that improves commercial viability and better fits the needs statement should always be considered.

Finally, difficult questions can be expected for project transitions that involve passing the oversight and development of proprietary technology to new team members who have not contributed to its initial development. While obviously situation-dependent, this is a topic that has logistical, ethical, and legal implications. If the project is eventually successful, teams will be faced with deciding founder status and ownership equity, having to weigh contributions such as concept origination, intellectual property, data collected, funding raised, assumed risk, and "sweat equity." There's also the difficult situation of properly recognizing the work of former team members if projects evolve significantly during their absence.

In most situations, it is prudent to visit the matter of ownership earlier rather than later, usually when large investments are distant. It is the responsibility of the original team, in preparation for handing the project off, to have formulated a clear project scope and management structure, if applicable. As new members are brought on to continue the project, internal issues such as the responsibilities of new and existing members, equity, and management structure can be addressed prior to any contributions made by new members. Updating both the management structure to include new members, and the responsibilities of all who have vested interest in the project, will help ensure project momentum. Having previously defined respective roles and maintained good documentation of project status and contributions will further help in defining ownership if a project matures to the level of business formation. It is natural for more people to *claim* significant ownership, justified or unjustified, as projects become more defined, less risky, and more valuable.

Pitfalls: Silent Dangers

1. Lack of innovative contribution by new students to existing projects
2. Loyalty to original commercialization solution and/or strategy
3. Failure to address ownership early

Case Study

At the conclusion of an academic cycle, one of our Master's projects had gained significant interest from the investor community for a product that added an antimicrobial advantage to particular surfaces. The technology was based on a recent body of work showing the promise of applying acoustic energy for preventing bacterial attachment, with which the students saw an opportunity to address the life-threatening complication of catheter-related bloodstream infections. The team designed an elegant solution to a very difficult problem and received follow-on grant funding from a foundation–university partnership. Due to other employment and project development opportunities, the initial team of students elected to pass this project on to faculty advisors and new team members and to simultaneously maintain an advisory role throughout future project development. New students with prior experience in this field were selected to continue the project, and spent a week overlapping with several of the outgoing students.

The new team set out to demonstrate technical feasibility through a series of bench studies in order to support continued efforts toward developing a clinically viable product. Prototypes were built and verified for generating the specified acoustic intensities; however *in vitro* efficacy could not be established. Numerous studies were designed to test the technology in a component fashion, but ultimately it was shown that the scientific principles on which the technology stood were invalid (an extensive survey of the literature also revealed the original published data was uncorroborated by other investigators). This testing took eight months, during which there was no development and no project milestones were met.

The apparent delay in project momentum led to internal conflict between the two generations of teams. Divisions arose regarding what tests should be run, the credibility of past and current data, and the findings' implications on project trajectory and commercialization strategy. Eventually these challenges resulted in former members becoming disengaged in project development and an unfortunate breakdown of team unity.

Outcome

Several events threatened the continuity of this project. First, the new team failed to conduct an independent review of major project elements, such as the project's essential scientific and technical validity. Instead, the new team continued along the testing and prototyping pathway delineated by the original team. This lapse resulted in significant time lost performing iterative testing of an essentially flawed design, when a critical examination of literature and existing data may have yielded key information early on. Involving experts in related scientific fields may have also rapidly brought to light these flaws, as students (both old and new) were not themselves fully versed in the foundational science of the initial technology.

Due to the extended time spent on unsuccessful research aims, teams became entrenched in their disagreement over effective project management, exacerbated by the fact that the former team was now remote. Even when the new team repeatedly discredited the published data upon which the initial design was based, the discord from prior months was not easily resolved. Division arose over proposed design changes out of fear of losing product momentum, and fear of major shifts in commercialization

strategy. These differences may have been alleviated if both teams of students had initially established a system for evaluating decisions and key project priorities. Although--or perhaps because--the outgoing team had decided to advise the new team, both teams struggled to identify the expected contributions, responsibilities, and roles of the other members.

Conclusion

While a transition between project managers is not uncommon in business, such a shift at the earliest stages of innovation is particularly challenging as prototypes, intellectual property, and business models are continually changing due to new data and ideas. The general rules that define good project management should help defend against the pitfalls that can accompany high-risk events such as project hand-off between teams. Poorly executed project management may be inconsequential during the academic period of a project or design, but will likely manifest itself at pivotal periods in the project lifecycle. Practicing good project management at the onset will help articulate team visions and goals, establish clear expectations, and ensure the technology, business, and risks are well understood. Although advocated here, it may be difficult, or even undesirable, to implement a team leader among a group of peers at the graduate level. Further discussion is needed on best practices to impart more professional project management while maintaining a healthy balance of participation from members.

The pitfalls explored in this paper are also applicable to teams that are not preparing for a full project hand-off, but where roles are shifting due to addition or subtraction of members or changes in the roles of current team members. As personnel shifts can disrupt project workflow, teams should incorporate anticipated changes into the management core early in the project lifecycle in order to prevent project derailment.

References

Kerr, Norbert L., and R. Scott Tindale. 2004. "Group Performance and Decision Making." Annual Review of Psychology 55:623–55.

The Standish Group International, Incorporated. 2013. CHAOS Manifesto 2013: Think Big, Act Small. http://versionone.com/assets/img/files/ChaosManifesto2013.pdf.

Yazdi, Youseph, and Soumyadipta Acharya. 2013. "A New Model for Graduate Education and Innovation in Medical Technology." Annals of Biomedical Engineering 41:1822–33.

Table 1. Recommendations for common pitfalls encountered during project transitions at the student level

PITFALL	RECOMMENDATION(S)
Lack of clearly designated project leader (groupthink)	• Develop teams with a balanced power structure at the proposal stage of a project lifecycle • Implement formal protocol for assessing major project decisions
Failure to recognize the authority of new project managers (role conflict)	• PI should aid in blending new project managers and communicate roles and responsibilities of all vested members
Loss of project knowledge through poor documentation and/or communication	• Strive for student-to-student hand-off versus PI to new students • Provide introductory review on good documentation practices
Poorly defined project scope	• Break milestones and deliverables into smaller pieces • Incorporate contingency plan at the proposal stage for project hand-off and loss of key personnel
Lack of innovative contribution by new students to existing projects	• New teams should conduct a brief independent review of major project elements
Project loyalty to original commercialization solution and/or strategy	• Revisit solution landscape as data becomes available that impacts commercial viability or better fulfills the need statement
Failure to address ownership early	• Define roles and responsibilities of all members with vested interest • Update project status and respective contributions often