MANAGING FOR THE TRIPLE BOTTOM LINE IN PROJECT-BASED LEARNING

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ABSTRACT

Project-based learning is a popular engineering education approach that involves at least three stakeholders – students, faculty and an external client. But more often than not, one or more of these parties have to compromise their goals in the interest of the learning experience. This discourages stakeholders and threatens the sustainability of project-based learning programmes. This paper defines the objectives of the stakeholders that engage in project-based learning, defining the triple bottom line that a project-based learning experience should aim to fulfil if it wishes to be sustainable.

The iTransport team at the Georgia Institute of Technology is one of many Vertically Integrated Projects that seeks to implement meaningful technology applications for real life clients through a multidisciplinary, multi-ranked student group. The paper further presents a case study of the first four semesters of the iTransport team highlighting that expectation management, management of team dynamics and keeping the triple bottom line front-of-mind through good project management principles is essential to addressing the triple bottom line.

1 INTRODUCTION

Melkers et al.[4:1] begin their paper on the Social Web of Engineering Education with these words:

> *"Engineering education is evolving to become an environment of project-based learning, research assistantships, and other mechanisms that approximate the research and collaborative aspects of true-to-life processes."*

Changing the traditional engineering education philosophy from only 'chalk-and-talk' to a combination of 'chalk-and-talk' and project-based learning has been a long time coming. Mills and Treagust[5] discussed and compared problem-based and project-based learning, concluding that a combination of initial chalk-and-talk style courses augmented by project-based learning experiences in later years was the best approach to cultivate the type of engineering graduates the industry requires. In short, project-based learning exposes graduates to real-life, open-ended engineering problems and instils the self-directed learning and collaborative skills essential to a successful engineering career. Melkers *et al.*[4] provide a detailed analysis of how students learn in project-based environments based on data and observations of the Vertically Integrated Projects (VIP) programmes at Purdue University, Georgia Institute of Technology and Morehouse College.

In the South African industrial engineering context there are typically two types of project-based learning experiences offered at an undergraduate engineering level: course-specific semester projects and final year engineering design projects. Course-specific semester projects are typically team based, creating a collaborative environment, but the engineering problem is narrowly defined with a pre-requisite of applying the specific engineering techniques learnt in that course. By nature these project teams are mostly from the same discipline and same year of study, limiting diversity and interdisciplinary problem solving. The engineering problems addressed in final year engineering design projects are much more open-ended and students are given the freedom to use any combination of engineering techniques. However, in many universities the IE final year design project is an individual affair, thus the student loses out on the collaborative aspect. Final year students generally have more guidance and input from advisors than course-specific project teams and there is a greater emphasis on self-directed learning. In both environments the project may be executed for an external client. In reality, both learning experiences address only a subset of the characteristics of project-based learning as described in Melkers *et al.* [4]: Collaborative, multi-ranked student teams –meaning undergraduates and post-graduates of various levels are included; multi-disciplinary teams; open-ended, ill-defined, real-life problems; a focus on self-directed learning and peer-to-peer learning; and regular interaction with faculty members or older post-graduate team members.

Nonetheless, the typical South African project-based learning environments share the same set of stakeholders as those associated with the VIP programme namely students, faculty members and external clients. Each of these three stakeholders have their own set of objectives that constitute their bottom line. For each of these stakeholders to remain committed and enthusiastic about a project-based learning experience, their objectives must be met. Paying attention and pursuing three different bottom lines simultaneously is thus key to the sustainability of project-based learning programmes. Section 2 of this paper defines the triple bottom line of project-based learning. Section 3 and 4 describe the VIP programme and present a case study of the iTransport team, making recommendations on how to harness team dynamics to achieve the triple bottom line.

2 DEFINING THE TRIPLE BOTTOM LINE

The involvement of the author in project-based learning activities was first as an undergraduate and post-graduate industrial engineering student in South Africa, then as a researcher at the Council for Scientific and Industrial Research (CSIR) working with a number of undergraduate engineering student groups. The author was also a research mentor for a number of final year industrial engineering design projects and an external lecturer for undergraduate simulation. Most recently the author's involvement was as post-graduate student and project manager in a number of project-based groups at the Georgia Institute of Technology. Interactions with faculty members, fellow students and clients throughout all these experiences moulded the definition of the triple bottom line of project-based engineering as outlined in this section.

The pedagogical goals of a project-based learning experience are usually the best, if not the only, explicitly defined objectives. Depending on the context of the learning experience and the nature of the technical skills required to solve the problem, the student bottom line may be defined as a variant of the following list of learning outcomes:

- Deepen knowledge of a technical field (programming, statistical analysis, algorithm development).
- Develop technical skills through applied problem solving (experimentation, data analysis, engineering design).
- Develop communication skills including academic writing, presentation skills, client interaction skills, and team communication skills.
- Practice managerial skills such as project planning and managing multidisciplinary teams.
- Develop people skills through collaborative interaction with team members and other project participants.

In summary, the student bottom line is centred on the broad-based development of the student's collaborative problem solving skills – as required in real-life engineering practice.

Faculty members participating in project-based learning would typically have dual objectives. Wearing the educator hat, a faculty member would have as his/her objective the achievement of the student bottom line, outlined above. The other hat the faculty member wears is the researcher hat. As a researcher, a faculty member may expect to achieve one or more of the following research outcomes through the learning experience:

- Explore a new avenue of research related to his/her current work;
- Execute experiments and data analysis related to current research;
- Apply and test research in real-life contexts;
- Generate research publications and presentations; and
- Generate the evidence of success to apply for further research funding or to commercialise research.

At the end of the day the faculty member is devoted to the development of the student's collaborative problem solving skills while simultaneously pursuing his/her research agenda. This defines the faculty bottom line.

Defining the client bottom line is more complex as there is a broad range of clients that could be party to a project-based learning experience. In South African programmes, clients can be categorised as either commercial clients or research institutions. Though commercial clients span just about all the economic sectors, typically including engineering consulting companies, manufacturing companies, mining companies, utilities companies, financial institutions, and chemical processing companies, they share a common goal – generating revenue from the sale of products and services at least cost. Research clients could be research funding institutions (such as the National Research Fund), research institutions (such as the Council for Scientific and Industrial Research or Medical Research Council) or even government departments or agencies (such as the Department of Science and Technology or the Department of Trade and Industry). These research clients have in common the goal of answering a specifically defined research question. Typically these research questions are of an applied nature – enabling the development or commercialisation of technology, products or services. Given the different objectives of commercial and research clients it makes sense to define two variants of the client bottom line.

The commercial client bottom line may include:

- Developing and testing new technologies for commercial use;
- Using student teams to perform tightly scoped sub-sections of ongoing internal or external projects;
- Identifying and building professional relationships with talented students for future recruitment;
- Providing learning and development opportunities for student bursars that are part of the project team;
- Developing relationships with engineering faculties; and
- Investing in engineering education, in general, through participation as a form of goodwill.

The research client bottom line may include:

- Performing focussed research to answer a specific (applied) research question;
- Testing and experimenting with existing research with the intent to commercialise;
- Developing centres of excellence and research competencies within their own institutions as well as tertiary institutions;
- Developing long-term, collaborative research relationships with tertiary institutions; and
- Investing in the development of engineering students as outlined in the student bottom line.

The triple bottom line is thus a large basket of varied objectives. In the case of the student bottom line, the nature of collaborative learning advocates longer-term projects to allow time for internal team dynamics to be established. Research based on experiences in the Vertically Integrated Projects (VIP) programmes run at the Georgia Institute of Technology and Purdue University confirms that students engaged in long-term projects report higher levels of learning than those engaged for a shorter period of time [4]. Similarly the research agendas of faculty members and research clients are long-term endeavours by nature. Although there may be clearly defined, short-term research outputs in both cases, research agendas are flexible in the medium and long term, always leaving room for future research projects. The first three objectives of commercial clients listed above can all be achieved through shorter-term projects, but to meaningfully invest in engineering education and build productive relationships with tertiary institutions requires a longer-term commitment. Clearly the element of time is key in achieving the triple bottom line.

In keeping with the spirit of project-based learning, the associations between stakeholders are much less (legally) binding. Usually there are no formal contracts in place and the client may or may not offer financial incentives for a job well done. This makes it crucial that the project-based learning experience be synergistic, addressing, at least partially, the objectives of all three stakeholders from the word go. Only when stakeholders see a tangible return-on-investment will they continue to participate in the project. This is true of all three stakeholders but is more apparent in the case of the client, where the client will often be the first to disassociate from an unproductive arrangement. Motivated students may turn into 'dead wood' if they perceive that they are not learning anything – eventually dropping out of the programme and taking all their accrued knowledge and experience with them. Faculty members will typically be the die-hards, either because of vested interest or simply job description. But even the most enthusiastic of professors will lose interest in time, finding other avenues through which to advance his/her research.

To create sustainable, long-term project-based learning experiences attention must be given to pursuing all aspects of the triple bottom line right from the beginning of the project. The question is how to do that. The following case study highlights some successes and challenges experienced during the first 16 months of the iTransport project – one of the VIPs at the Georgia Institute of Technology. The case study is based on the author's involvement as a post-graduate student and project manager.

3 THE VERTICALLY INTEGRATED PROJECTS PROGRAMME

The Vertically Integrated Projects (VIP) programme started at Purdue University in 2001. The aim of this programme is to fully integrate undergraduate education and post-graduate research. The VIP programme was brought to the Georgia Institute of Technology by Professor Edward Coyle, with the first students enrolling in 2009. At the time of publication, there were 13 active VIP teams of which the iTransport team is one [3]. The University of Strathclyde, Glascow has also adopted the VIP concept and have a number of projects up and running [6].

Coyle *et al*. [2] describes the purpose and benefits of the programme as well as the team structure and organisation for individual projects, using a case study as illustration. Teams consist of a group of students from sophomore level (second year) through to Masters and PhD candidates. Undergraduate students receive course credit for participation and may be part of a VIP team for up to seven semesters (each semester being approximately four months) while post-graduate students may participate for the length of their studies. Typically the work of the VIP team aligns in some way with the research of the post-graduate students. Post-graduate students typically assume a leadership role. Faculty members are an integral part of the team, serving as advisors, evaluators (especially for undergraduate students) and liaisons with external clients, if such exist for the specific team. The teams at Georgia Tech are distributed throughout the Colleges of Engineering, Science and Computing, drawing students from electronic engineering, biomedical engineering, industrial engineering, aerospace engineering, mechanical engineering, computer science and biology.

All three stakeholders discussed previously are represented in a VIP team. Undergraduate students typically pursue only the student bottom line while post-graduate students tend to be more focussed on the research outcomes – pursuing a faculty bottom line. Faculty members obviously pursue the faculty bottom line, but in the absence of an external client (either commercial or research client) they typically fill the role of the research client. External commercial or research clients may also be involved, depending on the research context and maturity.

4 CASE STUDY: THE ITRANSPORT TEAM

The iTransport team was created in Fall 2010 (August-December 2010) with its initial goal the implementation and testing of a self-coordinating bus control system on the Georgia Tech Trolleys – an on-campus transit system. The bus control system is based on an adaptive control algorithm developed by Bartholdi and Eisenstein[1]. The rationale for the self-coordinating control system is the following: Urban bus systems strive to maintain a constant headway between buses. This is undermined by inherent variability in the transit system including traffic, driver behaviour, passenger behaviour, and unexpected interruptions such as breakdowns. The result is collapsed headways where buses travel in bunches. Bus bunching has a detrimental effect on the predictability and punctuality of the service – severely impacting customer service levels.

The traditional method of countering bus bunching is implementing a schedule. Traditionally, schedules attempt to rectify inconstant headways by building in 'slack' at one or more control points along the route. If a bus reaches the control point on time, it waits for the predetermined slack period. If the bus is early, it waits for a longer period and if it is late it waits for a period smaller than the predetermined slack (or not at all). The problem with this static measure of control (and the *a priori* target headway it assumes) is that it cannot account for the full range of variances that may occur on a bus route on a typical day. This is evidenced by the frequent occurrence of bus bunching on urban bus routes, despite meticulous schedules.

The self-coordinating bus control system completely abandons the schedule in favour of the following process:

1. Buses travel along the route driving naturally, adhering to speed restrictions and stopping for passengers at necessary stops.
2. When a bus reaches a control point, information is retrieved to determine how many minutes ahead of the current bus is the bus that previously left the control point (forward headway) and how many minutes behind the current bus is the bus that will reach the control point next (rearward headway).
3. The algorithm then calculates the ideal waiting time for the current bus at the control point.

The underlying algorithm is proven to converge while the self-coordinating bus control system has proved successful and robust both theoretically through simulation of a bus route in the Chicago Transit System and empirically through live trials on the Georgia Tech Trolley system [1]. The task that lay ahead of the iTransport team at the beginning of Fall 2010 was to develop, test and implement the required software systems needed to fully implement the self-coordinating bus control system on the Georgia Tech Trolleys. Optimistically it was expected that this would take no longer than two semesters. In reality the team is now in its sixth semester with great hopes that the task will be completed by August 2012. In the author's opinion, the initial expectation was unrealistic - based on a superficial understanding of the technical complexity of the software systems required and an idealistic hope that project-based learning teams are as predictable and efficient as a team of engineers in industry.

The iTransport team consisted of between 12 and 15 students, except during the Summer 2010 semester when there were fewer than six students. The number of post-graduate students on the team grew from one to three over the four semesters. The majority of students were from the industrial engineering faculty with only a few students from computer science forming part of the team each semester. All post-graduate students were industrial engineering majors. The project leader was Professor John Bartholdi (Industrial Engineering) while Professor Russ Clark (Computer Science) advised and greatly assisted the software design and development. The Georgia Tech Department of Parking and Transportation was the commercial client of the iTransport team. The iTransport team is regarded a successful VIP team and has made promising progress, despite numerous frustrations and challenges along the way. The team has also been successful in addressing the triple bottom line as is evidenced by the research progress, positive feedback from team members, the many enrolment requests received each semester and the client's continued commitment and enthusiastic participation. The following four sections describe some of the most important lessons learnt along the way.

4.1 Expectation management

In project-based learning experiences, as in life, one of the biggest sources of disappointment is unmet expectations. Each stakeholder has their own expectations – from the youngest undergraduate to the client. It is important that these expectations be discussed openly and honestly at the outset, but it is even more important that expectations be managed as the project progresses. In the case of the iTransport team there were a few sets of expectations that had to be continuously addressed and revised.

The most crippling mismatch of expectations is between what the students (especially undergraduate students) expect they will be doing in the VIP team and what the faculty members and project managers (typically post-graduate students) expect the students will do. Students have limited, if any, exposure to real-life collaborative engineering projects. Their frame of reference is that of the typical engineering classroom where their learning and participation is mostly guided by the person standing at the blackboard. Even course related group projects do not compare as they typically have a well-defined scope and a prescribed set of engineering tools that should be 'practised' on the problem. In short, the project leaders expect to see autonomy, initiative, intellectual maturity and a certain level of proactiveness while students expect detailed guidance and constant feedback on their progress. The potential for frustration is clear. Ultimately, it is the responsibility of the project leadership to help students cross the chasm from the classroom to the VIP team.

Client expectations should also be handled with great care. The iTransport team is privileged to work with a client that has a deep appreciation for the try-fail-try-again approach of research and development. In addition the Georgia Tech Department of Parking and Transportation has a keen appetite for trying new things – such as throwing the schedule out the window, mounting RFID sensors along the bus route and hard wiring Android tablets in the buses (Figure 1). From the team's side it was important to communicate progress and future expectations honestly, concisely and as professionally as 'studently' possible to the client at least once a semester. This was done through client presentations and demonstrations. The iTransport project also required trial runs during the Spring 2011 and Fall 2011 semesters during which a group of students armed with clipboards, Android phones, yellow bibs and varied levels of enthusiasm 'took over' the bus route for a few days to test the software systems developed. Communicating with the client – both the management team and the drivers – well in advance was essential (Figure 2). During trial runs there would be constant communication between the team and the drivers, the manager of the drivers and management in general followed by a detailed 'de-brief' presentation and report to the client after the trial run.

Figure 1: Android tablet with countdown software mounted on a Georgia Tech Trolley
(Photo source: CNN light years http://lightyears.blogs.cnn.com/2012/05/16/waiting-for-a-bus-math-may-help/)

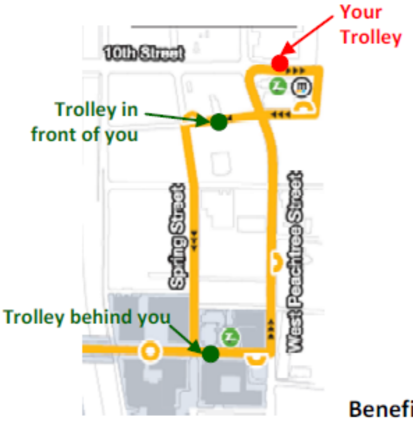
3 – 2 – 1 – GO!

VIP iTransportation - Software Live Trials

1, 2 & 3 November 2011

WHO? The VIP iTransportation team is a research group that is working with the Georgia Tech Department of Parking and Transportation to reduce bus bunching in the Tech Trolley system.

WHAT? To reduce bunching we propose replacing the schedule with another kind of control system. With the new control system, a Tech Trolley driver will drive naturally along the route and when he/she reaches a control point, an Android device mounted inside the Trolley will tell the driver how long to wait at the control point.



How does the Android device calculate my wait time?

At the control point the device determines...
- How far ahead of me is the Trolley in front of me?
- How far behind me is the Trolley behind me?

↓

An internal algorithm calculates the wait time

↓

The android device displays a countdown

Benefits **WHY?**
- Drivers no longer have to worry about schedule adherence
- The system better prevents and remedies bus bunching
- Trolleys can "recover" quicker from unexpected events, like breakdowns

The purpose of the live trials is to test the performance of the control system, NOT to evaluate you, the driver, in any way. We welcome your feedback during the live trials.

What will happen during the Software Live Trials? **HOW?**
- Trolley drivers will drive along the route as usual.
- When they reach the Transit Hub or MARTA a student standing at the stop will have an Android device that displays the wait time for the Trolley.
- The student will tell the driver how long to wait when the driver first arrives at the control point.
- The student will tell the driver when there is only 20 seconds left on the countdown.
- The driver departs once the countdown is completed and drives along the route as usual.

Note: If a driver wishes to take a restroom or personal break that would take longer than the calculated wait time, he/she is welcome to do so.

WHEN?

Tuesday 1 November 2011: **7am – 11am**
Wednesday 2 November 2011: **2pm – 6pm**
Thursday 3 November 2011: **10am – 2pm**

Before the live trials start each day, Trolleys will be running according to the schedule. After the live trials each day, the Trolleys will return to the schedule.

Figure 2: Handout prepared for drivers during Live Trials

Another expectation particular to the iTransport team was the expectation that implementing the self-coordinating bus control system would be straight-forward. The underlying algorithm and mechanics of the system had already been developed and tested, what remained was to develop the software systems required to implement it. Shoddy GPS data due to urban valleys and archaic hardware on the buses and a severe shortage of computer science majors hampered progress. The gravity of these issues only became apparent during the Fall 2011 semester although they had been flagged as potential issues during the very first semester. In retrospect, if more time was spent to understand the full extent and impact of these red flags in Fall 2010, a lot of time could have been saved.

4.2 Know the team

In the classroom all students are regarded equal, at least until test scores prove otherwise. Students are expected to have the same prerequisite knowledge, they learn the same material, do the same assignments and write the same tests. Individual student personalities have no bearing on what is taught and how it is taught. This is not the case in the project-based learning environment.

Individuals have different capabilities, personality traits and preferences and it is the opinion of the author that in project-based learning environments, individuals should be managed accordingly. This may seem slightly patronising but consider that most students lack the confidence cultivated by work experience and may be intimidated by the presence of post-graduates and faculty members. Conscious effort needs to be made by project leadership to get to know team members and match them with appropriate roles within the team. Doing this not only makes the student enjoy his/her work on the team more, but the student actually becomes more motivated and productive. Play to the strengths of the individuals.

Having said that, it is apparent that the 80-20 rule holds even in the project-based learning environment where a handful of students perform most of the work, another two handfuls are helpful and the remaining two handfuls seem bored most of the time. Rather than expending large amounts of energy to coax team members to becoming like the first group, project leadership should identify early on who falls into which category and adapt their time investment accordingly. (Granted, in some cases a little coaxing or 'coaching' is really all it takes, but these students can be easily identified through a few informal discussions and an assignment or two.) The first group of students respond well to increased responsibility and autonomy while the second group can be expected to complete well-defined tasks with a certain level of guidance. The third group is really the most difficult to manage in terms of productivity.

4.3 Handling the switchover

Imagine a project team in industry that every four months swaps out more than half of the team members for new team members that have had no exposure to the project whatsoever and probably lack the technical expertise the previous members had learnt. It is unthinkable! Yet student turnover is an accepted phenomenon in VIP teams and the iTransport team was no exception. Succession management, the institutionalisation of knowledge and meticulous documentation should therefore be ongoing activities in every VIP team.

There should always be students assigned to shadow sub-team leaders or people with specific technical expertise and project leadership should closely monitor that the necessary skills are indeed transferred.

The institutionalisation of knowledge is when what is known by a few is communicated to the rest of the group. This not only relates to technical knowledge, but also to design decisions and client interactions. In the iTransport team, sub-teams had to periodically present their technical work and design ideas to the rest of the team. In fact, the majority of the weekly iTransport group meetings were devoted to the discussion of technical issues and design decisions related to various sub-teams.

The importance of meticulous documentation cannot be overstated. The VIP programme institutes the practise of each student keeping a design notebook, primarily as evidence for future IP matters. But in the author's experience design notebooks are not the most effective way to document the work done by the team. With regards to software architecture, all designs and coding should be documented using standardised notation/protocols. Merely having 'comments inside the code' is not enough. In addition, writing up a detailed, technical progress report that summarises all the work done and design decisions made by the sub-teams (with references to electronic files and appendices) is invaluable. However, squeezing the time and motivation out of students to contribute to such a report at the end of a semester always proved challenging in the iTransport team.

Retaining knowledge and expertise in the group is but one aspect of 'handling the switchover', what about the many new faces that join the team each semester? Integrating new students can be distracting and chaotic. Accepting that the first few weeks of each semester will be focused on getting everyone up to speed already calms frustrations. The real challenge lies in finding ways to make new students a productive part of the team as quickly as possible. It is unreasonable to expect new students to catch up to other members before they can contribute. The project leaders should identify meaningful tasks that new members can complete with existing knowledge and expertise while they are learning. The feeling of contribution motivates new members to conquer the steep learning curve and it takes a load off of the existing team members.

4.4 Intensive coaching and guidance

The iTransport team had a scheduled group meeting of 90 minutes once a week where all the students had to be present. Faculty members joined as often as their schedules allowed but were kept up to date regarding group progress and were always available via email. The purpose of these meetings was to discuss work done in the sub-teams, plan trial runs, brainstorm design possibilities and discuss administrative issues. It was expected that sub-teams have separate working meetings on a weekly basis.

Given the level of coaching and peer-to-peer learning that is implied by the preceding discussions, it is proposed that more time be dedicated to group working sessions in the VIP programme. How much more time would depend on the technical difficulty of the work, team dynamics within the sub-team and the workload at the time. In the iTransport team it often happened that certain individuals spent inordinate amounts of time to complete work before the trial runs while others had nothing to do. It is believed that this was the result of insufficient peer-to-peer learning and delegation early on in the semester, exacerbated by the inflexible schedules of, especially undergraduate, students. If more time had been set aside each week for groups to sit alongside each other and work, this might not have been the case.

4.5 Keeping the focus on the triple bottom line

So far the recommendations in this case study have centred on expectation and team management. This is because a common understanding and good team dynamics are fundamental to achieving any bottom line, never mind a triple bottom line. Once the project leadership understands all the expectations on the table and know how to realise the potential of their student teams, doing the work that addresses the triple bottom line becomes much easier. The caveat is not to become so absorbed in team management that the team loses track of the bigger picture.

At the outset of each semester it may be worthwhile to devote a working session to reminding the team of the student, faculty and client bottom line and to reiterate the importance of working toward all three simultaneously. These broad objectives must then be linked to the short (one semester) and medium (one year) term goals of the team. A clear action plan with set deliverables should be associated with each goal and these should be tracked throughout the semester by the project leadership. This may seem like elementary project management principles, but they are often neglected in project-based learning environments. It is believed that this occurs because none of the students join VIP teams to become project managers – they are attracted to the project by its technical content and engineering challenge. The final recommendation is thus that project leadership recruit (older) students exclusively to be project managers.

5 CONCLUSION

Project-based learning experiences are becoming an integral part of engineering education as they develop critical problem solving and collaborative skills in engineering graduates.

But the student is not the only stakeholder and attention must be given to the objectives of the faculty members and external clients associated with these endeavours. This paper defined the stakeholder objectives that constitute the triple bottom line (student, faculty and client) of project-based learning experiences and argued that longer-term relationships/projects are more fruitful for all involved. The challenge is to ensure that all stakeholders remain committed and enthusiastic in the long term and this is only possible if the entire triple bottom line is addressed from the outset of the project.

The iTransport team is one of the VIP teams at the Georgia Institute of Technology and is regarded as a successful example of simultaneously balancing the interests of students, faculty members and an external client. A case study of the iTransport team highlights the lessons learnt in this regard during the first four semesters of the project. From the experience of the iTransport team expectation management, successful management of the team dynamics and a constant and deliberate focus on achieving the triple bottom line is essential to ensure a longer-term, sustainable project-based learning environment from which all three stakeholders can benefit.

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