JOURNAL OF MANAGEMENT AND ENGINEERING INTEGRATION

Editor-in-Chief

Nabeel Yousef, Ph.D.
Daytona State College
yousefn@daytonastate.edu

Associate Editors

Ahmad Elshennawy, Ph.D.
University of Central Florida
Ahmad.Elshennawy@ucf.edu

Al Petrosky, Ph.D
California State University, Stanislaus
apetrosky@csustan.edu

. Faissal A. Moslehy, Ph.D., PE
University of Central Florida
faissal.moslehy@ucf.edu

AIEMS President

Nael Aly, Ph.D.
California Maritime Academy

Scope: The Journal of Management and Engineering Integration (JMEI) is a double-blind refereed journal dedicated to exploring the nexus of management and engineering issues of the day. JMEI publishes two issues per year, one in Summer and another in Winter. The Journal's scope is to provide a forum where engineering and management professionals can share and exchange their ideas for the collaboration and integration of Management and Engineering research and publications. The journal will aim on targeting publications and research that emphasizes the integrative nature of business, management, computers and engineering within a global context.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Table of Contents

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Deriving Long-Term Benefits from Short-Term Study-abroad Programs

Nipoli Kamdar
Tony Lewis

California State University-Maritime
California State University-Maritime
nkamdar@csum.edu; tlewis@csum.edu

Abstract

Students generally report study-abroad participation to be transformative in nature. While numerous studies confirm the results of student surveys, some evidence suggests that study-abroad programs may not always make a significant contribution to academic learning. Part of the problem is caused by the fact that assessment of the academic learning achieved on study abroad trips is often incomplete, non-existent, or relies totally on self-reports from students who do not know what they did not learn. The authors discuss the lessons learned from three different types of assessments of the study abroad program at their institution. The authors also address the challenges of integrating experiential components of short-term study-abroad trips with traditional academic courses to maximize the learning associated with such experiences. A range of data-driven solutions relating to pre-trip planning and preparation, trip design and execution, and post-trip integration of experiential learning opportunities are presented. All solutions are designed to encourage students to engage in deeper academic learning in conjunction with short-term study-abroad experiences.

Key Words: study-abroad, assessments, cultural intelligence, experiential learning

1. Introduction

It is widely believed that studying abroad is one of the best ways for students to achieve individual growth and to develop the global mindset that employers demand. While many colleges and universities in the U.S. encourage students to participate in study-abroad programs, less than 10% of students who graduated in 2013 had done so (Open Doors, 2013). Students and learning institutions often find the costs of participating in study-abroad programs to be prohibitive. In the face of widespread resource constraints, many contemporary study-abroad programs have tried to reduce costs. One obvious approach is to reduce the length of the study-abroad experience.

According to a 2013 report by The Institute of International Education, 59% of all students studying abroad in 2011-12 were enrolled in short-term study-abroad programs (defined as less than eight weeks during the academic year). This is up from 55.4% just five years earlier. The increase in short-term study-abroad programs has led to heightened scrutiny about the effectiveness of such programs in meeting academic learning goals. While some have questioned the efficacy of short trips (*e.g.,* Kehl and Morris, 2007-08; McKeown, J. S. (2009), Zarnick, 2010); there is considerable evidence that students gain significant benefits. (*e.g.,* Ingraham & Peterson, 2004; Lewis and

Niesenbaum (2005); Loh, et al., 2011; Norris & Gillespie, 2009).

At our institution, a three-week faculty-led study tour is the most popular option for study-abroad. Our assessment data confirm the eye-opening and transformative impact of these experiences. However, the data also suggest that simply exposing students to international learning opportunities (*e.g.,* site visits to businesses based in foreign countries) is not enough to facilitate discipline-specific learning. The results of the assessment led to a reexamination of extent to which learning outcomes for the program were being accomplished and questions about how best to facilitate student learning on short-term study-abroad trips. This paper describes the lessons learned from our assessment data and proposes reforms to better integrate academic and experiential components.

Before we describe our assessments it should be noted that our institution is a small, primarily undergraduate university with approximately 1,100 students. Our school is unique in that every undergraduate is required to complete an international experience before graduation. Students can satisfy this requirement in a number of ways but most business and policy majors choose to participate in a three-week tour of one or more foreign countries. Students travel in multiple cohorts of about 15-25 students in each group with at least one faculty member assigned as trip leader. Prior trips have gone to Korea, Japan, Vietnam, Costa Rica, Morocco, and various locations throughout Western Europe. Common goals for all study-abroad trips are to visit locations important to seaborne trade and international business, to provide students with opportunities to apply theoretical knowledge gained in the classroom, and to develop a keen appreciation of differences in cultural practices and their impact on business operations.

2. Assessments

In 2013, three different types of assessment data were analyzed to judge the effectiveness of the international experience program. First, we examined how graduating students performed on the exit exam, particularly with regard to the questions relating to global business. Secondly, upon completion of the trip, students wrote an 8-10 page essay reflecting on what they had learned during their international experience. The essays were evaluated by faculty to determine the degree to which students had achieved the intended learning outcomes. Lastly, students were also required to fill out a cultural knowledge survey before and after their trip.

2.1. Exit Exam

At the end of their senior year, all business majors at our institution take a comprehensive exit exam designed by a third-party provider. Their performance can be compared to students at other schools for the purposes of external benchmarking. The exam covers the 12 subject areas considered to be part of the common professional component (CPC) of an undergraduate business program. One of these subject areas is the "global dimensions of business," and is comprised of questions relating to discipline-specific knowledge of international business, as outlined in Table 1. The questions attempt to measure students' knowledge about the functioning of international business.

Given the relatively unique international experience requirement, we expected our students to perform particularly well in demonstrating their understanding of the global dimensions of business. However, testing results indicated that our students were actually performing worse than students in similarly accredited schools. In fact, of the 12 CPC components, this was the category with the greatest difference –14 percentage points-- in scores between students at our institution and those at other IACBE (International Assembly of Collegiate Business Education) schools in the Western Region. Students at our institution

scored a dismal 46% on average and performed worse than the reference group in every single sub-category, as seen in Table 1.

Table 1. 2013 Exit exam Results

Exit Exam Global Dimensions of Business Frequency of Correct Responses		
Sub-Topics	Our University	IACBE Schools (Western Region)
Foreign Direct Investment	51	61
Intnl. Corporate Strategies	43	60
Intnl. Governance and Regulations	43	62
Intnl. Patents and Protections	45	47
Multinational Culture	50	60
Summary	46	60

2.2 Faculty Assessment of Reflection Essays

Faculty assessment of students' study-abroad reflection essays confirmed these findings. Instructors used a Likert scale to evaluate the criteria listed in Table 2 (1= strongly disagree; 5=strongly agree).

Students did well at describing their own culture in a global context and at describing some important features of the culture of the host country. Instructors either agreed or strongly agreed that over seventy percent of students had achieved the first two learning outcomes with mean ratings of 4.0 and 3.9 respectively. However, students did not exhibit mastery of learning outcomes relating to deeper discipline-specific knowledge, with less than half of the students demonstrating an adequate knowledge of global policy issues and international business and logistics practices. The testing data from the exit exam and student essays indicated that just exposing students to different countries and cultural contexts was not enough. There are many ways in which faculty can make better use of this potentially rich experiential learning opportunity.

Table 2. Assessment of Reflection Essays

Learning Outcome	Mean Rating	Percentage of students earning 4 or 5
1. Student understands his/her culture in a global and comparative context	4.0	71
2. Student demonstrates knowledge of the host country's culture	3.94	76
3. Student demonstrates knowledge of host country's economy	3.56	59
4. Student demonstrates knowledge of global and policy issues	3.34	45
5. Student demonstrates an understanding of international business and logistics practices in different cultural contexts	3.04	35

2.3 Cultural Intelligence Survey

Students' cultural awareness and ability to function in culturally diverse contexts was measured both before and after the trip using the cultural intelligence scale (CQS). The CQS is a survey instrument designed by P. Christopher Early and Soon Ang (2003) and it is widely used in industry and academia. The survey is comprised of twenty questions grouped into four categories –metacognitive (MetaCQ), cognitive (CCQ), motivational (MotCQ) and behavioral (BCQ). MetaCQ questions attempt to measure students' awareness of how they use cultural knowledge in cross-cultural interactions, while the CCQ questions measure knowledge of similarities and differences across cultures. MotCQ questions capture desire and ability to engage with other cultures, and BCQ assesses the students' ability to adapt their behavior and actions in different cultural situations.

Post-trip survey data reveal that students performed quite well on all but one dimension of the CQS . Likert scale ratings were lowest for the group of questions relating to students' knowledge of other cultures (see Mean Ratings in in Table 3). The percentage of students either agreeing or strongly agreeing with each of the questions on the CQS is provided in the third column of Table 3. Almost all of the students (96%) reported that they enjoyed interacting with people from different cultures. Similarly, the experience left most of them feeling positive about their ability to adjust to living and working in a different culture. On the other hand, more than half of the students did not feel that they had learned much about legal and economic conditions, arts and crafts, and religions of other countries.

Table 3. Post-Trip Results of CQ Survey

CQ Survey 2013 **1=Strongly Disagree , 5= Strongly Agree**	**Mean**	**% who Agree or Strongly Agree**
Metacognitive (MetaCQ)		
1. I am aware of the cultural knowledge I use when interacting with people with different cultural backgrounds.	4.3	85
2. I am aware of the cultural knowledge I apply to cross-cultural interactions.	4.3	82
3. I adjust my behavior as I interact with people from a culture that is unfamiliar to me.	4.3	89
4. I check the accuracy of my assumptions as I interact with people from different cultures.	4.1	76
Cognitive (CCQ)		
5. I have some familiarity with the legal and economic systems of other countries.	3.4	52
6. I have some familiarity with the religious beliefs of other cultures	3.0	32
7. I have some familiarity with the marriage systems of other cultures.	3.9	71
8. I have some familiarity with the arts and crafts of other cultures.	3.3	45
9. I have some familiarity with the rules (e.g., grammar) of other languages	3.9	73
10. I have some familiarity with the rules concerning non-verbal behaviors in other cultures	3.8	67
Motivational (MotCQ)		
11. I enjoy interacting with people from different cultures.	4.7	96
12. I feel confident that I can socialize with locals in a culture that is unfamiliar to me.	4.3	90
13. I feel confident I can deal with the stresses of adjusting to a culture that is new to me.	4.5	91
14 I enjoy living in cultures that are unfamiliar to me	4.0	88
15. I feel confident that I can get accustomed to the shopping conditions in a different culture.	4.5	90
Behavioral (BCQ)		
16. I change my verbal behavior when a cross-cultural situation requires it.	4.2	81
17. I use pause and silence differently to suit different cross-cultural situations.	3.9	66
18. I vary the rate of my speaking when a cross-cultural situation requires it.	4.1	81
19. I change my non-verbal behavior when a cross-cultural interaction requires it.	4.3	88
20. I alter my facial expressions when a cross-cultural interaction requires it.	3.9	70

In order to better understand the impact of the trip on the four dimensions of the CQS scale, we calculated the means for each category separately and compared it to data from the pre-trip CQS survey, as documented in Table 4. To provide the reader with a sense of the variation in each category both before and after the trip, we report the minimum and maximum percentage of respondents who

agreed or strongly agreed with the questions in each category. For example, it is clear from Table 3 that 76% percent of respondents agreed or strongly agreed with statement 4 (I check the accuracy of my assumptions as I interact with people from different cultures) while this number was as high as 89% for statement 3 (I adjust my behavior as I interact with people from a culture that is unfamiliar to me). Hence, the last column in Table 4 lists the Range for the metacognitive category as 76-89.

Our results indicate that post-trip averages were not significantly different from the pre-trip averages for the motivational and behavioral categories, as can be seen in Table 4. Hence, students' self-assessments of their interest in other cultures and of their ability to adapt to different cultural norms were only slightly improved by their participation in a faculty-led short-term study-abroad tour.

Table 4. Pre-Trip and Post-Trip CQS

	PRE-TRIP		POST-TRIP	
Category	Mean	Range (% with 4 or 5)	Mean	RANGE (% with 4 or 5)
MotCQ	4.3	77-96	4.4	88-96
MetaCQ	4.4	79-98	4.25	76-89
BCQ	3.9	66-87	4.08	66-81
CCQ	3.2	30-57	3.55	32-73

The biggest observable differences were in the Meta-cognitive and cognitive categories. Interestingly the mean score for questions in the meta-cognitive category was actually lower upon completion of the trip. It is extremely unlikely that a study-abroad tour would result in a decline in meta-cognitive cultural intelligence. A more plausible explanation is that these students, most of whom had never travelled abroad, had no occasion to question the assumptions they made about people and practices in other countries and were unaware of their biases. We speculate that, while travelling and studying in a different country, students might have experienced a "disconfirmed expectation," (*i.e.,* they experienced something contrary to their expectation, given their cultural biases) (Bhawuk, 2009). Reflection upon this disconfirmed expectation leads to greater self-awareness of biases (McRae 2011) and can result in the realization that they need to develop better meta-cognitive strategies for inter-cultural contexts.

Not surprisingly, the greatest differences in pre- and post-trip mean ratings were for the questions in the cognitive category. Students' knowledge of the legal and economic systems and cultural practices in other countries improved considerably after their international experience. However, as is clear from Table 4, of the four factors measured by the CQS, the cognitive category was the one with the lowest pre- and post-trip scores. Hence, students' own perceptions of their learning echoed the testing data and pointed to the need to restructure the program to both achieve the academic learning outcomes and take full advantage of the experiential learning opportunity.

3. Assessment-driven reforms

The evidence suggests that the way a trip is executed matters. Students do not achieve rigorous academic learning by simply being exposed to international experiences and given some basic homework like a topic essay or reflection paper. Hence the program must be overhauled to encourage more rigorous academic learning.

3.1. Goals and challenges

In redesigning the international experience, we are guided by four main goals. Our first goal is to prepare students with the necessary contextual and practical knowledge needed to quickly assimilate into an unfamiliar environment and to make clearer sense of learning opportunities abroad. Second, we hope to facilitate the trip in such a way as to simultaneously encourage discipline-specific learning and individual engagement and

exploration. Our third goal is to reinforce knowledge and experiences gained through study-abroad opportunities by integrating these into the regular curriculum that students will complete upon their return to campus. Our fourth goal is to enable continuing learning about the culture, politics, and economy of the host country by facilitating ongoing connections between students and the people, businesses, and institutions that they encounter in the host country.

In seeking to increase the academic impact of the international experience program we address two basic challenges that are characteristic of short-term study-abroad trips. First, there is the need to find an appropriate balance between structured academic activities and unstructured time that allows for individual exploration and learning. Short-term trip schedules tend to be tightly packed with as many cultural, government, and industry site visits as possible. We seek to increase the rigor of academic learning in a way that encourages and enhances individual engagement and exploration and allows the experiential learning to enhance discipline-specific knowledge.

The second basic challenge is combatting what has commonly been referred to as the island or bubble effect. Relative to longer trips, short-term trips provide lower incentives for students to engage with the people of the host country or to assimilate to their cultural norms. Students know that they will be abroad for only a short period of time. On longer trips, students do not want to spend an entire semester or year simply peering through the bus windows and talking to the tour guide, so they perceive a greater need to overcome their social anxieties and engage with local people. Moreover, if long-term study-abroad students can establish relationships with local people, they will reap the benefits for a much longer period of time than on short-term trips. The widespread availability of social media and cheap international calling for students to connect with home only exacerbates this problem.

Facilitating rigorous academic learning despite having limited time and motivating students to engage and assimilate in a foreign culture despite having lower social incentives to do so are two of the primary ways we seek to improve the experiential component of our international experience program. The study-abroad program has been referred to as “Learn by Going” (Keese & O’Brien, 2011). We seek to build a well-integrated global education program that would provide opportunities for learning by going, but also for learning before and after going. Towards that end, we propose bookending the international experience with two required academic courses, one to serve as a preparatory experience and the other to provide an opportunity to put the theoretical and experiential learning into practice.

3.2 Preparatory course

The preparatory course is critically important to maximizing the academic impact of the experience. If students understand what to look for, they have a much better understanding of what they are looking at. Preparatory meetings where logistics, liability, and health insurance are discussed are necessary (as described by Keese & O’Brien, 2011) but not sufficient. Recognizing the importance of providing students with the tools they need to make the most of their experiential learning opportunity, we developed a new course called the Global Economy. Students studied international trade theory and policy, as they would do in any traditional International Economics class, but within the context of cultural, political, and socio-economic conditions in the countries they would be travelling to at the end of the semester. Students were assigned to country-specific teams and each team was required to create a notebook with a detailed cultural and economic analysis of one of the countries they would be visiting. Each group was required to do two class presentations -one on culture and political climate that businesses operate in, and the other on the country’s socio-economic conditions, regulatory and financial institutions, and contemporary challenges. These

presentations were followed by extended question and answer sessions that allowed students to compare and contrast the countries that they would be visiting. The research project was intrinsically motivating as students knew they would soon be visiting the countries they were researching. As a result of this extensive preparation, students stepped off the plane with a basic understanding of the cultural norms and institutions of the country they were visiting.

In addition to this new preparatory course, we also reinstated the International Business as a required course to be taken during the sophomore year. We have already seen a big improvement in the performance of our students on the "Global Dimensions of Business" component of the exit exam. In Spring 2014 the mean score for students at our institution rose from 46% to 53%, while the averages for students at similarly accredited schools actually fell from 60% to 54%.

Table 5. 2014 Exit Exam Data

Exit Exam Global Dimensions of Business Frequency of Correct Responses		
Sub-Topics	Our University	IACBE Schools (Western Region)
Foreign Direct Investment	60	58
Intnl. Corporate Strategies	55	55
Intnl. Governance and Regulations	54	50
Intnl. Patents and Protections	29	37
Multinational Culture	33	40
Summary	53	54

3.3 Enhancing Experiential Learning

Given the limited time available on the trip, we suggest that only work that requires direct engagement in the foreign country should be completed on the trip itself. For example, when traveling abroad, students could engage in primary research, the product of which will be needed to successfully complete any written papers and/or oral presentations associated with the trip. To maximize intrinsic motivation we suggest allowing students to choose an important issue in the host country to research for their project. Working individually or in small groups, students could research potential issues before leaving for the trip. However, it may be best for them to wait until they arrive in the country to make a final decision on which issue they will pursue since they will be quickly confronted with large amounts of new information.

We also suggest requiring students to research an issue that necessitates significant primary research. In-country primary research relevant to the students' chosen issues might consist of interviews with local people or other resources that can only be accessed in the host country (*e.g.,* museum exhibits and other direct observations). Interviews can be used to pursue rigorous academic learning, but they also encourage individual exploration and require students to stop peering through the bus windows and to get out and engage with people in the host country, which can be a daunting task for many students. Students will need instruction on how to prepare relevant questions and how to engage in deeper, probing inquiry based on the interviewee's responses. Trip leaders may consider demonstrating this using another faculty member, or a student as a sample interviewee.

It is important that students be confronted early in the trip with opportunities to gain the discipline-specific knowledge that will be necessary to complete the in-country research. Hence, we suggest a heavy concentration of site visits and other rigorous learning opportunities in the first week or so of the trip to give students the background knowledge and inspiration they will need to choose an interesting issue and pursue relevant primary research. To maximize the learning from these visits, we suggest that students prepare questions in advance. If possible, faculty should lead debriefings after each site visit so students

can share what they have learned and generate ideas for additional questions to ask at future site visits.

Students also need time to explore on their own. Later in the trip it is important to stay in one place for at least a few days and to ease the pace of site visits. This will allow students to explore and assimilate culturally, but to do so with the experience and knowledge that they have gained from the schedule of events earlier in the trip.

We also strongly suggest pursuing partnerships with local universities. Due to the shared learning that occurs (between study-abroad students and students living in the host country), these are often quite easy to arrange. Moreover, interacting with local students provides opportunities to ask questions of peers, which many study-abroad students find less intimidating than interactions with older or more career-driven individuals. Experience suggests that students have a strong intrinsic drive to interact with peers from a foreign country, so these exchanges can be facilitated with relatively little structure or oversight.

3.4 Post Trip Reinforcement

Rowan-Kenyon and Niehaus (2011) explored the long-term impact of study-abroad programs by exploring the impact of a week-long study-abroad experience on its participants one year later. They found that students who did not utilize the knowledge gained on the trip in learning opportunities at home quickly forgot what they had experienced. However this was not true for students who subsequently engaged in related learning opportunities.

The literature on study-abroad programs recognizes the importance of debriefing and reflection upon completion of the trip. Often this reflection takes the form of a reflection paper and/or a research paper that provides an in-depth analysis of a significant issue or problem in the country they visited. The objective is to allow students to reflect on and learn from their in-country experience. However, we propose that the experience itself would be more impactful if, immediately upon completion of the trip, students had an opportunity to apply their disciplinary and experiential knowledge to a "real-world" problem.

We are currently working on leveraging the international experience in course projects for existing courses on campus. For example, students will be asked to apply their newly acquired knowledge of the country they visited in an International Marketing class scheduled for the fall semester following their trip. Student groups could devise a preliminary marketing plan for launching a new product or expanding a current operation in the country they just visited. They could be tasked with researching, for instance, how Nike's marketing strategy in Germany differs from that in Vietnam. Alternatively students pick a particular industry and analyze how the 4 Ps vary by country. Integrating such projects into the existing curriculum avoids placing additional curricular demands on students and does not add to the financial burden of the institution.

As part of their reports they will discuss the plan in the context of the cultural and economic analysis completed before their trip as well as their in-country experience. Student presentations and class discussions will allow class participants to learn not only from their own experience, but also from that of other students who travelled to different countries. Since we go to 4-8 countries every summer, students will be exposed to socioeconomic conditions and cultural and business practices in a wide range of countries.

Integration of the international experience into the regular curriculum can also be strengthened through the use of international teams to complete common assignments. This requires a bit more cooperation and coordination with an overseas partner university. Students can be assigned a group project like those described above and work together across borders using social media networks to facilitate collaboration. This approach has the ability to take peer

connections made in foreign countries to a new level by moving the conversation toward more rigorous academic goals.

Lastly, the short-term faculty-led experience can serve as a springboard for longer term engagement with the global community. Students can be encouraged to lengthen their trip or take a follow-up trip on their own. The institution can maximize the impact of limited study-abroad funds by encouraging students to participate in vetted exchange programs or service-learning opportunities. Over time it may also be possible to develop relationships with local businesses that may be willing to fund internship experiences. Though our program is in its infancy, we are already beginning to see students express an interest in extended international engagement. Six months after a student returned from a faculty-led tour of Vietnam, he took the initiative to push for an exchange program with one of the Vietnamese universities we visited. He was also able to obtain an internship with a Vietnamese logistics firm. He inspired other students to seek similar opportunities. Such experiences greatly enhance student learning and self-discovery gained from study-abroad trips with very little added cost to the student or learning institution.

4. Conclusions

Study-abroad programs are not inherently great vehicles for gaining discipline-specific knowledge, as shown by results of three different types of assessment at our institution. For those students who participate in study-abroad programs, the experience is often disconnected from their subsequent studies. These problems are exacerbated on short-term study-abroad trips which have recently increased in popularity. We present some approaches for establishing the connection between study-abroad experiences and the regular on-campus curriculum more firmly. We suggest that to facilitate more rigorous academic learning students must receive significant preparation and reflection opportunities. Moreover, we propose that short-term study-abroad trips require a focused effort aimed at pushing students to explore and engage on their own because the incentives to do so are minimized on short-term trips. We propose an integrated program of study that is designed to minimize interference with experiential learning opportunities on short-term study-abroad trips. This involves significant pre-trip student research and a post-trip recap course to be administered upon returning to the home campus that draws on the experiential learning gained during the study-abroad trip.

Scholars interested in future research into short-term study-abroad trips may do well to consider the role of additional resources at the home campus that can be aimed toward gaining greater academic learning and individual growth from short-term study-abroad trips. For example, many universities that are facing cost challenges related to study-abroad programs have begun to rely more heavily on exchange students visiting the home campus as a source of international exposure (i.e., bringing the international experience to the student rather than vice-versa). While we are skeptical of the idea that such experiences can adequately substitute for study-abroad trips, scholars may consider exploring the effectiveness of such experiences as a supplement to study-abroad trips that could further the intercultural understanding that students gain from their own travels. Important factors to consider might include the home country of the exchange student compared to the country visited by students from the host university. Scholars may also explore the effect of the type of interaction (in-class or extra-curricular) on students' ability to demonstrate rigorous academic learning in an international context.

Lastly, in a time of increasing resource scarcity international study administrators may be in need of new strategies for ensuring that funds are available for administering future trips. Scholars could assist administrators by providing them with an updated list of best practices to use to help assure that funds

generated from international study-related initiatives (e.g., hosting foreign exchange students) are actually used for the study-abroad program. Research in this vein may help to ensure the resiliency of study-abroad programs despite the numerous cost pressures that we have outlined above.

References

Bhawuk, D. P. S. (2009). *Intercultural Training for the Global Workplace: Review, Synthesis, and Theoretical Explorations.* In Rabi S. Bhagat & R. Steers (Eds.), Handbook of Culture, Organization, and Work (pp. 462-488). Cambridge, UK: Cambridge University Press

Earley, P. C., & Ang, S. (2003). *Cultural Intelligence: An Analysis of Individual Interactions Across Cultures.* Palo Alto, CA: Stanford University Press.

Ingraham, E. C., & Peterson, D. L. (2004). Assessing the Impact of Study-abroad on Student Learning at Michigan State University. *Frontiers: The Interdisciplinary Journal of Study-abroad, 10,* 83-100.

Institute of International Education. (2013). Open Doors Report on International Educational Exchange. Retrieved from http://www.iie.org/opendoors

Keese, J., & O'Brien J. (2011). Learn by Going: Critical Issues for Faculty-Led Study-abroad Programs. *The California Geographer*, *51*, 87-107.

Kehl, K., & Morris, J. (2007/2008). Differences in Global-Mindedness between Short-Term and Semester-Long Study-abroad Participants at Selected Private Universities. *Frontiers: The Interdisciplinary Journal of Study-abroad, 15.* 17-31. Retrieved from http://www.frontiersjournal.com/frontiersjournal.comissuesvol15index.htm

Lewis, T. L., and Niesenbaum, R. A. (2005). The benefits of short-term study-abroad. *Chronicle of Higher Education, 51*(39), B20.

Loh, C. A., Steagall, J. W., Gallo, A., and Michelman, J. E. (2011). Valuing short-term study-abroad in business. *Journal of Teaching in International Business, 22,* 73-90.

McKeown, J. S. (2009). *The first time effect: The impact of study-abroad on college student intellectual development*. Albany, NY: State University of New York Press.

McRae, N. H. (2011). Cultural intelligence: Developing students who can act local and think glob al. Proceedings of the 2011 World WACE Conference. Retrieved from http://www.waceinc.org/philly2011/conference_proceedings/Refereed%20Papers/Canada/NORAHM~1.PDF

Norris, E.M & Gillespie, Joan (2009). How Study-abroad Shapes Global Careers: Evidence from the United States. Journal of Studies in International Education, *13*, 382-397.

Rowan-Kenyon, H.T. & Niehaus, E. (2011). One year later: The influence of short-term study-abroad experiences on students. *Journal of Student Affairs Research and Practice, 48*, 213-228.

Zarnick, B E. "Short-Term Study-abroad Programs and the Development of Intercultural Sensitivity" (2010). Master's thesis. Retrieved from http://ecommons.luc.edu/luc_theses/512

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Engineering an Understanding of Economics

Nipoli Kamdar
Michael E. Holden
California Maritime Academy

nkamdar@csum.edu; mholden@csum.edu

Abstract

Premised on the belief that learning by doing is often the best form of learning, business students in a Principles of Microeconomics class were asked to work in teams to build remote control units for overhead projectors at their university and sell them to faculty members. Teams competed with each other to minimize costs and maximize profits, with the winning team being awarded cash prizes and bonus points. The remote control project is an example of an authentic learning task, with students being asked to create a useful product to be shared with an external audience. Proponents of authentic learning argue that learning is best achieved in circumstances that simulate decision making in the real world. The authors examine assessment data to ascertain whether the project led to greater student engagement and an improved understanding of basic economic principles.

Introduction

Economics is a subject that most students are interested in –until they actually take their first course in it. Introductory Economics is often taught in an uninspiring manner The subject matter itself can be dry with the emphasis on abstract theories and simplistic models that assume away many of the complexities of the real world. Furthermore, "chalk and talk" continues to be the dominant method of instruction in economics classes at a time when other disciplines have moved towards more student-centered pedagogies. A 2010 survey of academic economists teaching undergraduate classes reveals that lectures are used 83% of the time across all economics courses and that the median respondent "usually or always lectures." (Watts and Schaur, 2011) Remarkably, this median has remained unchanged over the last 15 years despite the move of other disciplines towards more student-centered approaches.

Economists claim that economics is not a set of facts but a way of thinking about the world, yet it seems that few students are able to apply what they learn in their economics courses to understanding the world around them. Students themselves recognize this. In June 2000 a group of disaffected graduate students in France published a petition protesting among other things the lack of realism in academic economics and the dogmatic way in which it was taught (Fullbrook, 2002) The French students petition was followed by similar petitions and "open letters" from students in many other countries (Yeunglamko, 2011) Dissatisfied students are calling for changes in both what is taught in mainstream economics and how it is taught.

Academic economists have also frequently called for reforms in economics pedagogy (Becker, 1997) For example, David Colander (2004) argues that current teaching practices put too much emphasis on decision-making in

the presence of full information and "not enough on the use of economic reasoning as an engine for discovery. While others have responded to the call to reconsider what should be taught (Colander et al, 2009 Frank 1998; Hansen et al, 2002 Yeunglamkou,2011) this paper focuses on the more modest goal of changing how undergraduate economics is taught. The paper describes the authors' efforts to 'engineer an understanding of Microeconomic principles by having students participate in a semester-long authentic learning task We begin by discussing the term authentic learning and then provide a description of the project itself. Students were asked to evaluate the project and the results of that assessment are provided here. The conclusion highlights the lesson learned by the authors about the benefits and challenges of creating authentic learning tasks.

Authentic Learning

Authentic Learning is a multi-faceted term, with different authors stressing different aspects. For example, Donovan, Bransford, & Pellegrino (1999) emphasize real word relevance in their definition of authentic learning as "a pedagogical approach that allows students to explore discuss, and meaningfully construct concepts and relationships in contexts that involve real-world problems and projects that are relevant to the learner.' Others highlight the importance of creating a product that can be shared with an external audience or stress the inherently multi-disciplinary nature of authentic learning tasks Lombardi (2007) provides a comprehensive list of the ten dimensions of authentic learning experiences: real world relevance, ill-defined problem, sustained investigation, multiple sources and perspectives, collaboration reflection, interdisciplinary perspectives, integrated assessment, polished products and multiple interpretations and outcomes.

In designing the authentic learning project described in this paper the authors were mindful, not only of the ten dimensions described by Lombardi, but also of their resource constraints and the limited prior knowledge that first year students could be expected to have The choice of project was inspired by a local campus problem. Each classroom at our university is equipped with an overhead projector; over time the remotes used to control these projectors have disappeared. Shorter faculty members have to climb on chairs or rely on a long pole to turn the projectors on and off. Taller instructors also find it cumbersome to operate these projectors as they often have to squeeze through tightly packed rows of students in order to do so. This is especially a problem in introductory classes which tend to be larger and also rely a lot on power point slides to transmit information. We saw this problem as a perfect opportunity to involve first year students in the creation of a solution.

Student groups in Introductory Economics had to compete to build the lowest cost working remote control unit and sell it as profitably as they could They were provided with a design and a list of components and expected to find the lowest cost suppliers of these components build the units, and then sell them for as large a profit as possible. Each group was given $20; if they completed the task under-budget they could keep the difference. Conversely if they went over budget they had to make up the difference with their own resources. The competition was broken down into three stages with different learning outcomes for each.

Cost Minimization

The first step in the competition was designed to expose students to the different cost concepts that they are expected to master when studying the Theory of the Firm This is different from the way textbooks generally approach the topic; most begin with the production function and the law of diminishing marginal productivity and then plunge into an extended discussion of the various cost concepts illustrated by a plethora of production and cost curves and accompanying equations. This approach while logically compelling seems to leave most students dazed, confused and comatose. The few that manage to stay awake

seem indifferent to the instructor's excited revelation of how all of the marginal and average product and cost functions can be derived from the shape of the total product curve. No one believes that any decision maker, in any firm, actually uses production and cost curves to make business decisions.

Eschewing the traditional approach, we had students begin with researching the cost of components needed to build remote control units. Real world relevance was no longer in doubt. Students found real companies which provided real prices for tangible components that students could see and eventually touch. Some components had to be ordered in groups of 3 or 5; hence students realized that some costs were fixed while others were directly proportional to the number of units ordered, i.e. variable. Custom circuit boards for example are manufactured using a standard panel size and the minimum order is related to how many designs fit on a panel. Students understood that with a minimum order of 5, if the class were making between 1 and 4 remote control units, the marginal cost of an additional circuit board was 0. They also understood that a marginal cost of 0 did not imply that the average cost of components fell to 0 when an additional component was purchased. This drove home the difference between the concepts of marginal and average. More generally, beginning with this practical approach gave them a better understanding of these concepts than they would have gotten from studying a chapter crammed with graphs like the ones below (Figure 1 and 2).

Students enjoyed this stage of the competition very much. Most groups found it easy to obtain cost information by visiting web sites. Disappointingly, no group actually contacted a supplier and tried to negotiate prices. Perhaps that was just in recognition of the limited leverage they would have given that they merely wanted a dozen units of each component. The student group that found the lowest cost supplier (not surprisingly, a manufacturer based in China) won the first round of the competition. All student groups purchased their circuit boards from this supplier.

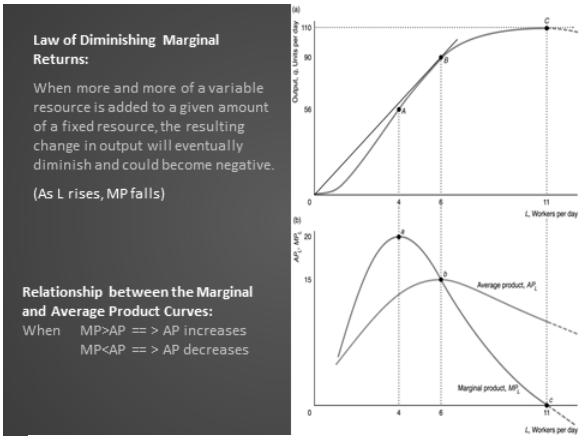

Figure 1. Traditional presentation of the law of diminishing marginal returns

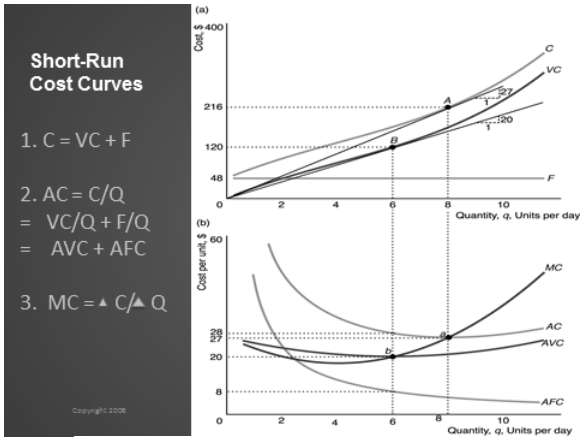

Figure 2. Traditional presentation of cost curves

Building the Remote

All student groups were required to build a working remote control unit. This was the phase of the project that students were initially most resistant to. "We are business, not engineering, students," they complained. In recognition of their lack of engineering knowledge, the circuit for the unit was actually designed by one of the authors of this paper an engineer (Holden 2014). Students were tasked with assembling the circuit by soldering the components into the circuit boards. Holden instructed the class in a 75 minute session to begin the assembly process. The groups were then required to work outside of class to finish

the remote (a soldering station was set up outside Holden's office.) Completed circuit boards were tested and mistakes fixed. Finally, students designed and fabricated an enclosure for the electronics. Figure 3 provides a photograph of the finished product - an assembled remote. Several groups realized that the enclosure is provided one of the few opportunities to differentiate their product from the rest and tried to make their cases aesthetically appealing.

Figure 3. Assembled remote

The non-economic skills the students learned from the process varied across the employment spectrum from electronic assembly (a job frequently performed offshore by low paid workers) to quality assurance and testing to consumer product design. Apart from underscoring the hands-on nature of the project, there were two reasons students were required to build the remote control units. First, an authentic learning task is inherently multi-disciplinary, just as most real word problems and challenges are. A sales or marketing manager must have a basic understanding of the products her company manufactures. Medical doctors might be called upon to do a cost-benefit analysis when prescribing certain tests and/or medical procedures. Entrepreneurs must understand both technology and business in order to successfully bring their innovations to the marketplace.

A second reason for requiring students to build the remote control units was to allow them to experience the production process, something business students rarely get to do. Despite the initial resistance, many students later reported that they enjoyed acquiring new skills that they never expected to learn in a business class. The novelty of the experience made it an impactful and memorable one. Moreover building the remote enhanced their understanding of basic principles such as the law of diminishing marginal productivity. For example each group quickly learned that it did not make sense to 'hire' all group members to assemble the circuit board since they had only one soldering iron. After the concrete experience of building the remote, it was easier to understand the law of diminishing marginal productivity and the relationship between marginal and average productivity. Students recognized that it was the size of the fixed factor (number of soldering irons) that drove the point of diminishing returns and that the crucial difference between diminishing marginal productivity and diseconomies of scale was that no inputs were held fixed in the latter case.

In addition there was much discussion of opportunity cost and comparative advantage when students were dividing up the many associated sub-tasks. Had anyone soldered before? Who could build a nice looking case to house the remote? Teams that worked well together were able to assign tasks to those who had the comparative advantage and generally performed better than teams where one member tried to "do it all," illustrating that self-sufficiency does not always produce the most efficient outcome.

This authentic task did not come without a cost of its own, however. In order to successfully complete the task both instructors and students spent a significant amount of time teaching or learning skills that had nothing to do with microeconomics. This is a trade-off that must be considered when planning an authentic learning task: would the time spent teaching

authentic supporting materia be better spent teaching the core subject? Studen opinion was divided on this issue as seer in sectior six of this paper.

5. Selling the Remote

To receive any credit at all for the project, teams had to sel their remotes to campus faculty. The team that made the larges profit was awarded bonus points. Since all components were sourced from the low cost supplier identified in the first round of the competition most groups had similar costs The smal variatior in costs came from the labor and materia costs associated with encasing and marketing the product. However differences in profits were driven not by cost differentials, but rather by differences in sales prices. Revenues varied from a minimum of $3 to a maximum of $100 with most remotes selling in the $20-$30 range Students learned to distinguish betweer initial target market and secondar y markets as they tried to identify those most likely to pay premium prices for their product:

> Our initial set of customers will consis t of CMA professors More specifically professors who use power point presentations daily with their lectures. …With the projectors mounted so high shorter professor will more specifically be a target for a custome r (sic) ….we will move on to the prankste market and try to sel to other students to see if we can pull in some last ditch profits …

Students learned that the better product did not always fetch a higher price, particularly when buyers do not have sufficien information about the availability of alternatives. For example students who were "first to market," or those who felt comfortable negotiating with professors were able to sel their products at a higher price than those with a more attractive unit or superior marketing materials Some groups realized that they did not have either the inclination or the aptitude for sales and preferred to outsource that to third parties. One such third party was a student who discovered that he really enjoyed the hustle of deal-making He offered to sel remotes for some of the teams in exchange for a small commission .He began with a commission of 10% but the commission got higher and higher as the deadline approached , reaching a jaw-dropping 90% the day before the deadline for the project!

6. Student Evaluation of the Project

Two different assessment instruments one summative and one formative, were used to assess the succes of the project. First students were asked a series of "clicker" questions about various aspects of the course including the remote control project. Secondly , each group was asked to turn in a written evaluation describing what they had learned and how they would modify the project to enhance the learning experience.

The clicker survey results show that the majority of students had a favorable opinion of the remote control project, although not overwhelmingly so. The data from the clicker questions (shown in figures 4 and 5) revealed that 28% of the respondents did not enjoy building the remote control. However more than half of this group agreed that the experience gave them a better understanding of production and cost concepts than they would have obtained with the traditional "chalk and talk" approach. Almost half of the class reported that they really enjoyed the opportunity to do such a hands-on project and many were excited about acquiring a new skill (soldering). Fifty–seven percent of the class either agreed or strongly agreed with the statement "Building the remote control unit and finding a custome for the product gave me a better understanding of production costs, competition and pricing than I would have gotten from the textbook alone.' A third of the class seemed to be indifferent to the experience , neither agreeing nor disagreeing with the above statement This was disappointing , given the amount of time and effort that went into planning and executing this project.

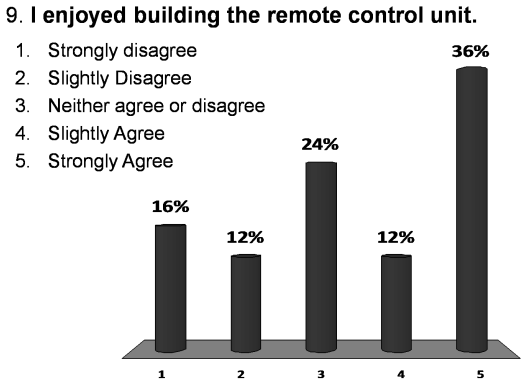

Figure 4. Student survey clicker results

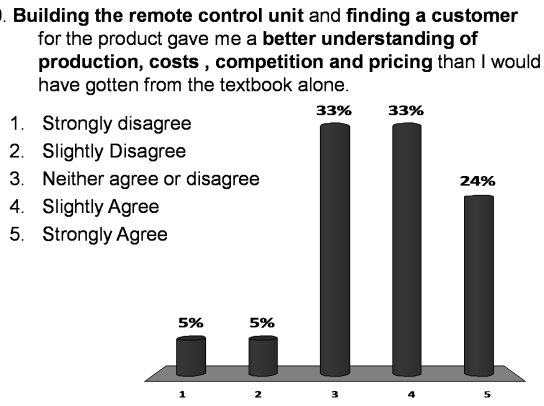

Figure 5. Student survey clicker results

Results from the written reports were more encouraging. Each group was asked to comment on its experience in class and provide the instructor with feedback on what worked and what didn't. Every single group mentioned the remote control project; we interpret this as support for the impactful nature of the project. Most of the comments were positive:

> Creating a remote by scratch and selling it was a new element … And was widely accepted with enthusiasm.

Indeed we were struck by the fact that despite grumbling about being asked to "do engineering" almost all the reports mentioned building the remote as one of the most enjoyable aspects of the project.

> The process of building marketing and finally selling the fabricated CMA remote was an interesting one. We believe that aside from the basic lectures and assignments the idea of actually building a remote spiced things up and made an aspect of the class fun. The group was able to learn a newfound skill… Aside from the technical fabrication aspect being able to analyze the target market supply and demand manufacturing and marketing technique .. stimulated us.

Many students were particularly motivated by the competitive elements of the project and its hands-on nature.

> The project for the projector remotes that's the project I loved doing the most. It was very hands on and entertaining I loved to learn about sauntering [soldering and basically be an engineer for a day. ….I'm excited to go to class today and see who won

Students recognized that in many cases there was no right answer and while that frustrated many some saw it as a positive.

> I think it is safe to say that by assigning these projects students had to think outside the box from a normal economics class in order to complete it.

Critical comments clustered around an inability to see the connection between the task and the subject matter of the course.

> Going into this project we didn't really know what to expect and ever how making a remote control would relate to microeconomics.

Students also had concerns about their grade being tied to the achievement of what they perceived to be unrealistic outcomes:

> I still find it difficult and somewhat unrealistic to sell a product with such little function for such a high price There is a low demand for this product at a price of around $20-$30, so we don't think that selling the remote should be a requirement instead extra credit.

Interestingly, a year later, during an accreditation site visit, students waxed eloquent about this experience and how valuable such experiential learning activities are. The very complexity and uncertainty that they complained about during the course were

now credited with simulating decision-making in the real world.

7. Conclusion and Lesson Learned

College and universities across the country are moving towards more student-centered approaches to teaching One such approach is the creation of authentic learning tasks where students come to view knowledge not as the end-product of their education but as a tool to solve real-world problems The authors' experience suggests that it is possible to design authentic learning activities that allow even "novice learners' to understand the building blocks of a discipline In addition to discipline-specific knowledge, students learn to seek information, work collaboratively, and make difficult decisions with incomplete information.

However there are a number of challenges in designing and implementing such activities. On the demand side there is the challenge of getting "buy-in" from students who are expected to participate in these authentic learning tasks on the supply side there is the challenge of acquiring the resources required to support such activities.

Most first-year students are used to a mode where there is one right answer and their task is to learn that answer They are also used to the silo approach to education where they are not expected to use knowledge acquired in one class in an assignment for another As such instructors must be prepared to face resistance from students uncomfortable with complex, ill-defined tasks that require them to use knowledge of multiple disciplines.

Student resistance to unconventional assignments is greater when students are uncertain of how their grades will be impacted. In the first stage of the remote control project, all students were assured of receiving credit for their efforts, with bonus points awarded to the group that was able to find the lowest-cost supplier However there was no such assurance for the other two stages of the project. They knew that failure to build a working remote or to find a buyer for that remote would result in a grade of zero for that stage of the project. Though the grading approach was highly authentic - success in business is judged on outcomes not inputs - it created a lot of anxiety for students If we want students to embrace authentic learning activities our assessment practices must change to allow credit for the process, for learning from mistakes and for successful collaborating with others.

On the supply side the biggest constraint is resources The assessment results point to a trade-off inherent in authentic learning tasks. The multidisciplinary nature of the projects requires extra time to teach material not part of the traditional class. Taken too far, authentic projects could impair learning by diluting the fundamentals with tangential tasks and topics. Holder spent one class session explaining how to solder and assemble circuit boards but this was not sufficient Students had to finish building their units outside of class, but needed technical support throughout the construction process. This put a rather large, uncompensated, burden on Holden's time, particularly because there was no common time for everyone to work on the project. Hence different groups approached Holder (and two other staff members who helped them build cases) for materials and mentoring on different days and different times. It would have been more efficient to use the common class meeting times to build the remotes but that would have led to less class time to "cover" the subject matter of a typical introductory economics course.

Due to the multidisciplinary nature of authentic learning tasks Borthwick et al (2007) point to the need to support such tasks by providing many resources from multiple sources.The remote control project would not have been possible without Holden's willingness to volunteer his time and expertise. The Dean's office provided funds to purchase supplies, two engineering technicians helped students build the cases, and two departments on campus agreed to lend us the use of their soldering irons. It will not be easy to procure

these additional resources on a continuing basis.

Borthwick et al also note the importance of breaking a complex authentic learning task into several steps and providing assistance and feedback at each stage This type of scaffolding and mentorship is particularly important in introductory courses where students have no or little background in the discipline Despite the fact that the remote control project was subdivided into three distinct phases with evaluation and feedback at the end of each stage and despite being guided by four mentors (the two authors and two staff members), students noted the need for additional support.

If authentic learning activities require more resources than traditional "chalk and talk" methods are they worth embracing? We are cautiously optimistic about the potential of such experiences to increase engagement and improve the student's ability to think like an economist Student evaluations of the remote control project were initially mixed but the majority of students felt that the experiential learning opportunity allowed them to get a better grasp of the material than they would have from the textbook and lectures alone. Anecdotal evidence suggests that their appreciation for the project grew with the passage of time, once they were no longer anxious about their grades. Indeed as the accreditation team discovered during their site visit to the campus, the remote control project was one of the highlights of the first year curriculum Will participation in authentic learning tasks increase long term retention of economic concepts That is a question we hope to answer by evaluating student performance on the Senior Exit Exam Pending those results we are cautiously optimistic about the potential of authentic learning tasks to improve students' ability to do economics not just know it.

References

Becker M. (1997) Teaching economic to undergraduates Journal of Economic Literature 35, 1347-73.

Borthwick, F Bennett, S, Lefoe, G, & Huber (2007). Applying authentic learning to social science: A learning design for an inter-disciplinary sociology subject. The Journal of Learning Design, 2(1), 14-24.

Colander (2004) The Art of Teaching Economics. International Review of Economic Education, 3(1), 63-76

Colander D. (2005) The Making of an Economist Redux Journal of Economic Perspectives, 19(1), 175-198.

Colander D., Follmer H., Haas A., Goldberg M., Juselius K. Kirman A., Lux T. & Sloth B. (2009) The Financial crisis and the systemic failure of academic economics Kiel Working Paper, No.1489 February.

Donovan M. S. Bransford J D. & Pellegrino J W. (Eds.) (1999) How people learn Bridging research and practice Washington DC National Academy Press.

Frank Robert H. (1998) Some Thoughts on the Micro Principles Course In W. B. Walstad and P. Saunders eds. Teaching undergraduate economics A handbook for instructors. New York Irwin McGraw-Hill pp. 13–20.

Fullbrook Edward.(2002 The Post-Autistic Economic Movement A Brief History Journal Of Australian Political Econom, 50, 14-23.

Hanser W. L. Salemi M. K & Siegfried J J (2002) Promoting economic literacy in the introductory economic course American Economic Review, 92(2), 463–72.

Holden Michael (2014) "CMA Remote." www.holdentechnology.co. N.p. n.d. Web 28 July 2014. <http://www.holdentechnology.com/component/content/article/34-atmels/64-projector-remote>.

Lombardi M. M. (2007 May) Authentic learning for the 21st century An overview Educaus Learning Initiative. Retrieved from http://net.educause.edu/ir/library/pdf/ELI3009.pdf

Watts M. & Schau G. (2011) Teaching and Assessment Methods in Undergraduate Economics:

A Fourth National Quinquennial Survey. Journal of Economic Education, 42(3), 294-309.

Yeunglamk, Louis K.C (2011) From Discontent To Reform Towards A Multidisciplinary Approach To The Study Of Economics: Australasian Journal of Economic Education, 8(1) pp.69-86

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Pinpoint: Wi-Fi Based Indoor Positioning System

Daniel Davis
Keyur Patel, Paulus Wahjudi
Marshall University College of Information Technology and Engineering, Weisberg Division of Computer Science
davis813@marshall.edu; patel48@marshall.edu; wahjudi@marshall.edu

Abstract

GPS technology has revolutionized outdoor navigation, but its long-range radio signal cannot successfully be accessed within the confines of a building. Indoor Positioning Systems (IPS) exist to provide a similarly useful solution for navigating complex indoor environments. However, current IPS technologies are plagued by two major problems. Existing systems are either prohibitively expensive to install or lack the accuracy to be deemed effective. We propose a new system that will overcome these obstacles by utilizing a Reduced Signal Strength (RSS) Algorithm that utilizes data from the structure's architecture to more accurately triangulate the user's location.

1. Introduction

For the purpose of this study, we defined an Indoor Positioning System (IPS) as a set of technologies used to determine the location of a user within some defined structure. Unlike well-known GPS technologies, IPS has not been applied on a widespread basis. It has, however, been utilized by the Smithsonian Institution to provide visitors with electronically guided tours of the museum (Sulick, 2012), and by shopping centers, including Hong Kong's Tai Po Mega Mall (Kopytoff, 2013), to aid shoppers in locating their favorite stores.

Perhaps the primary reason that IPS technologies have not experienced more widespread use is that, once again unlike GPS, there is no accepted standard for the implementation of such systems. In today's marketplace, there are two leading solutions for commercially available indoor positioning systems. In the upcoming segments, we will address the shortcomings of those systems before outlining a proposed solution.

2. Infrared (IR)

The most common positioning systems utilize Infrared light to offer absolute position estimation (Gu, 2009). One of the earliest examples of these systems is the Active Badge positioning system invented at AT&T Cambridge in the 1990s (Gu, 2009). Each active badge, intended to be worn by people inside the given building, transmits a unique IR signal every 15 seconds (Gu, 2009). Sensors are placed at each location within the coverage area of the system, and these detect the IR signal sent by the active badges (Gu, 2009). The position of the active badge may then be determined to room level accuracy from information received from the sensors (Gu, 2009).

The largest problem faced by all IR-based systems is that they require direct line of sight

for the sensors and transmitters to communicate (Gu, 2009). It also requires the building covered by the system to be retrofitted with sensors (Gu, 2009). While standalone IR sensors are inexpensive, the cost of the required network infrastructure is substantial (Gu, 2009). Users are then required to already have access to a compatible transmitter in order to be tracked by the system (Gu, 2009), preventing "spontaneous" use of the IPS. This limits the usefulness of IR-based systems for consumer applications.

3. Proprietary Signals and Sensors

Some proprietary sensor technologies have been created to generate more accurate indoor positioning. One notable example is the "Cricket" sensor developed by the MIT Laboratory for Computer Science (Mautz, 2009). These sensors have a stated indoor positioning accuracy of 1-2 cm (Mautz, 2009). This accuracy is achieved using a combination of RF and ultrasound signals (Priyantha, 2000). Stationary "beacons" are placed in the ceiling of a given room, and mobile "listeners" receive information from the "beacons" to infer the room it is in (Priyantha, 2000).

Another proprietary technology that has been utilized to achieve accurate indoor positioning is the Locata antenna, which uses a signal similar to that used by GPS satellites (Mautz, 2009). The creators of the system claim that it can achieve sub-cm accuracy even indoors (Mautz, 2009).

While these systems are quite successful in terms of functionality, their proprietary nature makes then unsuitable for consumer application. The need not only for buildings to be retrofitted with hardware, but for users to also employ a separate device has caused these systems to fail to gain mainstream traction.

4. Bluetooth Beacons

Considered the most popular of the current commercial solutions for indoor positioning, these systems require the regular placement of Bluetooth beacons throughout the structure to be navigated. Common systems require these beacons to be placed 30-50 feet apart throughout each level (Disha, 2013). For a structure with sufficient size and complexity to warrant the usage of IPS, this would spell the need for hundreds of beacons. Of course, each beacon requires some type of power supply. However, whether powered by a network of lines retrofitted to the structure or by battery, this presents a significant cost. Thus, we conclude that the primary problem with Bluetooth based IPS technologies is that they are nearly prohibitively expensive to install and maintain.

It should be noted, however, that while these systems cannot currently achieve the accuracy of the proprietary systems mentioned above, they have been shown to achieve a very usable degree of accuracy, consistently within 2-3 m (Gu, 2009), and have been commercially introduced to some degree of success. The utilization of Bluetooth solves one of the major problems with the use of proprietary sensors, as Bluetooth radios are now commonplace in consumer electronics, eliminating the need for users of the system to acquire a separate device. Apple's recently released proprietary standard for indoor positioning, dubbed iBeacon, utilizes Bluetooth beacons (Apple, 2013). Therefore, we conclude that in cases where fiscal concerns are less important than pinpoint accuracy, Bluetooth solutions may be superior to others.

5. Wi-Fi Based Systems

To overcome the cost inefficiencies of Bluetooth based Indoor Positioning Systems, multiple algorithms have been created to utilize a structure's existing wireless network for navigation. The most popular of these are the Fingerprinting Algorithm and the Reduced Signal Strength Algorithm.

5.1. Fingerprinting Algorithm

Fingerprinting algorithms require manual measurements of signal strengths for all wireless access points in range for each location needed for the desired granularity of the system (Disha, 2013). To better place such a task in perspective, imagine a desired level of granularity of three feet. Thus, the system implementers must make a measurement at every intersection point of a grid formed from squares with side lengths of three feet. Similar to the drawback of Bluetooth-based systems, this represents a very significant initial investment.

However, it should be noted that these systems are quite efficient once the initial installation is complete. This is because the measurements are simply stored in a database which can be queried by a user's device to determine his location (Disha, 2013). Also, though this is completely dependent on the granularity that measurements are taken, a fingerprinting based system can be implemented to achieve a high degree of accuracy.

5.2. Reduced Signal Strength Algorithm

Technologies utilizing a Reduced Signal Strength (RSS) algorithm attempt to triangulate a user's position by estimating the straight-line distance from the user's device to each access point in range (Liu, 2007). This distance is determined by measuring the power of the signal received from each access point (Liu, 2007). However, currently available RSS algorithms have one major drawback. They fail to take architectural considerations into concern for determining the distance to an access point (Disha, 2013). Thus, for example, if a given access point is detected on a user device with -57dBm of power, the algorithm has no way to recognize that the user may be only 10 feet away from the access point, but with a cinderblock wall between the two devices rather than being a clear 40 feet away.

Therefore, the problem with current RSS indoor positioning technology is different than that of the other systems discussed. These systems require only the minimal level of installation overhead, the programming of a floor plan. However, whereas the other systems discussed, once the initial investment is complete, offer efficiency and accuracy, RSS systems have their usefulness limited by poorer accuracy, and the triangulation is a slower, more computationally intensive process, limiting the potential for real-time tracking.

6. Proposed Solution

As we have discussed, the problems facing current IPS technologies are that they are either prohibitively expensive and time consuming to deploy or too inaccurate to be effective. We propose a solution to combine the cost efficient deployment of a reduced signal strength algorithm with the greater accuracy achieved by the other technologies. To accomplish this, we propose to overcome the major shortcoming of existing RSS algorithms by taking the target structure's architecture into consideration during the calculations. Thus, our goal is to successfully implement and test a Structurally

Conscious Reduced Signal Strength Algorithm (SCRSS).

6.1. Equipment Used

For all measurements described in the proceeding sections, the sample "user device" utilized was a Toshiba Satellite C55-A notebook computer with a Realtek RTL8188EE 802.11n compliant network adapter. The wireless router used was a Cisco Aironet 700 Series.

6.2. Background Research

The first phase of this research was to manually analyze signal attenuation. Before we could determine the effects of building architecture, we first had to develop a control case by measuring unobstructed attenuation. Using the laptop and wireless router described above, we measured the signal strength received from the router at several different distances. We then used JagFit curve fitting software published by the University of South Alabama to approximate a regression equation for the data. The data was entered to the software as the negation of the signal strength being a function of the distance. From this, we obtained the exponential equation given in Figure 1 below.

$$s(d) = 48.5\, e^{0.0036d}$$

Equation (1). Exponential equation determined from regression analysis of unobstructed signal attenuation

Here, s represents the signal strength of the access point, and d represents the straight-line distance from the access point to the receiving device. The signal strength is measured in terms of power in units of dBm, and distance is measured in feet.

Figure 2 is a graphical representation of this function, with the negation of the projected signal strength plotted on the vertical axis, and the distance from the access point on the horizontal axis. Also shown on the graph are some data points used in the regression analysis. It should be noted that this equation is not intended to be a generalization of signal attenuation for all hardware combinations. This is very specifically catered to the hardware described in section 5.1.

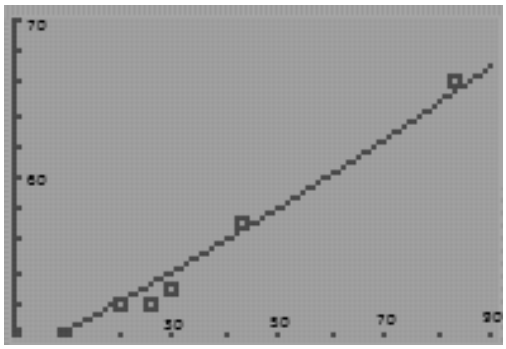

Figure 2. Graphical representation of regression equation.

We were then able to observe the effect that passing through several materials had on signal strength by comparing the measured value against the predicted value for unobstructed signal strength. We found that the power lost after passing through a medium can be approximated as a constant value for a given type of material. For example, we determined that a signal passing through a cinderblock wall experiences a power loss of approximately 6 dBm, signal travelling between stories of a building with average ceiling height loses approximately 11 dBm, but signal transfer through a wall constructed of plasterboard (drywall) does not cause any measureable amount of signal attenuation. Of course, these measurements could vary based on the particular types of materials used in a given building, so optimizing the system for accuracy in a deployment environment would require

some measurements for each wall material used in the structure.

6.3 Implementation

The second phase of this project was to design an Indoor Positioning System utilizing the signal attenuation observations made. The goal of this design was to achieve a system with the capability for useful levels of accuracy with a practical cost initial cost. It should be noted that the minimum deployment overhead for any Indoor Positioning System is to program a floor plan. Thus, a primary goal of this project is to develop a deployment mechanism that is reduced to only slightly greater complexity than that minimum. The primary addition to the deployment of this system is the need to specify the type of each wall in the floor plan. In addition, to improve accuracy, one must measure the attenuation caused by each type of wall used, as building materials can vary from building to building.

It is important to note the difference between the proposed system and Wi-Fi fingerprinting based systems. The proposed system requires each type of wall within the structure to be evaluated for its impact on signal strength. This is not the same type of measurement required to install a fingerprinting system, in which signal measurements must be made at each point on an imaginary grid of arbitrarily defined density. The number of different building materials used to construct walls in a single building is in nearly every case many times smaller than the number of measurements that would need to be made to install a fingerprinting system in a reasonably sized structure. This leads to a significantly reduced initial investment than required to install a fingerprinting-based system.

6.4. System Overview

The main system is hosted on an Ubuntu server, which the user connects to over web sockets. In order to deploy the system in an environment, the building must have a blanketing Wi-Fi network. We are currently developing a user application for Android, with the intent that the concept may be ported to any Wi-Fi enabled portable device.

6.5. Pinpoint Server

The server application is designed to be hosted on an internet connected remote server. We chose to use Java for this application, due to its convenience for web socket programming and MySQL database integration. In the future, we will analyze whether the language effectively handles heavily trafficked input data, and, if deemed necessary, port to a faster language such as C++.

Floor plans are stored in a MySQL database. Each floor is represented as a two dimensional Cartesian coordinate grid, with the third dimension being the level of the building. Walls are represented as line segments with starting and ending points, and each has an attribute signifying its material, and therefore its signal power loss. Access points are stored by their location (three-dimensional coordinates) and their unique MAC address.

The database is then populated with predicted signal strengths for each access point. For the purpose of population, each access point is represented as a circle of diameter 1 ft. Rotating around the circle, a line is extended every one degree to its first intersection with an outside wall. Signal strengths are approximated every 1 ft. along these lines using the equation determined for unobstructed signal attenuation, and the appropriate power loss is

applied when the system detects that the line being analyzed has intersected a wall.

This system allows all heavy calculations to be completed in the preprocessing stage. Once the database is populated, the system is ready for operation. A socket connection is opened, over which users can send request queries. Queries include the MAC addresses of all access points in range of the user's device along with the signal strength of each. The database is queried for a list of locations where the signal strengths match for each MAC address. Ideally, enough access points are measured so that the query reveals a small area where the user could be. In this case, the returned coordinates are averaged, and the predicted location is returned to the user. If a single location cannot be determined, each possible area has an average calculated, and all are returned to the user. The user application will handle this error, but present the user with all the possible locations in the case that it may help their navigation.

6.6. User Application

A user-friendly application to interface with the Pinpoint system is currently being developed for Android with the intent of portability to other platforms. The application displays a stylized version of the building's floor plan. It causes the device to repeatedly scan using its Wi-Fi radio, and sends the measurements to the server over a socket connection. If a single location is returned by the server, the user's location is indicated on the floor plan diagram. If not, an error message is presented warning the user that a single location could not be determined, and all potential locations are displayed on the map.

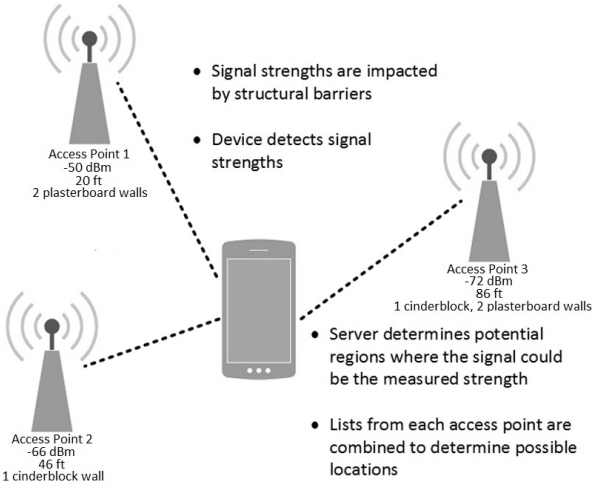

Figure 3. Illustration of user device operation

7. Future Work

The most immediate work to be completed is to further test the algorithm for predicting signal propagation. This testing will lead to a greater understanding of the model and refinement of the system to improve accuracy.

It is still necessary to find a way to better generalize the model for unobstructed signal attenuation. At this time, we hope to determine the relationship of the power of the antennas of the transmitter (access point) and receiver (user device) to the model, so that it can be easily modified based on these two parameters.

Another area of concern that we have not yet tested is the attenuation effect of moving objects in the environment. The most relevant example is the case of a group of people crowding into a given area. Their movement could potentially affect the propagation ability of the Wi-Fi signal in that area. We currently have not analyzed this phenomenon to determine if it could have a sufficiently significant impact to affect the performance of the system.

Currently the system can only be accessed by transmitting information to the server application using a PC. In the near future, we hope to complete the more user-friendly Android application, and to implement a best-path algorithm for navigation purposes.

Finally, a long-term goal is to develop a graphical utility for programming floor plans. This would significantly reduce the time and costs involved with deploying the system, further increasing its usage potential.

8. Conclusion

Indoor Positioning Systems undeniably have a place in 21st Century society. They have already been utilized to provide guided museum tours (Sulick, 2012), and to help people find their way through their favorite shopping center (Kopytoff, 2013). They could be applied to help travelers navigate large airports, or to provide guidance to seats at large entertainment venues. IPS technology even has the potential to save lives if utilized by emergency medical personnel. Seconds saved in locating an individual can mean the difference between life and death in an emergency.

Current IPS technologies have failed to achieve widespread success, as available solutions are either prohibitively expensive to deploy or too inaccurate to be effective. Pinpoint's Structurally Conscious Reduced Signal Strength Algorithm has the potential to solve these problems. We are currently in the process of deploying the system for the blanketing WiFi network of a university library. We will use this environment to further test and tune the algorithm. The final stage of the project will then be to package it in a way that will allow the system to be implemented simply and efficiently for any indoor environment.

9. References

Disha A. A Comparative Analysis on indoor positioning Technique and Systems International Journal of Engineering Research and Applications, 3, 1790-1796 Retrieved July 30, 2014 from http://www.ijera.com/papers/Vol3_issue2/KF3217901796.pdf

Gu Y. Lo A. & Niemegeers I. A Survey of Indoor Positioning System for Wireless Personal Networks IEEE Communication Survey & Tutorials 11(1) 13-32.

iOS: Understanding iBeacon (2013, December 4). iOS: Understanding iBeacon Retrieved July 31, 2014, from http://support.apple.com/kb/HT6048

Kopytoff, V. (2013, November 12). Stores Sniff Out Smartphones to Follow Shoppers. . Retrieved July 30, 2014, from http://www.technologyreview.com/news/520811/stores-sniff-out-smartphones-to-follow-shoppers/

Liu H. Darabi H. Banerjee P. & Liu J (2007, November) Survey of Wireless Indoor Positioning Technique and Systems IEEE Transaction on Systems Man and Cybernetics Part C (Application and Reviews, 37, 1067-1080.

Mautz, R. (2009). Overview of current indoor positioning systems. Geodesy and Cartography, 35(1), 18-22.

Priyantha, N., Chakraborty, A., & Balakrishnan, H. (2000, August). The Cricket Location-Support System. Paper presented at the 6th ACM International Conference on Mobile Computing and Networking, Boston, MA. Retrieved January 13, 2015, from http://nms.lcs.mit.edu/papers/cricket.pdf

Sulick, S. (2012, July 10). Smithsonian Museums Now Mapped from the Inside Out. Smithsonian Museums Now Mapped from the Inside Out.

Retrieved July 29, 2014, from http://newsdesk.si.edu/releases/smithsonian-museums-now-mapped-from-the-inside-out

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Risk Research Trends in the Project Environment

Stephen Allen
Truman State University
sallen@truman.edu

Abstract

The three cornerstones of project performance are scope, budget (or cost), and schedule. If a project environment experienced no uncertainty during its life cycle and assumed design by experienced and efficient planners and estimators, then a project's constraints of scope, schedule, and budget would be realized as planned. Yet, the actual project environment is fraught with risk elements such that if the elements come to pass, the project's overall performance will be impacted. The consequences of these risk elements may affect all three of the cornerstones with both positive and negative consequences. The risk elements in projects are often the most challenging to manage. To aid project planners and managers, the Project Management Institute (PMI) suggests a project risk management framework within the Project Management Body of Knowledge. This research study reviews and relates recently published works specific to risk in the project environment. The research in this article examines the focus and density of ongoing project risk research. The research articles are then analyzed for trends within scope impact, budget, and schedule variances. The articles are also analyzed for their deployment of the risk response strategies for both negative risk elements (threats) and positive risk elements (opportunities).

1. Introduction and background

Defining a project in words can be challenging. In 2002 Humphreys & Associates defined a project as "a defined objective to develop or produce a new product, capability, or to expand capacity within a specified time frame and budget." (Humphreys & Associates, 2002) A project may be even more readily defined by a set of common characteristics that include its temporary nature, uniqueness, well-defined objective and defined set of budget and time. (Jones, 2007) The definition of a project according to the Project Management Institute (PMI) is as "a temporary endeavor undertaken to create a unique product, service or result." (PMI Project Management Body of Knowledge, 2013) While the exact definition of a project may be elusive, society as a whole views public works such as road or building construction and the creation of a dam as examples of projects.

Realistically project work has been undertaken globally for thousands of years. Thus the importance of managing projects effectively continues to be a critical management objective for all organizations. (Meredith & Mantel, 2012) Consider a significant historical project like the management and execution of the Manhattan Project. The outcome of the Manhattan Project had a more significant and enduring outcome within the fields of science, government and politics than perhaps any other. (Shore and Zollo, 2015) The managerial pressure to be both successful and a careful steward of the project's required resources is immeasurable. (Collett, 2005) The evolution of project management now includes the management of knowledge used and generated during a project's development execution. (Desouza & Evaristo, 2004)

As a consequence, the formal techniques and tools of project management have been overseen and developed by the Project Management Institute. As outlined by the PMI, the management of quality projects is guided by three modest cornerstones of project development and measurement: scope, budget

(cost) and schedule. The analysis of these cornerstones continues to be enlarged and refined over time. (PMI PMBOK, 2013)

Projects themselves, while governed, assessed and managed by the three cornerstones, fail to adequately describe the complexities of successful project management. That is, the three cornerstones alone forgo the complication of project risk factors. These three project cornerstones and the element of risk are shown in Figure 1. The simple diagram in Figure 1 fails to convey the interwoven risk complexities of the three cornerstones that ultimately measure the success of projects both attempted and completed.

As an example of these interwoven project complexities, consider the design, management and execution of a large, expensive and intricate project. An intense planning effort is required for such a project. In many cases, the project begins before the effort is fully planned. As a consequence, the planning effort is seldom a standalone process as the three cornerstones of project performance are often intertwined during the design phase. A positive or negative impact on one of the cornerstones may have a linear or non-linear impact, either positive or negative, on one or both of the remaining cornerstones. It is unlikely that the impact of changing a single constraint would only affect performance in that cornerstone's particular situation.

A project design team has a substantial undertaking in the successful creation of a comprehensive project plan. Theoretically, if an organization were to employ perfect project designers, planners, schedulers, estimators, etc. then the designed project, when executed, would be completed on schedule, at cost and at the expected technical level for the client. In fact, project planning optimization may be achieved through the analysis and deployment of design options with some increased levels of success. (Brown & Singh, 2014) Realistically, the project environment cannot expect such orderly performance due to the many intricacies of the project dynamic.

In ultra-complex projects, the project may well be authorized and initiated far earlier than what many of the more problematic technical concepts of scope can be adequately designed and developed. Millions of dollars may be spent before these problematic design features are developed and solved leading to the assumption of great levels of future risk within the project. Further, when considering a global project's additional dimensions of cultural diversity and the existence of emerging uncertainties, the likelihood of a successful and efficient project is increasingly hindered. (Wong, Unsal, Taylor & Levitt, 2010)

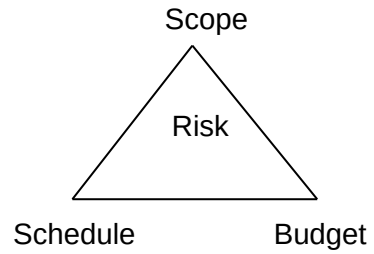

Figure 1. Project cornerstones

The prior example leads to the routine instance of risk elements being introduced into the project environment. This example, while seemingly extreme, has an unknown scope requirement. This unknown scope requirement may ultimately cost as expected, more than expected, or less than expected. Practical expectations tend toward a higher cost than expected. In addition to the described cost of uncertainty or risk, there is also schedule uncertainty or risk. Here as well, the time requirement for the scope element may proceed as planned, but may also be quicker or longer than expected. Practical expectations tend toward taking more time than expected.

2. Project risk management

The term risk has different meanings to different users. Simply defined, risk may be

thought of as a consequential uncertainty. Another risk interpretation is the examination of environmental conditions that may cause a detrimental effect on any of the project's cornerstones of budget, schedule and scope. (Pinkerton, 2003) For many people and organizations, the general connotation of the term risk implies a negative consequence. Negative risk consequences are very important and hinder the successful completion of a project effort. Given the negative impact on project performance of negative risk elements, significant research in the area of project risk management is expected.

Despite the widespread understanding and anxiety of negative risk elements on project performance, there also exist opposite risk elements. These other risk elements are known as positive risks. Positive risk elements may enable or enhance the current project underway directly and positively by affecting the project performance cornerstones. That is, a positive risk element may reduce cost, shorten completion time and/or enable scope achievement. Consequently, there is an expectation that better project managers and organizations also consider the existence of positive risk and view those consequential opportunities.

2.1. Recognized risk

All project efforts entail some level of risk. The importance of risk management within the project context cannot be understated. Accordingly, a consistent definition of project risk and the methodology to deal with risk elements is vital to project success. Globally, many institutions have issued risk management guidelines and practices. (Frick, 2010) These guidelines suggest the consideration of similar risk management techniques for every project.

In 2010, the International Organization for Standardization or ISO set forth a standard known as ISO 31000 (Alarm, 2010) outlining risk management standards within the context of project management. The ISO 31000 definition of risk is the effect of uncertainty on objectives. The standard goes on to include risk effects that may be positive or negative with regard to the project's deliverable. This inclusive statement on risk indicates the need for project team members, managers and organizations to clearly understand and internalize the project's objectives and deliverables for optimal project performance. Failure to consider potential risks and to plan for the eventuality of risk leads to poor project performance.

The Project Management Institute (PMI) issues a Project Management Body of Knowledge (PMBOK, 2013) reference that includes defining risk within the project context. The 5th edition of the PMBOK cites the following definition: "Project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost and quality." The PMBOK further indicates that individual project risk may not reflect total overall project risk. This comment reinforces the importance of a strong commitment to identifying risk, risk management, and risk management planning.

2.2. Risk management process

The risk management process contains several specific steps shared by the many agencies issuing risk management processes. (Letens, Van Nuffel, Heene & Leysen, 2008) These steps include the following process components: risk management planning (RMP); risk identification (RI); qualitative risk analysis (QualRA), quantitative risk analysis (QuantRA); risk response planning (RRP); and risk monitoring and control (RMC). This process is diagrammed in Figure 2.

Negative risk elements, should they occur, adversely affect the three project cornerstones of scope, budget and schedule. Significant disruptions in project completion and cost increases are notable for negative risk elements. These phenomena are noted across multiple disciplines. (Backalic & Maslaric, 2012) (Denic, Moracanin, Milic & Nesic, 2014) (Kaldunski, 2011) Only after the scope or

technical aspect of the project effort is defined and planned can the scope/technical performance risk level be measured as well as its impact on the scope, budget and schedule. The precise negative risk elements are specific to the planned project effort. Each identified scope/technical risk element should be evaluated by using qualitative and quantitative risk analysis tools projecting the likelihood of occurrence versus the severity of consequence or negative impact to project performance. Understandably, risk elements identified with higher likelihood and higher negative consequences require superior risk response planning efforts. Should the identified risk element actually occur, then a plan of action is ready to roll out using a negative risk response strategy. (Le, Caldas, Gibson & Thole, 2009)

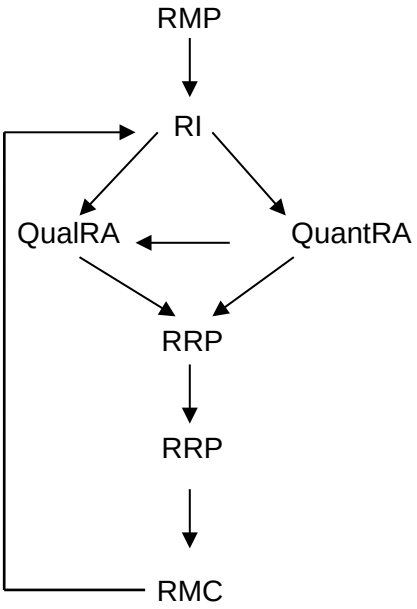

Figure 2. Risk management process diagram

It is safe to assume that negative risk elements exist for all project efforts. Their impact also negatively affects schedule performance. Individual project effort activities typically present different levels of risk. (Nicholas, 2004) The level of schedule risk is monitored through the deployment of Earned Value control tools using a schedule performance index (SPI) and a schedule variance (SV) measure from earned value management techniques. Additionally, the negative risk element affects the budget (or cost) cornerstone. However, as previously stated, both scope/technical risk and schedule risk contribute to budget risk. The level of cost risk is monitored through control tools using a cost performance index (CPI) and a cost variance (CV) measure from earned value management techniques (Humphreys, 2002)

2.3. Negative risk response strategies

Negative risk elements or threats are items such that, if they should occur, pose a negative impact to scope, budget, schedule or combinations of the three project measures. (Liu, Zou & Gong, 2013) (Zou, Zhang & Wang, 2007) Once negative risk elements are identified through the risk identification step of the risk management process, a response strategy is developed based on the degree of seriousness to the project performance. There are four negative risk response strategies: avoidance, transference, mitigation, and acceptance.

Through the strategy of avoidance, a negative risk element is typically dealt with by changing some portion or part of the project effort to eliminate the threat. Through a process of transference, the negative risk element is typically dealt with by changing the responsible party. In some cases this may be a change to a sub-contractor, a consultant or another specialty party. This strategy, however, does not eliminate the threat but merely moves the onus of responsibility to another group. Using the process of risk mitigation, risk planners seek modifications of scope to reduce or eliminate the negative risk element threat. Mitigation is the most prevalently used negative risk element strategy as scope processes may be planned well in advance of scope execution. The acceptance strategy is significantly different from the prior three strategies. Through acceptance, the project team does not seek any scope modification in advance and is willing to address the threat should the threat occur.

(Nicholas, 2004) These four strategies of avoidance, transference, mitigation and acceptance enable planners to deal with anticipated threats in an orderly fashion (PMI, 2009).

2.4. Positive risk response strategies

Positive risk elements or opportunities are items that may exist, occur or present themselves during project execution and may have a positive effect on scope, budget or schedule or combinations of these three project measures. (Meredith et al, 2012) (PMI, 2013) As noted in the literature, there may be less encouragement by management for the study and development of positive risk elements as they may be seen as actions taking focus and resources away from the completion of the current effort. (Frick, 2010) Additionally, the project manager may foresee a positive risk element that may not necessarily impact the current project execution, but may have a positive impact on the project team or organization. There are four positive risk response strategies: exploitation, enhancing, sharing and accepting. (Meredith et al, 2012) (PMI, 2013)

Through the strategy of exploitation, a positive risk element is dealt with by an identified change action to attain or realize the opportunity that was identified. Through the strategy of enhancing, positive risk elements are typically dealt with by modifications to scope such that a positive impact occurs to schedule and/or budget. Through the strategy of sharing, an additional responsible agent is typically deployed to achieve scope through their expertise, but more importantly is chosen to capture a benefit as a positive scope performance consequence. Through the strategy of accepting, the opportunity is recognized but not actively acted on at present. The particular positive risk element should be catalogued by the organization's project management office for further strategic analysis on the part of the project's organization. (Hillson, 2003) (Hillson, 2009) (Lechler, Edington & Gao, 2012) (Ward & Chapman, 2012) (PMI, 2009)

3. Research methodology

This research study utilizes the journal analysis methodology adopted by a number of authors. (Crawford, Pollack & England, 2005) (Kwak & Anbari, 2008) (Littau, Jujagiri & Adlbrecht, 2010) (Allen, 2011) The methodology process involves identifying principal journals pertinent to the research questions. An investigative timeframe is established to review the journals for articles that may relate to the research questions. Next a keyword screen is deployed to identify possible relevant journal articles for further scrutiny.

This study was developed to investigate several current research trends involving risk within projects including: to ascertain the demographics of the research study areas; to discover to what level of project risk research is theoretical or applied; and to what extent are the risk response strategies being deployed and documented. Additionally the research investigates to what extent are recent research conclusions publishing works that cite the connection between risk and its impact on scope, budget and schedule.

In Crawford et al, two key project management journals were used to provide data for this article. Later, Littau et al and Allen improved upon the data collection used to address research questions by expanding the journal search list to the top four encompassing project management journals. These four journals are the *Project Management Journal* (PMJ), *International Journal of Project Management* (IJPM), *International Journal of Managing Projects in Business* (IJMPB) and the *International Journal of Project Organisation & Management* (IJPOM). These four journals are highly focused on the research needs of the project management discipline.

In a similar fashion to the existing journal analysis methodology, the most recent full five-

year timespan (2008-2012) for the published journals was used. A keyword screen search was then used to identify relevant articles for the research questions in this study. The keyword screens utilized risk and uncertainty for article identification. An additional article search quality measure was expended as all article titles were read and studied for a relational inference to the research study questions. This style of data collection is a labor-intensive approach, but an approach that yields timely results when studying research questions for recent trends in the project risk area.

4. Research conclusions

During the period of 2008-2012, the four analyzed project management-related journals published a total of 887 research articles. The number of individual published articles by journal is shown in Table 1.

Table 1. Data source

Journal	Article Frequency
PMI	176
IJPM	433
IJMPB	185
IJPOM	93
Total	887

Overwhelmingly, the majority of published research articles investigated one or more of the multitude of facets of the management of projects. In the end, only a minority of articles (twenty-seven) were found to be suitable for answering the research questions posed in this study. The twenty-seven articles were then analyzed in response to the research questions.

First, these twenty-seven articles may be divided into theoretical and applied articles. There were five articles published that investigated purely theoretical aspects of risk while twenty-two articles researched applied risk. Of the twenty-two published articles related to applied risk, seven articles indicated a focus on project risk specific to a particular country's project environment. Fifteen articles focused on a specific industry or area of study. The seven articles that studied project risk relevant to a specific country included the following countries: China (3), Ghana (1), Indonesia (1), South Africa (1) and the United Arab Emirates (1). The fifteen articles that targeted a specific industry or type included the following areas and types: information technology/information systems (6), construction (3), mega projects or programs (3), other unclassifiable (2), and pharmaceutical (1).

The twenty-seven project risk-related articles were then analyzed for deployment of risk impact to scope, schedule and budget and the deployment of positive and negative risk responses strategies. The initial article review revealed that ten of the twenty-seven articles focused on theoretical risk modeling development. Of these ten articles, two articles utilized theory development with applications to scope, schedule and budget risk implications.

The seventeen remaining project risk-related articles most often studied risk implication to the three project cornerstones of scope, schedule and budget. Overwhelmingly, implications to scope were the most studied. However, taking the next step in studying a risk response strategy for the analyzed risk elements was far less common. Of the seventeen articles investigated, only twelve continued with a risk response analysis. Of these twelve papers, the majority of negative risk response strategy studied was risk mitigation. Of the seventeen articles investigated, only four considered a positive risk response analysis with the majority involving the use of risk exploitation. Total results are shown in Tables 2, 3 and 4. Despite the potential benefits, both short and long term, for the identification and leveraging of positive risk elements in future projects, this research agreed with Frick's claim that fewer resources are put forth on identifying and leveraging positive risk elements. (Frick, 2010). These findings may be significant for organizations

seeking continuous improvement opportunities for the long term success of their organization.

Table 2. Overall results

Negative Risk Strategy	Positive Risk Strategy	Scope	Schedule	Budget
10	4	16	9	10

Table 3. Negative risk response results

Avoidance	Transference	Mitigation	Accept
0	1	11	0

Table 4. Positive risk response results

Exploitation	Enhancing	Sharing	Accept
4	3	1	0

5. Recommendations and further research

Overall, this paper identifies a serious and unexpected paucity in the area of project risk research. It was expected that a meaningful level of research would investigate risk as the project's risk level has a significant impact on the success of meeting the project's cornerstone performance goals of scope, schedule and budget.

There were many results that investigated the risk/cornerstone linkage through the connection to scope risk, schedule risk and budget risk. However, taking the next research step in studying and perhaps recommending particular negative and positive risk strategies was particularly limited. For many of the risk response strategies there were no published research efforts.

The most significant level of negative risk strategy response researched was mitigation. Of the positive risk strategies, exploitation and enhancing were the most documented in the research. These results are interesting in light of the fact that the strategies of mitigation and exploitation are presently the most widely used strategies (PMI, 2009). Given the rise of the enhancing strategy in the research, these results may have an application to practitioners in the project area.

From a demographic perspective, project efforts that were country specific focused on China. This specific emphasis on China is consistent with the massive economic expansion experienced in China. (Mok & Yep, 2008) (Rasiah, Miao & Xin, 2013) (Tian, 2004) (Zhengyi, 2004)

The majority of project risk application areas were traditionally studied areas of information systems/technology, construction and mega projects. Additional research opportunities are plentiful and needed in other undocumented application areas.

6. References

Airmic, Alarm, IRM. A structured approach to Enterprise Risk Management (ERM) and the requirements of ISO 31000. 2010.

Allen, S. (2011). Ethics and Project Management: A Journal Analysis. *Journal of Management & Engineering Integration*, 4(1), 11-19.

Backalic, T. & Maslaric, M. (2012). Navigation Conditions and the Risk Management in Inland Waterway Transport on the Middle Danube. *Transport Problems: An International Scientific Journal*, 7(4), 13-24.

Brown, T. & Singh, S. (July 2014). Project Optimization Through Engineering. Chemical Engineering, 121(7), 51-58.

Collett, S. (2005). Managing Mega Projects. *Computerworld*, December 12, 2005, 39(50), 40.

Crawford, L., Pollack, J., & England, D. (2006). Uncovering the trends in project management: Journal emphases over the last 10 years. *International Journal of Project Management*, 24, 175-184.

Decouza, K. & Evaristo, J. (April 2004). Managing Knowledge in Distributed Projects. *Communications of the ACM*, 47(4), 87-91.

Denic, N., Moracanin, V., Milic, M. & Nesic, Z. (2014). Risk Management in Information system Projects, *Technical Gazette*, 21(6) 1239-1242.

Frick, D. (2010). Embracing Uncertainty in DoD Acquisition. *Defense AR Journal*, 17(3) 355-374.

Hillson, D. (2003). Effective Opportunity Management for Projects. Marcel Dekker, Inc.

Hillson, D. (2009). Managing Risks in Projects. Ashgate Publishing.

Humphreys & Associates (2002). *Project Management Using Earned Value*. Humphreys & Associates.

Jones, R. (2007). *Project Management Survival: A Practical Guide to Leading, Managing and Delivering Challenging Projects*. Kogan Page, Limited.

Kadlunski, M. (2011). The Element of Risk in International Investment Arbitration. *International Community Law Review*, 13(1/2), 111-124.

Kwak, Y. & Anbari, F. (2009). Analyzing project management research: Perspectives from top management journals. *International Journal of Project Management*, 27, 435-446.

Le, T., Caldas, C. Gibson, G. and Thole, M (2009). Assessing Scope and Managing Risk in the Highway Project Development Process. *Journal of Construction Engineering and Management*, 135(9), 900-910.

Lechler, T., Edington, B. & Gao, T. (2012). Challenging Classic Project Uncertainties into Business Opportunities. Project Management Journal, December, 59-69.

Letens, G., Van Nuffel, L., Heene, A. & Leysen, J. (September 2008). Towards a Balanced Approach in Risk Identification. *Engineering Management Journal*, 20(3), 3-9.

Littau, P., Jujagiri, N. & Adlbrecht, G. (2010). 25 Years of Stakeholder Theory in Project Management Literature (1984-2009). *Project Management Journal*, 41(4), 17-29.

Liu, Y., Zou, P. & Gong, W. (2013). Managing Project Risk at the Enterprise Level: Exploratory Case Studies in China. *Journal of Construction Engineering and Management*, 139(9), 1268-1274.

Meredith, J. & Mantel, S. (2012). *Project Management: A Managerial Approach*. John Wiley & Sons, 8th edition.

Mok, K. & Yep, R. (2008), Globalization and State Capacity in Asia. *Pacific Review*, 21(2), 109-120.

Nicholas, J. (2004). Project Management for Business and Engineering. Elseiver, Butterworth, Heinmann, 2nd edition.

Pinkerton, W. (2003). Project Management: Achieving Project Bottom-line Success. McGraw-Hill.

PMI. Practice Standard for Project Risk Management. (2009). Project Management Institute.

PMI. Project Management Body of Knowledge (PMBOK) (2013), Project Management Institute, 5th edition.

Project Management Institute, http://www.pmi.org.

Rasiah, R., Miao, Z. & Xin, K. (2013). Can China's Miraculous Economic Growth Continue? *Journal of Contemporary Asia*, 43(2), 295-313.

Shore, B. & Zollo, G. (2015). Managing large-scale science and technology projects at the edge of knowledge: the Manhattan Project as a learning organization. *International Journal of Technology Management*, 67(1), 26-46.

Tian, Q. (2004). China develops its West: Motivation, Strategy and Prospect. *Journal of contemporary China*, 13(41), 611-636.

Ward, S. & Chapman, C. (2012). How to Manage Project Opportunity and Risk: Why Uncertainty Management can be a much Better Approach than Risk Management. John Wiley and Sons, 2nd Edition.

Wong, K., Unsal, H., Taylor, J. & Levitt, R. (April 2010). Global Dimension of Robust Network Design. *Journal of Construction Engineering & Management*, 136(4), 442-451.

Zhengyi, W. (2004). Canceptualizing Economic Security and Governance: China Confronts Globalization. *Pacific Review*, 17(4), 523-545.

Zou, P., Zhang, G. & Wang, J. (2007). Understanding the Key Risks in Construction Projects in China. *International Journal of Project Management*, 25(6), 601-614.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Building a Conceptual Business Process Modeling Architecture Repository

Sandra L. Furterer
Kennesaw State University
sfurtere@kennesaw.edu

Abstract

Business Process Management is a disciplined approach to analyze, document, measure, monitor and improve business processes, with the goal of achieving consistent, targeted results aligned with an organization's strategic goals. Many organizations are building process model repositories that enable operational excellence and business process transformation through process improvement, lean and six sigma methodologies. This paper will describe an approach for building a conceptual business process modeling architecture repository, including developing the conceptual process architecture framework which includes an operational model, process taxonomies, and the governance structure.

1. Introduction

Business Process Management (BPM) is a disciplined approach to analyze, document, measure, monitor and improve business processes, with the goal of achieving consistent, targeted results aligned with an organization's strategic goals. (Chang, 2006) To enable the modeling, analysis and improvement of business processes, the processes must first be documented to gain a common understanding of how each process is actually performed in an organization. The process models must also be stored and accessed electronically to be used as an asset in the organization's BPM program. This paper will develop and describe a conceptual process architecture that has been used to develop the foundation for building a conceptual business process modeling architecture repository to support BPM. We will first start with a description of how BPM evolved from other quality, productivity and information technology bodies of knowledge. We will then define BPM and discuss the value that BPM brings. We will describe the need for a conceptual business process model architecture repository. Next we will present an approach and framework for the conceptual business process modeling architecture repository.

2. Evolution of Business Process Management

In the graphic in Figure 1, we see three bodies of knowledge, Quality, Productivity, and Information Technology that have evolved into what is today known as business process management. The Quality body of knowledge started with Statistical Process Control in the 1920s (Montgomery, 2013). The statistical concepts along with the principals of the quality gurus, Dr. W. Edwards Deming, Joseph Juran, Philip Crosby, and Armand Feigenbaum, and others became the foundation for Total Quality Management (TQM), which became popular in the 1980s. At about the same time, Business Process Reengineering (BPR) grew in popularity. The principles and tools of TQM and BPR evolved into Six Sigma. The Productivity body of knowledge, started in the early 1900's with the Ford Production System (Henry Ford Production System, 2013), and evolved into Just in Time and The Toyota Production System (Toyota Production System, 2013), which then evolved into Lean (Womack and Jones, 1996). Lean and Six Sigma integrated and synthesized the principles, tools and methodology combining to form Lean Six Sigma.

In the Information Technology body of knowledge, we began in the 1970s with MRP (Materials Requirements Planning) (APICS MRP, 2013) and MRP II (Materials Resource Planning), which evolved into ERP (Enterprise Resource Planning) (APICS ERP, 2013), and CRM (Customer

Relationship Management) (APICS CRM, 2013). BPMS (Business Process Management Systems) technology supports Business Process Management, where the principles of Lean Six Sigma formed the basis for the principles and improvement tools of BPM.

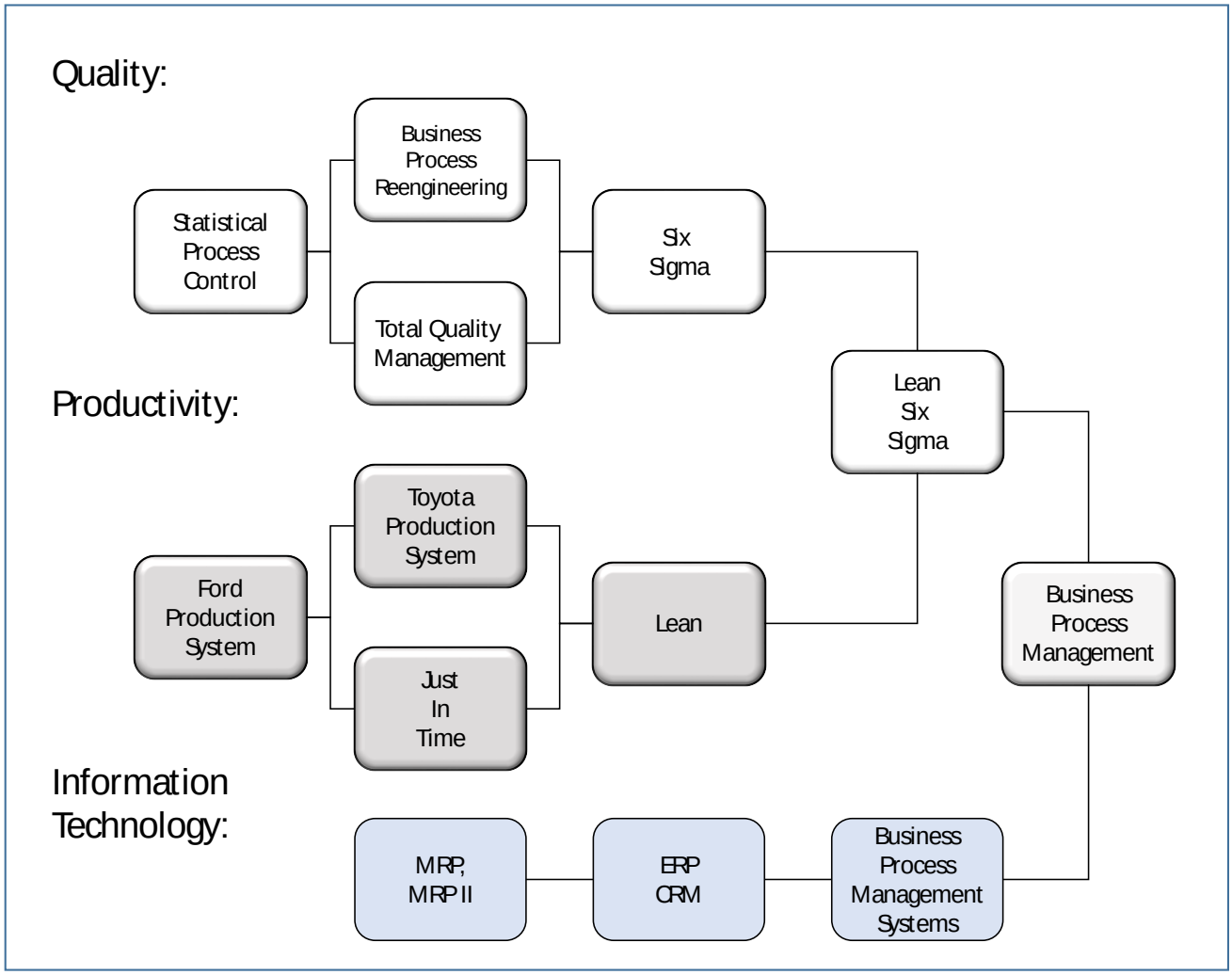

Figure 1 Evolution of Business Process Management

3. Definition and value of Business Process Management

It is fascinating to see how these seemingly disparate bodies of knowledge, principles, tools, and methodologies have evolved to Business Process Management.

The word process is sometimes overused, it seems that everything is a "process" and perhaps it is, but let's clearly define what we mean by a process, since it is such an important concept in Business Process Management. A process is a sequence of events or activities, that uses inputs to produce outputs, in other words to complete "work". There should inherently be a transformation of these inputs to outputs to create value from the process. People, computers,

and machines can all perform process activities. To have repeatable and stable processes, processes should be standardized, coordinated, measured and reusable. The process components can be ; in other areas of the business that apply. To have a standard process, we should first understand and document the process. We also need to have control mechanisms that ensure that everyone in the process is following the standard process. The processes should be coordinated and designed purposefully. The processes should have metrics and be measured to ensure that they are meeting the targeted goals.

As you are understanding and designing the processes it is important to understand that processes begin with simple activities that use an input from a supplier and provide an output to a customer. These simple steps then connect to additional suppliers with inputs to an activity, with an output to a customer, which create a system of processes that are connected and interdependent. That is why it is so important to see the connectivity of how our work impacts others in the organization.

As we described in the introduction, Business Process Management (BPM) is a disciplined approach to analyze, identify, design, execute, document, measure, monitor, improve, and control both automated and ; business processes to achieve consistent, targeted results aligned with an organization's strategic goals.

BPM provides great value to an organization. It enables the effective and efficient management of business processes, helping us to do the right processes the right way. The effectiveness helps us to perform the right processes, and the efficiency aspect allows us to perform the processes with the right level of resources. BPM enables alignment of core processes to business strategy, through identification of the processes and prioritizing those processes with the key improvement initiatives that align to the business' strategies. BPM enables managing processes proactively and predictively, based on the prioritization with the key business strategies.

BPM enables understanding and elimination of root causes of process problems. BPM also enables designing processes to prevent problems, instead of reacting to problems and crisis management. BPM provides the infrastructure for continuous improvement and quality management. It allows the organization to improve before automating. There is nothing worse than automating a broken process. BPM enables understanding and elimination of root causes of process problems. BPM also enables designing processes to prevent problems, instead of reacting to problems and crisis management. BPM provides the infrastructure for continuous improvement and quality management.

4. Need for and description of a conceptual business process modeling architecture repository

Yan, et al, in 2012 performed a survey of the state of business process modeling architecture repositories and found that these electronic repositories were not leveraging the full functionality of information management tools. They also presented a business process framework that includes a management model and a reference architecture. They found electronic business process repositories to be valuable to manage, collect and store process models. Yan (2012) also reviewed several process architectures that could be used for building a process modeling repository.

BPM enables institutionalizing process improvement, by enabling the knowledge capture of processes in some type of data repository so the processes can be leveraged as an asset to the organization. Too many times in organizations, we create process maps for a specific purpose, such as a specific improvement project, or for an audit, and then fail to keep this process documentation updated as it changes. We then must start from scratch the next time we improve or audit the same process. A process repository is a collection of process models that can be used to: 1) model your processes; 2) understand the current state of your operations; 3) design a future state of your operations; and 4) Identify

gaps and develop improvement recommendations. The technology that supports a process repository can include several different types: 1) Business Process Modeling Tools; 2) Enterprise or Business Architecture software; or 3) Business Process Management Software or Suites.

A business process map repository can include business process models that meet the needs of the business. A model is an abstraction of something for the purpose of understanding it before building it. (Rumbaugh, et al, 1991). Models can be: mathematical, graphical, narrative, physical or a combination of these (abpmp.org, 2014). In the process repository, our models will be mostly graphical and narrative. Dam and Ghose (2015) proposed a novel approach for assessing how frequently businesses revised their business activities and process maps in their repositories through looking at the revision history within the repositories. This provides evidence of the importance to build and keep an organization's business process repository current, and ensure that the process owners are using the knowledge embedded in the process maps.

The BPM models typically include policies, processes and procedures, as shown in Figure 2 (Furterer, 2014). The policies model can include: management directives which include policies and business rules, as well as organizational assessments. A directive defines, constrains, or liberates some aspect of an enterprise. It is intended to assert business structure or to control or influence the behavior of the business. There are two types of directives, a business rule and a business policy. A business rule is a directive intended to influence behavior. It can be an absolute requirement, a suggestion, or something in between. Generally, a business rule specifies what is allowed and what is not allowed. A business policy is a non-actionable directive whose purpose is to govern or guide the enterprise. Business policies provide the basis for business rules. Business policies also govern business processes. There are specific types of business policies, namely, organizational, leadership and regulatory policies. Organizational policies govern the organization. Leadership policies help to manage the organization. Regulatory policies are policies defined by the organization to address and respond to regulations enacted by regulatory agencies, such as the Food and Drug Administration (FDA), or the Office of Comptroller and Currency (OCC).

The assessment model helps us to perform a SWOT (Strength, Weaknesses, Opportunities, and Threats) analysis as part of the strategic planning process. The SWOT includes the strengths and weaknesses of the organization, and the opportunities and threats in the external environment. The assessment judges the impact to the organization based on the SWOT analysis. The assessment also identifies the influencers of the organization. The influencer can be external or internal. The external influencers include the environment, technology, regulations, accreditation requirements, and licensure requirements. The internal influencers can be assumptions, issues and management prerogatives.

Processes in the BPM repository are called a business process model. The business process model has three primary purposes; communication, knowledge capture and analysis (abpmp.org, 2013). In using a business process model for communication we want to convey a rigorous understanding of the business process and the ability to manage change. In analysis we want to be able to study the process for optimization and transformation purposes. Finally in knowledge gathering we are interested in understanding the associations of business processes and activities. For the purposes of building a process repository we are concerned with capturing the activities that make up a business process and with providing concise and meaningful names to the business processes that orchestrate those activities. In our model, we provide a hierarchy of the process model starting with a value chain model. The value chain model decomposes into a business function model, and then leads to process models which describe the sequence of activities that transform work. For the purpose of analysis and communication a business process model takes the form of a process/workflow diagram and we are interested

in the sequencing and constraints of activities. Process models include the following elements: activities, sequence of flow, roles, information systems, information (inputs and outputs), and process attributes.

Procedures in our repository can include work instructions, training, checklists, scorecards and metrics. Work instructions are detailed descriptions of how the work should be informed. They instruct the process owner how to perform a process at a detailed, step-by-step level. Training can be stored in a repository, by cataloguing training plans, and training documentation. Checklists are used to control a process, and ensure that all of the important tasks are performed. Scorecards and metrics are used as mechanisms to control the process that provide results and measurements of the process characteristics. Process metrics are used to measure the processes, and typically include throughput, cycle time, efficiency, process times, wait times, delays and defects. Throughput measures system capacity and volume of the process. Efficiency measures the efficient use of resources. Process times measure the time it takes to perform each process step. Wait times and delays measure the time that the unit (product or customer) waits at each step of the process and the reasons for delays. Defects measure the non-conformities to specifications and customers' requirements in the process to assess the quality of the process.

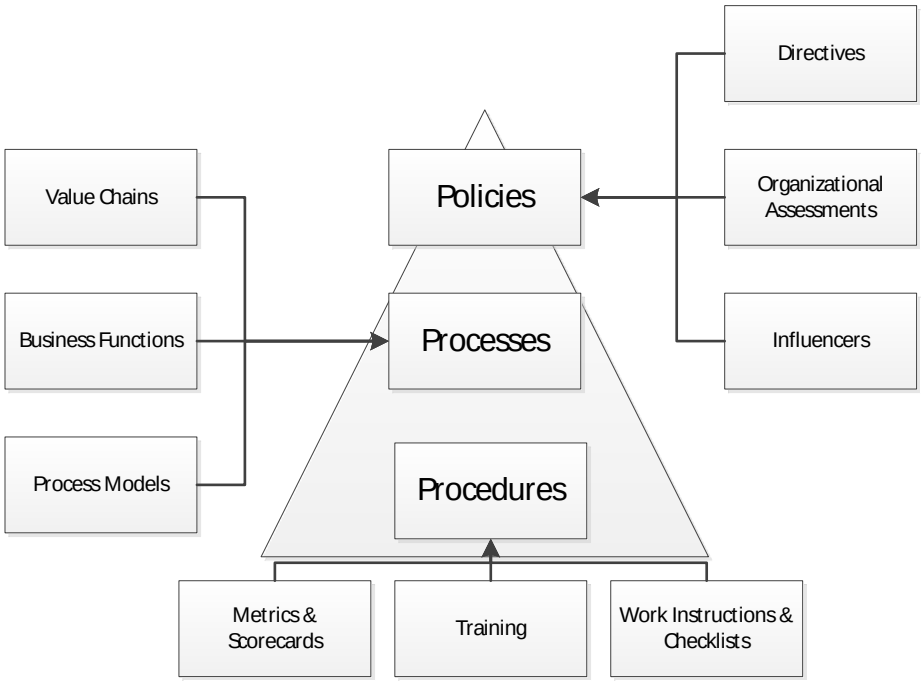

Figure 2. Business Process Models

5. An approach and framework for building a conceptual business process modeling architecture repository

The research literature provides guidance for approaches to building and maintaining a business process repository. Lazarte, et al (2013) proposed a model-driven architecture method to manage cross-organizational process maps that enhance collaboration across the organization. They suggest using a distributed process map repository to ensure synchronization, consistency and interoperability of the process map repository. Jin, et al (2013) performed research to assess best approaches for accessing process maps in large repositories and suggested using indexes to enhance evaluation of process maps for applicability and re-use. Smirnov, et al (2012)

proposed an approach for extracting process models from large process model repositories by using action patterns, which are groups of common activities that appear in process maps.

A simple approach to building a conceptual business process model architecture repository includes three steps, as shown in Figure 3:

1) Developing the conceptual business process modeling architecture models, in section 5.1
2) Defining the process taxonomies, in section 5.2, and
3) Building the standards and governance structure in section 5.3.

The business process modeling architecture repository enables the organization to align the strategies, operational, governance, and technology elements. It provides the Meta models, elements and relationships that constitute the BPM Repository.

5.1 Developing the conceptual business process modeling architecture repository models

The conceptual business process modeling architecture models discussed in the previous section, can help to align the organization's strategy, business capabilities, technology, and process models. It provides the Meta models which include the model elements and the relationships of the model elements to each other. Meta is a term used to indicate a concept or abstraction from a concept (www.dictionary.com). The Meta model then represents the conceptual business process model. The author designed a Strategic Business Process Architecture (SBPA), that includes several conceptual models used to describe and document an organization, including: Strategy, Operational, Governance, and Technology (Furterer, 2009).

The Strategic Business Process Architecture consists of the following models (Furterer, 2014), (Furterer, 2009):

1) Strategic Models: Models describing the business' strategies, goals and objectives.
2) Operational Models: Models describing the organization's value system and process models, including the business' activities and functions.
3) Governance Models: Models describing the leadership, organization and workforce models, including: people, engagement, leadership, organization, and workforce management.
4) Technology Models: Models describing the conceptual domains of the organization, information, business vocabulary, information and application models.

5.1.1. Strategic Models Overview

The Strategic Models help us to understand the mission, vision, strategies, goals, objectives and tactics of our organization. The Strategic Models will also enable us to capture the environmental and organizational assessments that are so commonly part of strategic and operational planning efforts. Part of the Strategic Modeling is also defining the business policies, rules and regulations that impact our ability to do business, be licensed, certified and accredited to do business in our markets.

The Strategic Models are:

- Mission, Vision and Culture Model
- Course of Action Model
- Desired Results Model
- Directive Model
- Assessment Model
- Influencer Model

5.1.2. ***Operational Models Overview***

The Operational Models help us to understand what we do in our business to meet the strategic goals. It models the value chains that help us to understand how our organization provides value to our customers, and decomposes the value chains into the business functions, processes and activities performed. The Operational Models help us to identify and connect to the business capabilities that are required to meet the customers' needs for us to stay in business.

The Operational Models include:

- Value System Model
- Business Function Model
- Business Process Model

- Business Capability Model
- Metric Model
- Market Model

5.1.3. Governance Models Overview

The Governance Models help us to understand how we manage the workforce, including how we motivate them to be engaged in teamwork, improving processes and the organization. The models also include the training and development plans that help us to enhance the skills of our associates. These models also include the recruitment plans that help us to recruit new associates to our organization. The performance assessment plan defines how we assess the performance of our associates, and identify areas of improvement. The career progression and succession plans are also part of the workforce development models. The credentialing and licensure requirements are identified as part of this model, so that we ensure that the skills and competencies are identified that our associates must have to meet these requirements. The leadership models describe how leaders lead and govern the organization.

The Governance Models are:

- Organizational Model
- Leadership Model
- Workforce Model

5.1.4 *Technology Models Overview*

The Technology Models help us to understand the business vocabulary, the information that is used to transform our processes, and connect to the business components that enable process optimization and our business capabilities. It also provides a way to understand the information applications that support our process transformations.

The Technology Models include:

- Conceptual Information Model
- Application Model

When just beginning the BPM repository the first set of models to populate can be the operational models, including the policies, processes and procedures discussed in the prior section.

5.2 Defining the process taxonomies

The Value System and Business Function Model, two of the operational models discussed in the prior section, can be used to define the process taxonomies.

5.2.1 Value System Model

The value chain is a chain of activities that provide value to your customer and enable competitive advantage. The concept of a value chain was first described and popularized by Michael Porter (Porter, 1985). The industry wide synchronized interactions of those local value chains create an extended value chain, sometimes global in extent. Porter terms this larger interconnected system of value chains the "value system." A value system includes the value chains of a firm's supplier (and their suppliers, etc.), the firm itself, the firm's distribution channels, and the firm's buyers (and presumably extended to the buyers of their products, and so on). (http://en.wikipedia.org/wiki/Value_chain) Value systems can consist of value activities, also called primary activities, and support activities.

Value activities are the key, critical activities that provide value to the customer, and that can differentiate our organization from our competitors. The support activities are necessary, but are not core to providing the value to our customers.

In our value system we define the concept somewhat differently than Porter's model. We define a value system as an aggregation of the value chains that provide value to the customers. The value chains are the sets of activities that provide a specific service or product line to the customer. In a manufacturing organization, the majority of the product lines would use the same activities and value chains to create the product, so multiple sets of value chains would not be necessary. For a service organization the activities that are part of the value chain could vary for different service lines more than a manufacturing organization's value chains. By defining our value system differently, we enable our model to be used for a manufacturing and a service organization.

To further illustrate the distinction, a healthcare organization's value system could consist of the following value chains: The primary value chains are the following:

- Provide Emergency Services
- Provide Inpatient Services
- Provide Outpatient Services
- Provide Surgical Services
- Provide Women's Services

The supporting value chains include:

- Provide Supply Chain Services
- Provide Human Resources Services
- Provide Infrastructure Services

5.2.2 Business Function Model

The Business Function Model can be used to develop the process taxonomy. It describes an inventory or catalogue of the functions that the organization performs related to the value chains. The Business Function Model (BFM) is used to identify business functions and the processes that comprise them. A business function consists of those operations performed in the organization. The functional decomposition diagram itself does not depict process flows, but rather the hierarchical organization of functions and the processes that they include. The BFM then is in essence a taxonomy of business functions in that each top level function generalizes its lower level functions. An example of a hospital's Surgical Services high-level functions is shown in the value chain and business function decomposition in Figure 3.

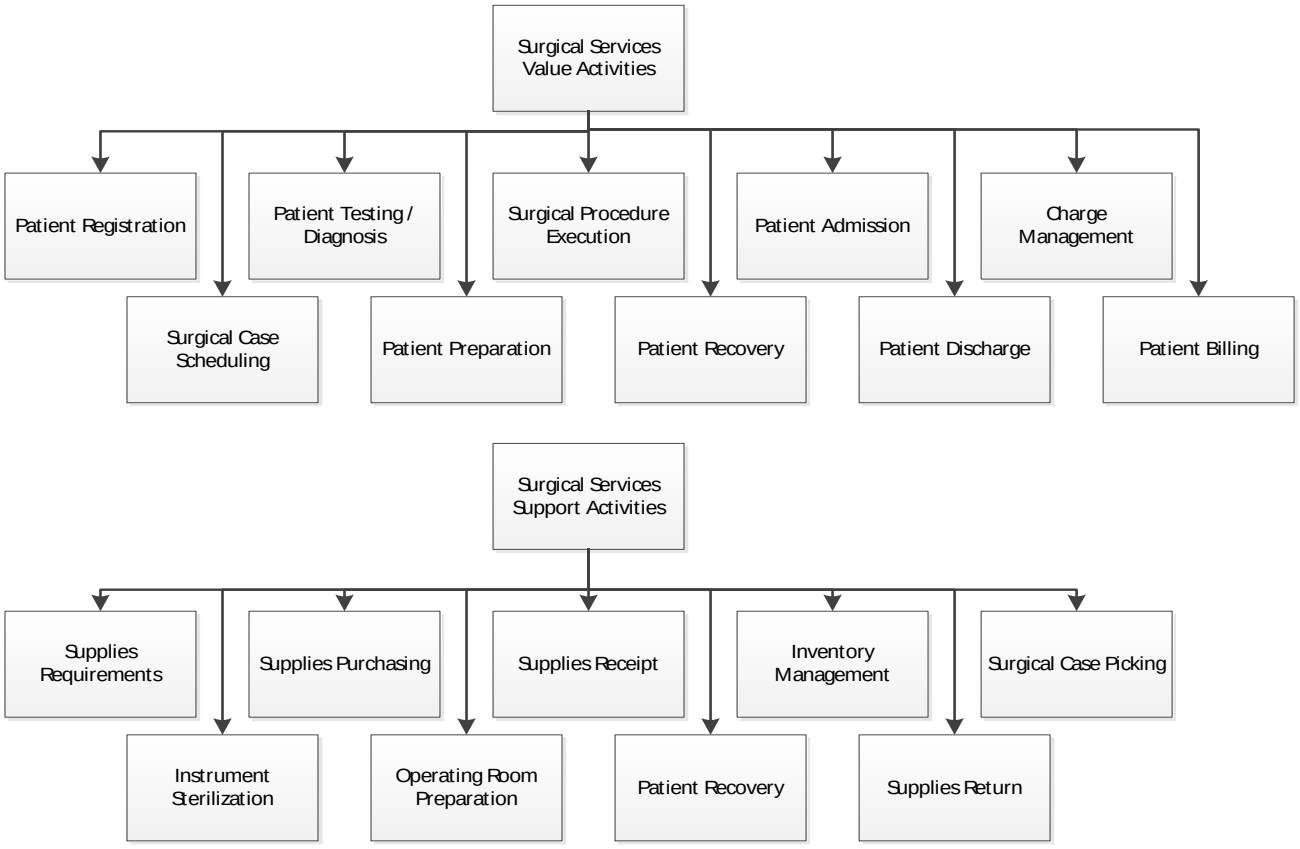

Figure 3: Surgical Services Value Chain and Business Function Decomposition

5.3 Building the standards and governance structure

Process modeling, mapping standards and the governance structure should be defined to ensure that the BPM Repository provides consistent, standard, usable, and re-usable process models. The governance structure should include how often to review and update the

process models, as well as how to update them based on major process changes, such as Six Sigma and information technology initiatives.

Some organizations build a BPM Center of Excellence (COE) to govern the BPM repository. The role of the COE is to: identify, consolidate and report status on BPM projects across the enterprise; set the standards for the BPM repository, process modelling and mapping; provide common tools and methods for BPM; train and educate the organization on BPM principles, practices and tools; provide governance on process design and integrating business processes and the enterprise level; prioritizing and allocating scarce resources to the BPM effort; track and report process performance metrics to process owners and executive management.

The steps to developing a BPM COE are to:

1) Attain executive sponsorship: This is the most critical step, because without executive support, the BPM center of excellence will not thrive.
2) Define goals and success criteria for the BPM center of excellence.
3) Define governance structure: of how the COE will govern the processes and what they will be responsible for.
4) Establish a BPM architecture, such as the Strategic Business Process Architecture (SBPA).
5) Set up a BPM library and repository: there are so many different BPM repository tools, it can be challenging to select the one for your organization, where the success can be dependent upon the process maturity of the organization.
6) Establish change management practices.
7) Take a process inventory: many organizations, especially service organizations don't have a process inventory or existing process mapping documentation.
8) Prioritize process selection based on strategic objectives.
9) Start executing BPM projects.

6. Conclusions and Future Research

A business process modeling architecture repository is one of the first steps in the process maturity journey towards documenting and standardizing the organization's processes to leverage them as assets, instead of as the cost of doing process improvement. This paper provided an approach and conceptual process architecture, referred to as the Strategy Business Process Architecture meta models that was used to build process models in a hospital. There is much more research that can be performed to further validate the approach and process architecture for building a BPM repository, across many different industries, organizational cultures and processes. Additionally, the conceptual Strategic Business Process Architecture models can be applied across additional industries and organizations to ensure that the meta models and relationships support a wide-variety of process repositories.

References

APICS, Enterprise Resource Planning, http://www.apics.org/industry-content-research/publications/ombok/apics-ombok-framework-table-of-contents/apics-ombok-framework-5.1, 2013

APICS, Customer Relationship Management, http://www.apics.org/industry-content-research/publications/ombok/apics-ombok-framework-table-of-contents/apics-ombok-framework-5.1, 2013

APICS, Material Resource Planning, http://www.apics.org/industry-content-research/publications/ombok/apics-ombok-framework-table-of-contents/apics-ombok-framework-5.1, 2013

Chang, James, Business Process Management Systems Strategy and Implementation, Auerbach Publications, Boca Raton, FL, 2006.

Dam, Hoa Khanh and Ghose, Aditya, Mining version histories for change impact analysis in business process model repositories, Computers in Industry February 2015 67:72-85

Furterer, S.L. Graduate Seminar, Business Architecture Manuscript, Southern Polytechnic State University, 2014.

Furterer, S.L. Enabling Enterprise Six Sigma through Business Process Architecture Modeling Techniques, The Quality Management Forum, Volume 25, 7-10, Number 3, 2009.

Henry Ford Health System, Henry Ford Production System, http://www.henryford.com/body.cfm?id=47243, 2013.

International Association of Business Process Management Professionals, BPM CBOK, Version 3.0, 1st Edition, www.abpm.org, 2014

Jin, Tao, Wang, Jianmin, La Rosa, Marcello, ter Hofstede, Arthur, Wen, Lijie, Efficient querying of large process model repositories Computers in Industry January 2013 64(1):41-49

Montgomery, D. Introduction to Statistical Quality Control, Seventh Edition, John Wiley & Sons, Inc., Hoboken, NJ, 2013

Porter, Michael E. Competitive Strategy: Techniques for Analyzing Industries and Competitors. New York: Free, 1980.

Rumbaugh, James, Blaha, Michael, Premerlani, William, Eddy, Frederick, Lorensen, William, Object-Oriented Modeling and Design, Prentice Hall, Englewood Cliffs, New Jersey, 1991.

Smirnov, Sergey, Weidlich, Matthias, Mendling, Jan, Weske, Mathias, Action patterns in business process model repositories, In Managing Large Collections of Business Process Models, Computers in Industry February 2012 63(2):98-111

Toyota Production System, http://www.toyota.com.au/toyota/company/operations/toyota-production-system, 2013

Value Chain, http://en.wikipedia.org/wiki/Value_chain, 2010.

Villarreal, P. A distributed repository for managing business process models in cross-organizational collaborations, Computers in Industry April 2013 64(3):252-267

Womack, James P., and Daniel T. Jones. Lean Thinking: Banish Waste and Create Wealth in Your Corporation. New York, NY: Simon & Shuster, 1996.

www.dictionary.com, meta definition, 2013.

Yan, Zhiqiang, Dijkman, Remco, Grefen, Paul, Business process model repositories – Framework and survey, Information and Software Technology 2012 54(4):380-395

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.