Time to Graduation Improvement Study - A Lean Flow Chart Approach

At California Polytechnic State University

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ABSTRACT

In order for Cal Poly to continue to stand out among other universities, there is a strong need to graduate their students in the typical 4 years. With a falling economy, both the budgets of Cal Poly and the student are decreasing. The longer a student takes in receiving their bachelors, the higher the costs will be in both money and time for the student and the university. Today, the average Cal Poly Industrial Technology student takes 5 years to graduate. That extra year of school will cost the student on average $8,523 in tuition fees on top of costs of living and books.

This senior project will propose a template of flow charts that will help students, teachers, and the registrar in understand the current flow and capacity for students trying to get through the curriculum and graduate. Flow charts were chosen because they are easy to understand visual aids that can be understood by any person wanting to benefit from this.

Acknowledgements

We would like to specifically thank Professor Olsen in helping guide us through this project. He was our technical advisor during this project, and has gone above and beyond to make sure we both stayed on track with the project and helped to guide us over the several roadblocks we were challenged with. Along with Professor Olsen, we would like to thank Gina Whitaker for helping us understand how to write a proper research report.

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INTRODUCTION

Problem Statement

The problem is how long it takes students to matriculate with a degree in their major from Cal Poly. We want to find out why the total cycle from freshman year to graduation is so high. Students attend this university ultimately to gain a degree and become employed in their field. The system of a university providing education to a student can be thought of as a business. If the process of providing a college education and a degree can be thought of as a business, we can apply concepts of lean thinking to how Cal Poly does "business." Cal Poly will be acting as the company; the customers are the students. Currently, the service Cal Poly is offering averages four to five years to completion. In lean terms, their service has a total cycle time of four to five years. Both the company and their customers would benefit from reducing the total cycle time. With a reduced total cycle time, the company can provide services to more students, and hand out more degrees per year. The student benefits by graduating in a shorter time, saving approximately $3,000 in tuition alone and about 3.5 months for each quarter they eliminate from their overall time at Cal Poly.

This research is being done to show how lean principles can be applied to academic programs, benefitting both students and the university. To earn a degree is very expensive and time-consuming. Saving students money and time will directly correspond to more students getting a college education.

The research will, map out the average college student's path to graduation within the Industrial Technology department starting from week one of school as a freshman. By creating a flow chart of the service, problems will arise through the documentation making it easier to both identify and fix these problems. With documentation of why certain areas of this process need to be fixed, those working for both the university and the Industrial Technology department can help decrease time to graduate and will have a better idea of how to do so.

The target market is students looking for a faster and cheaper education. By decreasing the time to graduation, Cal Poly could market their process of educating as the most efficient in California. Both students and family members who help pay for students' education will be directly affected by this research.

Project Needs

This research report will be most valuable to those who made key decisions on student coursework, admissions, and the hiring of faculty. The Institute of Planning and Analysis department (IPA) will find our research to be of much importance as well because they are in charge of delivering much of the information we will be analyzing. Since our report is specific to Industrial Technology students, the faculty and more importantly the head of the IT department will find this information very useful. The report will help bring to light the issues holding back Industrial Technology students from graduating more quickly. This information will help them provide a more efficient educational experience to Industrial Technology Cal Poly students.

Table 1. Needs

Identify non-value added times in Cal Poly	4
Identify takt time for graduation rate	1
Identify opportunities for improvement (Kaizen)	4
Research similar studies in other educational institutions	2
Propose solutions for Kaizen events	3

Background or Related Work

At the Atlanta Journal-Constitution they address a similar problem. They get complaints from graduates about the many roadblocks of getting a degree such as needing more flexible schedules, needing more available counselors and other such academic support. A quote from one student said, "Help us succeed." Addressing such problems as these can also decrease total cycle time for student graduation and if anything it will add to the value of the process (ajc).

Another person who addresses similar problems is Kevin Carey. He writes an analytical article on graduation rates and in this article he uses many statistics from the Graduation Record Survey (GRS).. One of the figures he cites is that out of all four-year universities, (about 1,400), less than one third of the colleges graduate students within six years. This in itself is a grotesquely low rate of graduation. In our senior project we hope to find a solution that will decrease the amount of time it takes for students to obtain these degrees.

Objectives

In this senior project the objectives are twofold. One objective is to analyze graduation rates in depth. To do this we will need to analyze certain degrees, looking at the typical graduation rates for those degrees and finding out what typically hinders graduation for that degree. and come up with a plan possibly a VSP on how to go about shortening the graduation for this degree. By doing this we will lower the total cycle time for obtaining that degree and drop the average cycle time for Cal Poly to graduate students in other majors as well. In essence, we hope to cause a domino effect: by improving Industrial Technology graduation rates, other degree programs will drop the cycle time for graduation from their majors, and Cal Poly will graduate more students overall. Another objective is to find a way to implement improving graduation rates so that any student—rich or poor, with free time or none--can manage to utilize these changes and finish college faster.

Contribution

This project will contribute to Cal Poly's efficiency by improving graduation rates. If implemented, the project will shorten graduation times, getting students out of college more quickly, and resulting in faster turnover at Cal Poly. This turnover will limit Cal Poly's waste in inventory and allow Cal Poly to more effectively use inventory space. The increased rate of graduation will increase Cal Poly's reputation with its customers for low cycle times and greater overall output. .

This report is of interest to anyone whose job is either directly or indirectly responsible for decreasing the time it takes to graduate Industrial Technology student at Cal Poly. In a broader sense, these applications used specifically for Industrial Technology students can be applied to other majors in the university and to other universities nationwide.

Scope of Project

This project will have multiple parts. It will include what has already been researched on the maximum time it takes to graduate from Cal Poly and other universities; an analysis of the current process Industrial Technology students must go through in order to graduate; and proposed solutions that Cal Poly's IT department can use in order to increase efficiency. This project does not entail any other department other than the IT department. It is important to note, however, that other departments can use our style of problem solving to effectively achieve shorter graduation rates for their departments as well.

This project is based on the same techniques manufacturing companies use today to increase quality, decrease waste, and increase throughput of their products/services. In times of a difficult economy, companies are searching for new ways to compete with each other, and they are finding that advancements in technology are not the only answer. By more effectively using the resources they already have, they can compete with those companies who may have better technologies and resources, but who may not be utilizing them as well. With limited budgets, universities will find that more effectively utilizing their resources will save them substantial amounts of money. Customers often bear the brunt of budget cuts, but in saving money and time by implementing this research, universities will be able to worry less about these cuts and the impacts they will have on both their customers and their educational programs.

SECTION 2

LITERATURE REVIEW

The purpose of this literature review is to create a layout of the current problem and proactive solutions that have successfully brought down the time to graduation. The greatest benefit will come from reports related to both time to graduation and process management techniques. Since our studies thus far in school have been related to manufacturing, our approach will be a very systematic and process oriented approach in solving this problem.

The focus for this literature review was based on relative statistical data to help assess the situation and any previous research done on our subject. We came across several very useful sources of information. The http://ies.ed.gov/ has years of school related statistical data. This website is the institution of education science, which was formed in 2002 as the primary research arm of the United States Department of Education. Two other relevant articles found were created by Complete College America. Complete College America's articles broke down the current situation on time to graduation problems in America and also offered solutions to help bring down this statistic. The most important article found was a research report done specifically on a time to graduation study in American colleges. Done by the Population Center at the University of Michigan, the key to this study was primarily on understanding the decrease in college completion rates.

Institute of Planning and Analysis (IPA) - Cal Poly

There were several research reports done by Cal Poly's IPA program that had useful information pertaining to our research. Most of this information will be the key data placed into our Flow chart; however, some will also be supplemented alongside our FLOW CHART to base our proposed solutions off of. The information provided was able to cover a lot of key areas we will need to make decisions off of, but we will need to narrow down the data from a broad number based off the college of business to data specific to the Industrial Technology department. Although some areas do narrow down to the IT department, not all do. Here is the list of data we found.

This first piece of information is a data table showing the number of sections per size of class there are. For example, we see that there are 72 sections of classes at Cal Poly ranging from 2-9 students in each of those classes. We will definitely need to narrow this down to only the IT department, but this helps give us an idea on relative class sizes here on the university. What we can see is that 60% of classes range between 20-39 students. Pushing for smaller class sizes may seem to enhance the student's experience, but the need to compensate with larger class sizes to some extent to better utilize classroom size availability may be more important.

Number of Class Sections with Undergraduates Enrolled

Undergraduate Class Size (provide numbers)

	2-9	10-19	20-29	30-39	40-49	50-99	100+	Total
CLASS SECTIONS	**72**	**255**	**544**	**530**	**173**	**166**	**57**	**1797**

	2-9	10-19	20-29	30-39	40-49	50-99	100+	Total
CLASS SUB-SECTIONS	**159**	**577**	**524**	**89**	**38**	**17**	**2**	**1406**

The next important table shows our employee count. Again, this is based on the entire Cal Poly University staff population, so we will need to find a way to funnel these numbers down to the correct department level.

	Full-time	Part-time	Total
a.) Total number of instructional faculty	697	473	1170

Next to "Total Undergraduates" on the top-left of the table, we find "!4.45" in red. This identifies the average number of units taken by a Cal Poly student for Fall 2012. In an ideal situation, we would want the average number of units IT student have taken in the last 6 quarters to find a better and more applicable average, but if that cannot be found we will use this number.

Fall 2012	CAFES	CAED	CENG	CLA	OCOB	CSM	Other	TOTAL
Total Undergraduates (14.45)	3,679	1,424	4,908	2,646	2,285	2,530	64	17,536
New Freshmen	830	319	1,107	512	506	538		3,812
*New Transfers	177	87	78	153	46	92	60	693
Continuing Undergraduates	2,672	1,018	3,723	1,981	1,733	1,900	4	13,031

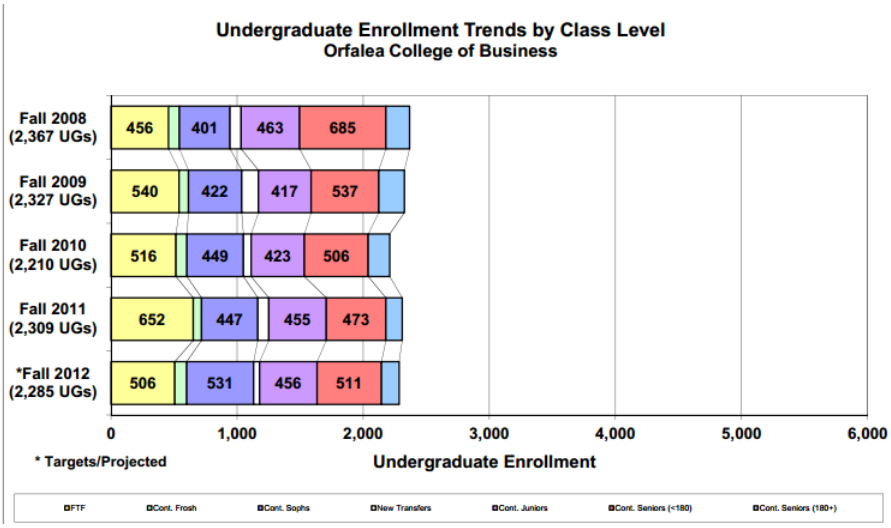
This will be an important data table in our research because it shows the total number of IT students that are in the program right now. Speaking in terms of Lean, these students can be thought as inventory. Inventory within the process is called WIP (work in process.) We have found that in Fall 2012 there were 246 undergrad Industrial Technology students.

CAL POLY

Fall 2012 Undergraduate Headcount Estimates and Targets by College and Program

Column Reference		A	B (C+D)	C	D (G+H)	E	F	G (I+K+L)	H (J+M)	I	J	K
			F2012 PLANNING ESTIMATES			Sub-sets of new undergrads						
College/ Major		Total UG Fall 2011	Total UG Fall 2012	Cont & Ret (proj.)	TOTAL NEW STDTS	FTF Apps Rec'd (thru 1/29/12)	TR Apps Rec'd (thru 1/29/12)	TOTAL FTF	TOTAL Transfer	Non-MCA FTF	Non-MCA Transfer	Ear Deci (FT
College of Bus	BUS	1,903	1,878	1,417	461	4,731	1,197	425	36	15	9	11
		1,806 97	1,765 113	1,344 73	421 40	4,441 290	1,087 110	390 35	31 5	15 0	8 1	114
	ECON	253	246	182	64	556	141	57	7			1
		244 9	231 15	175 7	56 8	523 33	125 16	50 7	6 1			15
	IT	153	160	133	27	74	15	24	3	1	0	1
		144 9	147 13	124 9	23 4	69 5	15 0	20 4	3 0	1 0	0 0	10

This data table has the enrollment trends for the college of business from Fall 2008 to Fall 2012. What we can take from this is that the inventory level (number of students) has been changing throughout the years. A balance between grade levels of IT students differs from year to year between 22-58%. By keeping the flow of students level from year to year we might find several advantages. If one thinks of the IT curriculum as a tunnel, and there are students flooding the tunnel trying to achieve their BA as quickly as possible, there's the possibility that some parts of the tunnel may get backed up. For example, if 3rd year courses are extremely impacted during one term, one would expect that the impacted classes would be 4th year courses. Having to shift around the requirements to meet this demand quarter by quarter is difficult and time consuming. If the school was able to create a perfect flow of students year in and year out, this transfer of resources wouldn't be as troublesome.



National Center for Education Statistics

Another important data set found through the National Center for Education Statistics was the National Postsecondary Student Aid Survey. The most recent survey was a few years back in 2008, but it was important to at least note these trends. Two data set tables studied was the time to the BA and trends in time to the BA. Within the time to the BA, there was a couple of key statistics to focus on. The average number of months from enrollment to achievement of the BA was 75.7 months (6.3 years), and the medium was 52.0 months (4.2 years.) 42% of these recipients did so in 3-4 years while 32.3% of the recipients completed their BA in 4-6 years. There was also 12.1% to have completed their degree in 6-10 years. It's important to note that the goal of obtaining a degree in only 4 years was actually accomplished by a little less than ⅓ of these recipients. The next data table showed something a little more promising. The number of BA recipients to have accomplished this in 48 months or less has increased from 38.7% in 1999-2000 to 44.2% in 2007-2008. This shows that universities have made substantial improvements between 1999 and 2007.

The Institute of Educational Sciences have disclosed two very important reports: NLS72 and NELS:88 longitudinal. These reports show have determined that students who are less prepared for college are much less likely to finish their BA degrees. Preparation for college pertains to both high school GPAs and prior college credits before attending a 4-year college. Research was

done on the demographics for college users versus completion rates of BAs and there was no observed change in time to graduate. An important factor that should be considered is the implication of the working student and how this extra time spend to make money effects their time to graduate. In their specific study, this correlation actually showed a dramatic increase in the time to graduation because of work.

Complete College America

Complete College America also gave some insight to this issue. The first article was written in February of 2011 and dealt with three policies to reduce time to degree. They measure the costs by both calendar year and by credit hours (units.) They portray the costs to the students in regards to both time and physical money. Traditionally, the average bachelors degree was 120 units and obtained in 4 years while doing 30 units a year. Recently, times have changed with an increasing amount of units needed to graduate. In 2011, it was found that the average number of units to graduate was 138, which calculated to 4.6 years if the average student is still doing 30 units a year. It was shown in 2011 that 60% of BA recipients take longer than 4 years to graduate, and that close to 30% take longer than 6 years to graduate (Johnson 2011). They seem to put blame on several sources of time to degree. These sources include unit approval from community to university level, ill preparation for correct unit transferring classes from community level advisors, increased amounts of major changes, and unclear roadmaps for freshmen to follow to graduate on time. They also go into how the government fails by funding students to stay in school, not to graduate more quickly. The government also fails at providing enough financial aid to students thus causing them to work more and attend school less to help pay for school.

After addressing the situation, Complete College America then discusses three main policies that will help fix these issues. The first policy is on controlling credit creep by limiting program length. The University of Florida did an interesting study in the mid 1990s where they surveyed nearly 100 universities around the country to find degree requirements. They found that some schools were being affected by credit creep much more than other universities, and wanted to dive into why exactly this was occurring. Within a year of this study being released, 600 universities were reviewed and 300 of them decreased the required units to graduate by an

average of 6 units. If we estimate based on research found through the institute of educational science that about 40,000 people obtained a bachelors degree in this time, we see that 6 units translate to 240,000 less units needed. 240,000 units divided by 120 units is an extra 2,000 graduates.

The second policy they discussed was on establishing a model 2-year and 4-year road map for all programs to develop for their students. They start off by stating how intimidating and confusing it may be for new students to comprehend class requirements. Progress can easily be subjected. By implementing a road map of specific classes to take each quarter/semester students can take the right courses and instructors are aided in which courses to teach to help give students the right classes to stay on track. This is done by providing proper communication between advisors, teachers, and students and also creating a system through technology to track the progress of the students.

The third policy to be followed is guaranteeing the transfer of general education requirements. It's been stated in this article that over 50% of BA achieving students have attended higher education schools prior. They go on to state how they can separate transfer students into two groups to better serve them. The first separation is called the general education block. This guideline states that universities need to create a general education requirement for students to meet in order to transfer in. They need not finish an associate's degree which would take more time, rather only predetermined general education requirements. This helps both students to reach towards a common milestone and provides a policy to reduce duplication of common courses. The second block regards creating common education categories. This pertains to creating specific general education requirement per major type. This should be universal within the state to avoid different education requirements for the same major at different universities. This will keep in line state objectives and reduce the number of irrelevant course taking by students.

The next article by Complete College America was similar and was titled "Reduce Time and Accelerate Success." In this article they aim at stressing the importance of a reducing time to graduate and effective ways to decrease this. Their argument to reduced time to graduate is to

decrease the cost of the student, increase revenue for the university, and increase the chance of the student actually graduating. In a Florida study they found that excess courses taken not directly associated with students' degree cost about $62 million dollars a year.

They had several key initiatives to tackling this issue. The first one is to require graduation plans and early declare of majors for students. The next step is to decrease unnecessary course taking. An interesting strategy probably looked by several professors is to take attendance. By making this a policy, it forces the student to feel obliged to attend class and thus having a better chance at succeeding in the class. The next example was differentiating between university tuition costs by flat rate or by unit rate. By giving a flat rate, students are more obliged to taking more units since they are paying a set amount anyways. When given the opportunity to pay by unit, students probably feel it to be more practical to work on the side and take less units to help pay for school. Finally, they gave insight on the importance of pre-college coursework to get students ahead of the game for college. Many practical ways of doing so are by taking advanced classes, international baccalaureate programs, and early college dual enrollment programs. Specifically in my research, by starting college coursework in high school the process steps will be shortened and thus time to graduate will clearly become shorter as well.

Population Center-University of Michigan

The most important literature review is on the research report done by the Population Center at the University of Michigan. Here, we gain insight on some very important topics. They focused on first explaining the problem of how time to graduate is actually decreasing. They split up their report in different sections. One section was done on how an increase in the costs for college is increasing and thus students are working more to pay for college. While working, these students are allotted less time to focus on graduating and thus take longer to graduate. Along with this we take into account the fall in the economy. Because there is less money provided by families to help pay for the student's education, the burden of paying for a higher percentage of the education falls on their shoulders. We are finding that more students are becoming part time students so they can work, thus increasing time to graduation. Another important analysis was based on the need for a BA degree. As the economy falls, we see that it is harder and harder to

find a job. With jobs becoming scarcer, the need for a BA is higher since the competition is now greater for each individual. With more people applying for universities, supply and demand shows that universities must either increase costs or have less money to evenly distribute to resources within the university to teach. Either way, the student's completion time to graduate will decrease because they will need to work more to pay for higher costs or they will be forced to an education with fewer resources provided by the university. A perfect example of less resources providing by a university are course closings.

Further along this study was an analysis on previous education preparation. Research was done on time to completion by those in different scoring quartiles in math, reading, and science. Overall, there was a significantly faster completion rate and higher graduation rate for those in higher scored quartiles. This shows that a better preparation in grade schools will significantly decrease the time for a student to finish their BA. It's important to note that a possible root cause for a slow time to completion is the readiness of the student to attend college. Although my study will begin by flow chart students from day one of attendance at Cal Poly, there are several predetermining factors that will affect this process of obtaining a BA.

Advantages and Limitations of Previous Studies

There are many advantages of the one research report I've found and reviewed. It had tons of information on evidence to show how time to graduate has increased, the implications of these increases in time, and the effects this has on the economy. It was important to see how they used empirical data to state their claims in a manner that was easily understood and believed. It was also important to note the causes of the higher times. These causes are root causes and the areas needed to be faced to decrease time to graduate. The limitation I found was that the study wasn't current. Data that was more up to date would have been a lot more beneficial; however, the analysis of the data was still very relevant to present day.

The same goes with the statistical data I found. The data was able to show me the trends from previous years, and the general inclination of times to graduate, but these statistics were still outdated.

Finally, through the articles I found from Complete College America I was able to gain a more practical sense of why decreasing time to graduate is beneficial to all parties and possible solution to accomplish that. It was good to see what steps other universities around the US have taken thus far to help this issue.

The purpose of my literature review was to gather as much info as possible on graduation rates in higher education and look into what some of the roadblocks might be for these rates in our review we found a decent amount of information some sites being a lot less helpful than others.

In this literature it gives great in-depth knowledge on the graduation rates. To start this literature review alerted me to the GRS being the graduation rate survey, which is a federal database. The GRS accounts for about 90% of the undergraduate education of America. The other 10% being private profit schools, etc. And from the GRS as cited by Kevin Carey's work, it says about 83% of undergraduate freshmen that enter college as a full time student come into college with the intention of getting a bachelor's degree. The statistics that came after this are what came as a shock. For starters one out of five colleges graduate less than one third of these students within less than six years. This percent is unusually low being that colleges generally are geared toward getting students out in four years. Kevin goes on to say "The picture gets even worse for minority students, Of 772 colleges and universities in the United States where at least 5% of the full-time undergraduates are African American: – 299 have a graduation rate for African American students under 30% – 164 have a graduation rate for African American students under 20% – And 68 have a graduation rate for African American students under 10%." This just goes to show some of the contributors to graduation rates are caused by ethnicity, which is a common roadblock in most higher education facilities. In our project this information can become of great use in trying to discover ways to combat the total cycle time in students graduating in cal poly. Even though race hasn't been a big problem in particular to cal poly because its race make up is completely lopsided, according to a percentage last updated in 2012 by CSUmentor site about 66% of the student body is white, 0.7% is black, 14% is Asian and about 15% is Hispanic. So while Kevin's information is valuable the ethnicity values in cal poly are too low to really attribute the graduation rates to race issues. And even if that were that case it would be difficult to apply lean management very effectively to such a topic.

Truth without Action

In this journal, Also by Kevin Carey, we discover some other factors that could contribute to graduation rates and the roadblocks that encounter. In the literature Kevin talks about accountability for higher education and basically continues to bash higher education for not trying hard enough to meet decent graduations rates. He also speaks about the no child left behind act saying, “In January 2002, President Bush signed the No Child Left Behind Act into law, ushering in an era of unprecedented federal control over the schools. As with higher education, states had worked throughout the 1990s to establish K–12 accountability systems, and just as with higher education, their efforts often fell short. Congress decided to take matters into its own hands, and soon each of the nation’s 90,000 schools was required to test students in reading and math and be subjected to serious consequences if scores fell short of government-created standards.” Funny enough higher education jumped into gear and tried to come up with an equation to help create higher accountability in their graduation rates. But as before as Kevin Carey explained before their efforts eventually just tapered off and fell short once again. The failure he spoke of before was from the 1990s when the higher education saw an explosion accountability system but eventually failed. while the information given by this journal is very insightful, our project seeks to look for a less full scale undertaking, because coming up with an accountability system that would work for the college that so many failed at doing before would prove to be quite difficult for a couple of students and furthermore wouldn’t would be slightly difficult to apply lean management to. What we seek is to find out is there smaller groups of problems that we can tackle for a possible fix, which in the end could result in a foundation that could help create these so called accountability policies Carey was addressing.

This literature gives some insight into Cal poly’s actual issues in its graduation rates, and with this information we can gather more ideas and what can be done to assist cal poly in improving its rates. In this document the give some numbers on graduation rates and what areas could use improvement. To start they give five key points on the analysis they compiled from their efforts. These points include “One: Colleges and programs vary distinctly based on the measures and time-frames of this study. One key example of these differences occurs in the fact

that students in CLA and CBUS graduate sooner, in their fourth or fifth year, as opposed to students in CENG or CAED who tend to graduate in their fifth or sixth year. CAED does have two five-year programs that contribute significantly to this difference.

Two: There have been distinct jumps in graduation rates at particular points-in-time. The four-year graduation rate jumped with the Fall 1999 cohort and the five-year and six year graduation rates jumped with the Fall 1998 cohort. 3. The majority of students who have left Cal Poly as juniors or seniors, left in good academic standing. Four: About half of the students who left Cal Poly after one year, left in poor academic standing. Five: Students who change their major at some point in their academic career at Cal Poly have higher graduation rates than students who stay in their original major." There are three valuable points that we can take from the previous study and adapt as our own to apply lean management thinking to possibly help improve graduation rates. The first point would be determining the difference in degree tracks between the different majors that would cause someone in CSC to graduate later than someone in KINE. Another point was that half the students who left cal poly their first year was due to poor grades. In this situation we might be able to apply a VPP model type approach that could be in turn used by these students to help them in their studies. The last point being students who changed their majors as opposed to those who stayed in their major had higher graduation rates. It is possible we can take this point and apply it to our project if we could manage to get down deeper into the root of why this is. We could apply the five "Whys" analysis to discover this issue and from there formulate a plan on how to go about fixing this issue.

FIRST-TIME FRESHMAN

Cohort	*Average Headcount	*Average SAT	HS GPA	1-Year Retention	4-year Graduation	5-year Graduation	6-Year Graduation
Fall 1990	1,817			85.4%	7.5%	39.8%	58.1%
Fall 1991	1,626	1095	3.40	84.9%	9.7%	42.2%	57.4%
Fall 1992	1,394	1120	3.50	86.4%	11.4%	40.5%	59.7%
Fall 1993	1,676	1121	3.54	87.1%	9.7%	45.9%	64.4%
Fall 1994	2,098	1125	3.49	85.6%	12.7%	50.0%	64.5%

Fall 1995	2,507	1132	3.52	86.4%	14.9%	53.0%	66.0%
Fall 1996	2,869	1124	3.48	85.8%	16.5%	49.9%	64.4%
Fall 1997	2,291	1159	3.60	87.1%	16.0%	50.7%	65.3%
Fall 1998	2,466	1164	3.64	89.0%	16.8%	54.5%	68.6%
Fall 1999	2,850	1162	3.64	88.6%	21.3%	55.7%	68.9%
Fall 2000	3,253	1165	3.62	88.6%	20.8%	54.6%	
Fall 2001	3,629	1169	3.64	88.2%	21.7%		
Fall 2002	3,075	1192	3.71	89.1%			
Fall 2003	3,006	1195	3.73	90.0%			
Fall 2004	2,900	1212	3.77	91.3%			
Fall 2005	3,570	1204	3.73				

Here is some statistical data recorded by the IP&A that could greatly assist us in discovering why graduation rates the way they are. In this data set it shows the large margin of 4 years graduates verses 6 year graduates. Being at almost a 40 percent difference with 4-years being at a 21% and 6-years being at a 68%. In our project we hope to better understand why these percents are so lopsided toward 6-year graduates as opposed to 4-year and formulating an approach to fix these numbers, as to flip the percents between 4 and 6 year graduates. According to CNN(2012), In some states, recent changes have been particularly dramatic. Average tuition and fees for in-state residents at public four-year colleges soared 16% to 21% last year in Arizona, California, Georgia and Washington, according to a report released last week by the College Board. (The average increase at public colleges over the same period was 8.3%; none of the figures in the report were adjusted for inflation.) What's more, students in some of those states may see more hikes in the upcoming year: Washington recently approved a tuition increase at several of its public universities, while California students may face another double-digit increase in the second semester of this academic year. "The potential for this to get worse is very real," says Rich Williams, higher education advocate at U.S. Public Interest Research Group. So according to this information the price of tuition has been for many public colleges everywhere, which in turn could cause undue hardships for college students. This undue hardship could adversely affect the graduation cycle times in ways such as causing students to get more jobs to accommodate tuition raises which in turn could adversely affect their grades or cause them to

take less classes to make time to work or even just to lessen the amount of classes they need to pay for. These effects of tuition being raised can point most of the blame at reduced funding to state schools and as an article from Brianna Walker explains (2011), UC media specialist Klein said the UC's tuition increase will offset about 26.3 percent of the reduced state funding, with the rest being covered by cost-cutting and revenue-generating actions, such as cutting classes and library hours and laying off employees. So with such consequences occurring across the board this could cause a great hindrance to graduation cycle times if a student is unable to get a certain class available more than only once a year. But with a little further research another article by Jung shows (2008), The average full-time enrollment at public colleges increased from 8,086 to 8,468 over the period from 2002 through 2004, as Table 1 shows. The full-time enrollment of the six disciplines selected for this analysis likewise increased between these two time points. During this same period, average college tuition increased from $3,915 to $4,849; thus the average tuition increase over the 2 years was $934. These descriptive statistics imply that college enrollment has increased despite increases in college tuition. The simultaneous increase of tuition and enrollment might be explained by changes in other factors included in our model, such as changes in financial aids, instructional costs, or dormitory capacity. Another explanation for these increases in tuition and enrollment may be that tuition has weak or no effects on enrollment, as some studies have reported. The simultaneous increase of tuition and enrollment has continued over the last decade (our calculation based on IPEDS data). So according to this data, enrollment isn't influenced by the tuition so by relation we can say does tuition really play an effect on the graduation cycle if the enrollment doesn't decrease from it and is even increasing during the time tuition is increasing. This would need to be further researched in its entirety to draw more definite conclusions, but this can help narrow down the search since this issue has no real definable weight behind it to warrant looking for a solution.

Table 1 Descriptive statistics

Variables	*N*	Minimum	Maximum	Mean	*S.D.*
Total full-time enrollment					
Enrollment of 2002	470	416	35,116	8,086	6556.2
Enrollment of 2004	470	1,020	33,518	8,468	6727.6
Disciplinary enrollment					
Education_2004	396	12	4,550	776	676.7
Engineering_2004	237	12	6,079	1,035	1202.9
Biology_2004	459	10	4,781	474	573.0
Mathematics_2004	442	10	723	79	79.6
Physics_2004	438	10	1,040	139	128.5
Business_2004	459	21	6,273	1,245	1116.6
In-state tuition					
Tuition of 2002	470	1,816	8,994	3,915	1398.3
Tuition of 2004	470	2,070	10,856	4,849	1689.5
Tuition increase	470	−362	2,807	934	513.1
Financial aids					
Grants	470	35,646	26,742,765	4,731,837	4722029.6
Loans	470	21,504	18,409,624	2,811,641	2713396.8
Instructional expenditures	457	3,612,048	790,576,000	75,603,199	97411723.6
Dormitory capability	440	234	19,446	2,891	2495.0

Literature Review Conclusion

Our project will provide a more concise study to decreasing time to graduate. In lean manufacturing, it's always a good idea to start by choosing one product and creating a flow chart to find solutions to that one product. Tackling problems found throughout a company at once can be very overbearing and difficult to achieve. By simplifying the problem one can still find universal solutions to fix problems found elsewhere.

SECTION III

PROPOSED SOLUTIONS

Introduction

The purpose of this section is to offer methods to analyze data, and then solutions from what may be gathered from analyzing. In a manufacturing setting, processes must be broken down in order to find variation and unutilized efficiency. For a company to build a specific amount of widgets a month they must take into account several different parameters. First they must take into account how many working hours they have during this 1 month time period. From there, they must figure out how long it takes for one widget to run through the complete cycle. The total cycle is different for every company, so determining the start and end times will be specific to the company. From there, each process step (whether value added or wasteful) must be documented with their cycle times, inventory levels, and machine uptime. Finally, the number of workers needed for each process will need to be documented. Once all of this information is found, we can now document this data into useful representations of the data. In most cases, a flow chart will be the strongest tool used. This flow chart can represent data and help those trying to make the process more efficient to find problem areas to improve on. In our research, we will use this same guideline of flow chart to represent the data, and then out proposed solutions to help create a more efficient process. There are certainly more way of creating a more efficient process, but for the means of our report we found the method of flow chart and creating supplemental diagrams such as a flowchart along with the map to be the most useful.

The plan is to create some form of methodology to effectively organize data. Data cannot be fully utilized until it is in some form analyzed to the extent to which the user can propose solutions from it. Once the data is organized, we can propose specific solutions that can be properly backed up from our analyzed data. A flow chart will be something that can be easily updated from year to year, so it will be nice to document the findings throughout the year to see how time to graduate responds later down the road.

Solution Flow Chart- 4 Types

The purpose of flow chart is to offer a systematic methodology for laying out recorded information into a user-friendly representation of the current time to graduation rates for Industrial Technology students. It is difficult to view recorded time to graduate times through the years and really grasp the meaning of them. By flow chart the situation, the process can be broken down into specific process steps to be further analyzed. The key metrics we will be looking for are total cycle time, specific year to year cycle times, total units needed to graduate, the flow of courses, and finally the process cycle efficiency.

The total cycle time will be defined as the time it takes from day one of the student's teachings at Cal Poly to the day they receive their diploma. Decreasing the total cycle time will be the primary objective for our proposed solutions. In order to so we will need to have more specific information regarding this number.

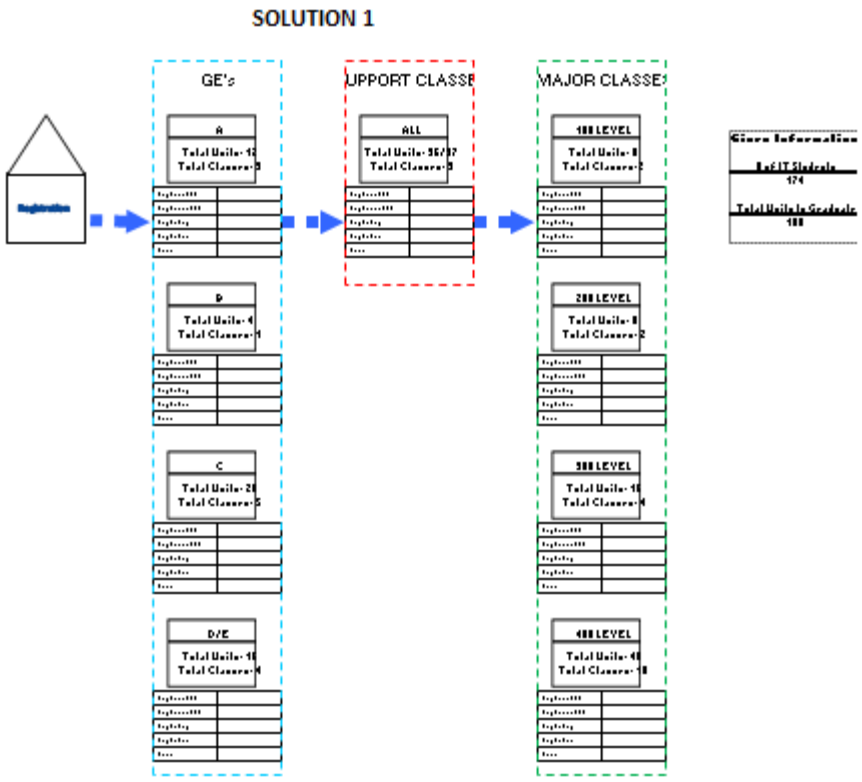
Once we have our total cycle time, we will further break down this number into sub-units called sub cycle times. These sub cycle times will be divided into quarters. We will calculate the average number of units completed per quarter, and from there be able to calculate the value added (or % towards graduation) the average student has completed. It is from here that we can dive deeper into the analysis into more specific completions by gathering data on which courses have been completed that meet specific requirements. Examples of these requirements include; GWR, support courses, class pre-requisites, specific G.E. requirements, etc.

As a supplement of the flow chart, a flow chart will be created for the possible routes that can be taken for graduation completion. As a student, there are tons of routes one can take in order to graduate. With the greater number of routes of class completion, there are greater possibilities of wasted steps being taken by students that will hinder their time to graduate rate. It will be important to take this into account because of the importance of pre-requisites and the fact that only certain courses are offered during certain quarters. There have been issues with students following certain paths and getting delayed in the process by having to wait on specific classes. This waiting time would be considered a wasteful step in our flow chart, and should be analyzed.

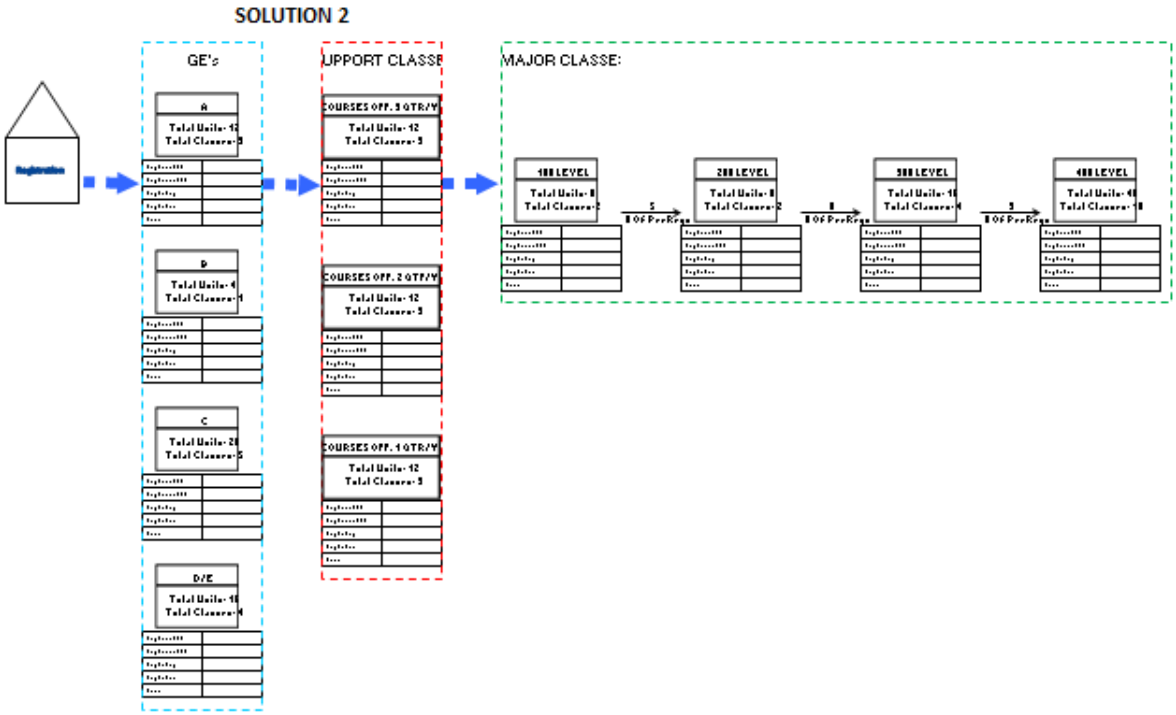
Once we have completed all of these analyses, we will calculate the process cycle efficiency. This metric is usually calculated by diving the value added times by the total cycle time. In order to compute for the value added time, we will divide the average total units taken per quarter by the average number of units taken per quarter that were degree applicable. For a more applicable efficiency rating, we will take into account any other wasteful times from this total cycle time that we find from the flow chart such as wait times, extra class selection outside the major, and possible leave of absences taken by students.

Once we are able to create this present day flow chart, it will be important to create a future state flow chart. The first goal will be the most important, a decreased time to graduate value. This value will be achieved by decreasing the specific cycle times of each process step and by cutting out any wastes. Overproduction and waiting are two of the greatest forms of wastes in a manufacturing setting, and will be applied to our research in the form of un met pre-requisite classes from quarter to quarter, classes only being offered during specific quarters, and students taking classes outside of Industrial Technology curriculum.

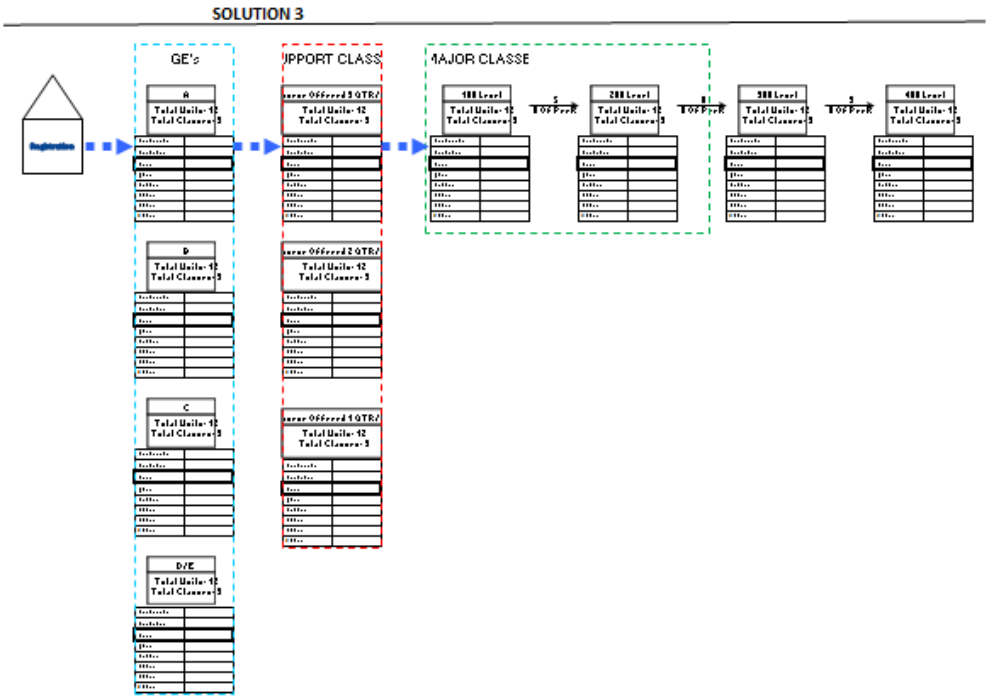
Solution 1



Solution 2



Solution 3



Solution 4

		EFFECT													
		A1	A2	A3	B1	B2	C1	D1	D2	IT150	IT233	IT310	IT407	Total	Qtrs Offe	Importance
CAUSES (PRE-REQS)	A1													2	1	2
	A2													2	2	1
	A3													1	3	0.333333333
	B1													2	2	1
	B2													0	3	0
	C1													1	2	0.5
	D1													0	1	0
	D2													1	3	0.333333333
	IT150													2	2	1
	IT233													1	1	1
	IT310													1	2	0.5
	IT407															

SECTION IV

RESULTS

This project is aimed at solving or improving the current graduation rates. At Poly the typical student graduates in about 5 years. Back in the literature reviews it shows in charts created by Cal Poly's IP&A office how the graduation rate is about 55% for 5 years in the year '98. And that the for 6 years it is about 69%. This data was taken a couple years back, but it showed trends of increasing about 3% on average per year 10 years before that . With this being identified we can safely predict that the next 10 years and so on that there will continue to be an average increase in the graduation rate of about 3%. But this also includes the fact that the college population has steadily increased. This information along with other information we have gathered such as the effects of different incidents on graduation rates such as working and going to school, being from a low income family, playing sports and going to school and etc. We decided to key in on something a bit simpler to start off in creating a solution. And with the solutions we created we hope to improve and design them to better address outlier issues such as finances. Our key idea we focused on was class scheduling for the typical student so as to get them out in 4 years. In Our solutions we used the key tool of flow chart from lean management. We believed that with a flow chart a better visual tool could be created from it, what is meant by this is that with a flow chart we can create and map out the complete class catalog for IT majors. And with mapping out the complete curriculum for IT we could take a look into a way to reduce the muda , meaning in this case time wasted and overproduction, which would represent a student taking too many classes. If one of these proposed solutions were to plausibly work in creating a viable method/path in taking classes and getting done in only four years of college. And being able to improve upon the solution to add outliers and create a product that can be continuously improved on. So in this section the advantages and disadvantages of the flow chart solutions we came up with will be discussed. Once this is done the paper will refer back to the needs table created back in the beginning of the paper to determine the value of each solution in solving each of these needs. After discussing each solution the paper will describe, which solution was chosen as the best solution to use and the reasons to why this solution was better than the other solutions presented in the project. Most of the solutions currently proposed are skeleton models being that we need information we do not currently have and are currently

working with contacts from the IP&A office on solving after meeting with them and discussing with them exactly what numbers were needed to start.

Solution 1: In solution 1 a basic model of the flow chart for creating better graduation rates is given. It shows how many classes are needed for areas A B C D/E for general education to meet the IT curriculum requirements. For example it shows in area A 12 units are needed to meet the graduation requirements and so on. Then this solution shows the units and number of classes required for support courses. This trait continues on into level 100-400 major courses. And below each general education area, support course area and 100-400 major course area it will list the average courses taken per quarter, average sections taken per quarter, average class capacity, average class enrollment, and utilization of each course section during these quarters. This information would be eventually filled with actual numerical data as the IP&A provided such data. This version of the FLOW CHART model and each model hear after will is made based on 4 classes being taken per quarter and will encourage the taking of 4 or more classes.

Advantage: With this 1st solution ideally it would be useful for the beginning college student. With this a college student can look at it and determine what beginning GE courses they want to take based off how many people have taken the class the quarter before or maybe the year before (depending on if the class is offered quarterly or yearly). The flow chart would also place the classes in a way that would encourage students to get the GEs done before other later classes down the road. With this thought process it would create a stream of college students who were moving in the general same direction, which creates a way of keeping classes available. So freshmen will get done with earlier GE courses which will keep these classes open for future generations of students and at the same time this would ideally keep these students from jumping the gun and taking higher level classes that should stay open for juniors or seniors. This would help reduce time wasted by students having to take more unnecessary classes, but they take these courses to keep a full time student status.

Disadvantages: One of the main disadvantages of this FLOW CHART is that is doesn't show the in depth need of each class such as prerequisites. This could cause a student to waste time because they would want to take a support class due to most of their GEs being done but the last GEs they need are what they need to take that support class. Examples likes this would be a major setback of this value stream. Along with that this value stream would need to be constantly

updated for each quarter for each year due to last second catalog changes or class sections becoming canceled or ill-funded. This would definitely cause major complications when trying to create a handout you can give out to students at the beginning of the year. Another disadvantage or downside to this solution is that it relies on students going over the handout by themselves and determining what they want to do. Multiple effects could come out of this such as students possibly not understanding the curriculum or maybe not even knowing what a general education or support course is. In this case creating a program, that was required to attend, to inform the incoming class what these areas mean on the hand out. This still leaves the problem of the time it would take and money required for a program such as that.

Solution 2: This solution basically uses the same base model, but added in number of prerequisites for each major level required. Along with this knew view being added, the solutions a small example of the support curses being divided up, as to fit them to each quarter. And with of it was divided up it shows how 3 quarters can fit 3 support classes each leaving 1 more spot available for a major class ideally. This is assuming the student follows the intended 4 classes a quarter recommendation.

Advantages: This version of the FLOW CHART model will give incoming students a greater incite n how to pick their starting classes and how to schedule them from here on out. This would grant them the ability to see what perquisites are blocking their preferred class path choice. One of the greater problems encountered by students is making a schedule and going to enter in the class catalog for registration to find out that the class has a requirement not met by them. This creates a large amount of time that was possibly wasted by the student that could have been avoided with this model. This model also gets the student thinking in what direction is ideal for dividing up classes shown in solution 2. So like in the solution support classes were divided u into 3 quarters, this doesn't have to be the case of how the student ends up dividing the classes but is merely way to get the student brainstorming of how they want the ideal schedule with the FLOW CHART model guiding them. To simplify or better explain exactly what this is doing, one can think of this as working on a puzzle from the outer already connected pieces of the puzzle. This creates a better more organized way of piecing together a puzzle, just as this FLOW CHART model would create an organized way of approaching selecting your classes.

Disadvantages: This FLOW CHART model contains many of the same disadvantages as the first solution such as creating keeping a Model like this up to date. Also having the problem of actually getting this model to incoming students so that they actual complete It. Also this solution too closely resembles the roadmap you can get if u went to your advisor.

Solution 3: This solution is geared completely toward improving/helping the IT department. It gives a FLOW CHART model that teachers and faculty can look at and determine what is needed for class sections or class sizes in the way of seeing to the need of 3rd and 4th years ideally. So in this FLOW CHART model it will show the faculty how many how seats are available versus how many seats are taken but not just for IT courses which is already present on the PASS program used by poly but it would give a clear picture of what seats available and seats taken for GE courses in area A, B, C and D/E. It would only show those courses required by the curriculum. Along with this information it will show how many 1st, 2nd, 3rd and 4th years there are in each of these GE areas. The FLOW CHART model would show this information to the faculty not only for the current quarter but also for the past and future quarter. So these means that the teacher would be able to see how many 2nd or 3rd years were in a certain GE class a quarter before. Also in reverse a faculty member will be able to look at this FLOW CHART model and see what GE or support classes will be available for the coming quarter.

Advantage: There are many great advantages to a system such as this. To start a faculty member will be able to look at this FLOW CHART model and look to a prior quarter to see what classes would be needed for the current upcoming quarter. More specifically this means a teacher can go and look at an Area A or B GE to see how many current 4th years have taken that class. So then the teacher can then determine if a need for certain class availability can be met now that the 4 years have completed a prior required class. This will this FLOW CHART not only throws numerical data at teachers but organizes it in a way they can easily look over digest. This same concept can be applied to the major classes 100-400. Because it's easy to overlook what classes are being taken 1 quarter 3 quarters later down the line. So maybe a larger group of IT students take IT class 1XX, so then next quarter that large group who have completed IT 1XX having an overwhelming need of IT class 2XX or 3XX. This FLOW CHART model will help identify group clusters such as this so it can't easily be identified a certain class level should be available during this time.

Disadvantage: This model doesn't contain many defects. But out of the few noticeable ones would include potentially being complicated. This could originate from the fact of having to go through the FLOW CHART model and look at each specific number for each given class for students' age. This could easily turn into a time consuming task.

Solution 4: This solution gives better insight on the flow of classes with pre-requisites, including when they are offered and what classes would need it next meaning what its output was, basically it is an interrelationship chart. It gives a cause and effect side. The cause side relates to classes that are pre-requisites and gives an idea of how many classes would need this particular class before you can take it. So for example if row A1 is heighted twice that means two columns of classes need A1 as a pre-requisite before you can take those certain classes. The effect side gives the columns of classes that need pre-requisites, so this means if column A3 is highlighted 3 times that means this class requires 3 pre-requisites before you can take this class. At the end of this chart it gives numerical values which state how many times the class on the current row is needed as a pre-requisite. Next column shows how many times this class is offered a year and at the last column it states the importance value. This importance value is obtained by dividing the number of times this class is needed as a pre-requisite by how many times it is offered per quarter. So a class that it need for 6 other classes and only offered 2 quarter gets a importance value of 2, which is a relatively high value indicating the importance of getting this class done.

Advantages: This chart does a greater job of showing the relation between classes needed and classes taken toward degree completion when looking to find a route that gets high traffic classes out of the way. So when a faculty looks at something like this it will happen them understand why their class section are uncharacteristically packed some quarters more than others. So then they can look and determine if they need to make more class sections available certain quarter more than others. Looking at the importance value will give faculty a sense or way of prioritizing certain classes in the curriculum, also being able to see what classes outside the major are offered.

Disadvantages: Unlike the other solutions this chart while useful doesn't give a sense of the percent utilization of each class being offered. So even if a class gets a high importance value there is a chance that class won't have be packed so it wouldn't invoke the need for more class section next quarter. It also doesn't communicate the fact that of who is taking these classes. So is the class comprised of seniors, juniors or even freshmen, if it is composed of freshmen this should cause less alarm in the system being that they have over three years of school left and are not in critical positions.

SECTION V

CONCLUSION

In this project the focus was to lower graduation rates. Two separate literature reviews were formed and research in one focused mainly on outliers that affected graduation rates along with looking into Kevin Carey's work in higher education and research he did himself on graduation rates. The other literature review provided great information found from research done at other colleges looking into the advantages and disadvantages of each and taking away from it what could be applied to this project. It also uses many numerical tables from research and data presented from the IP&A office along with other sources. Things that were learned included seeing the wide variety of outliers that play a role in affecting the graduation rate, such as things like relative funding of either the student or the learning institute. Also what the student may have on their plate besides just school such as sports, a job, and other extracurricular activities. One key thing that was also learned was how start up endeavor or projects may start intending to address many problems, but how this is unrealistic and a set focus or step in addressing the problem the project/product is made for should be established and late perfected or developed. In the case of this project we changed our focus to just making a working model of the FLOW CHART model instead of trying to create a prototype that encompassed all or most outliers in graduation rates such as accounting for transfer students coming in or whether a student is working to stay in school so the FLOW CHART model would need to show this. But after all this being said the FLOW CHART model will still be complicated considering all the numbers and data input that would be required from the IP&A office for this to work. With this information inputted into the FLOW CHART model it would give a great visual to teachers and faculty on how to better prepare for classes and what sections would be useless and better suited dissembled then added to other sections. The FLOW CHART model addresses the greatest need that was evaluated earlier in the project to be "identify non-value adding events or time". Also it addressed the need of creating kaizen. The FLOW CHART model allows for easy identification of value wasting such as picking out classes which aren't needed possibly by 4^{th} or 5^{th} years and removing them from the curriculum to possible make space for classes, which would better address what is needed for the IT majors that quarter of the year. And with this FLOW CHART

it leaves room for continuous improvement so as to allow the adding of outliers to the FLOW CHART and through the natural improvement of student cycle time in flow it would create.

Future Work

This research report has gained ground on creating a basic template for analyzing time to graduation for students. This template is very universal, and can be used by any major. The limitations for us were based on gathering real time data by the IPA office and the registrar office. Both were spoken to and sent documents to regarding the information needed, but the timelines must have been too short for them considering they have a ton of other projects in progress. The first goal for anyone taking this project to the next level will to first analyze the current flow charts. It is important to capture both the capacity requirements needed for the students, and also the real time flow to be able to identify areas for improvement.

SECTION VI

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APPENDIX

A. GANTT CHART

	Task Name	Duration	Start	Finish	Predecessors
1	Agreement Form	1 day?	Mon 10/1/12	Mon 10/1/12	
2	Project Proposal	1 day?	Mon 10/1/12	Mon 10/1/12	
3	Progress Report 1	1 day?	Fri 10/26/12	Fri 10/26/12	1,2
4	Progress Report 2	1 day?	Mon 11/19/12	Mon 11/19/12	
5	Speak with Ind. Tech. Teachers	6 days?	Wed 11/21/12	Wed 11/28/12	
6	Speak with Ind. Tech. Students	1 day?	Fri 12/7/12	Fri 12/7/12	5
7	Measure facility sizes	1 day?	Mon 12/10/12	Mon 12/10/12	6
8	Determine class sizes	6 days?	Fri 1/4/13	Fri 1/11/13	7
9	Determine required units to graduate	6 days?	Fri 1/4/13	Fri 1/11/13	7
10	Decrease Time to Graduation Methods	6 days?	Fri 1/4/13	Fri 1/11/13	7
11	Create Flow Chart of time to graduate	1 day?	Tue 1/22/13	Tue 1/22/13	9,8,10
12	Create List of Tools to analyze with	1 day?	Fri 2/15/13	Fri 2/15/13	11
13	Final Report	1 day?	Thu 3/14/13	Thu 3/14/13	12