AC 2008-2786: THE PARTY'S OVER: SUSTAINING SUPPORT PROGRAMS WHEN THE FUNDING IS DONE

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The Party's Over: Sustaining Support Programs When the Funding is Done

Abstract

In the lifecycle of an engineering education grant, the phase where best practices are sustained and disseminated is perhaps the most crucial stage for maximizing impact. Yet this transition phase often receives the least attention as project team enthusiasm can wane, while funding tapers off, and faculty priorities are pulled in other directions. There are numerous obstacles associated with sustaining program changes, even those perceived as very valuable. Typical challenges are: What happens when the funding runs out? What grant-developed programs should be sustained by the university? Does the institution need to internally allocate resources in an annual budget large enough to replace the grant?

Ultimately, sustaining successful programmatic improvements is about "change management" in an institution. In this paper, we will review the literature relating to institutional change in engineering education. We will build on current curriculum change models, in the context of a major engineering education grant at Boise State University that included a variety of curricular enhancements, academic support, and outreach efforts. Over the past two years, the project team focused considerable effort on institutionalizing the most successful programs, and met with mixed results. While many programs will continue and benefit students long-term, other programs, even ones with stellar success and solid assessment, have not been entirely adopted for a number of reasons that we will examine. We will review the role assessment played in the process of program transfer (from the grant to the university) and lessons learned about building alliances with other campus partners to achieve university-level buy-in, well before the last stage of the grant. Finally, we will discuss two factors that are not identified in institutional change literature, but that contributed significantly to the successful transition of our programs — the importance of taking a research based approach, and flexibility in time and resource allocation.

Introduction & Overview

At Boise State University, we are currently winding down a multi-year, $1,000,000 program development grant to support freshman and under prepared students in the first two years of engineering programs. (The grant period was initially four years, then extended to five, with no additional funding.) Boise State University [enrollment 19,540 overall, 1,771 engineering], located in Boise, Idaho, is a metropolitan institution that provides affordable access to education for a diverse population of capable students, from National Merit Scholars seeking an urban college experience to non-traditional students balancing family, work and education. Most of the students are undergraduates and a significant portion are first generation and/or lower income.

Our grant-funded initiative comprised a broad array of academic enrichment and support (internships, supplemental instruction, scholarships), curricular changes (integrated freshman and pre-freshman learning communities) and recruitment (community programs, camps). The overarching goal defined by the sponsoring agency, the William and Flora Hewlett Foundation, was to "support programs to increase retention and recruitment efforts, and to improve student learning through better undergraduate teaching." [1] The breadth of our university initiative is presented in Appendix A, along with information about assessment methods for each component, resulting publications and reports, and institutionalization status.

We believe our experience, particularly in affecting lasting change at our institution, provides some valuable lessons not only for recipients of similar grants, but also for funding agencies and university administrators.

Institutional Change in the Literature

Over the past 20 years, the growth of engineering education as a scholarly endeavor in its own right has been well documented.[2] While progress has been steady, most experts agree that there is much more work to do before it enjoys the same status and respect given to more traditional fields of research. A small, but growing portion of the current literature in engineering education addresses the study of "change management" on an institutional level; what governs change and how to make it happen. Four NSF-funded coalitions, which were in place from 1990 through 2005 and involved 40 ABET accredited institutions, have been exemplary laboratories for studying the process of institutional change, in particular the process of transition from "pilot" or "experimental" educational processes or practices to those that are pervasive and accepted as the norm. Clark[3], draws on the experience of the Foundation Coalition to convey a change model, which is represented schematically in Figure 1. (Labels underneath each element have been added for later reference.) A key finding of the Coalition paper is that simply presenting

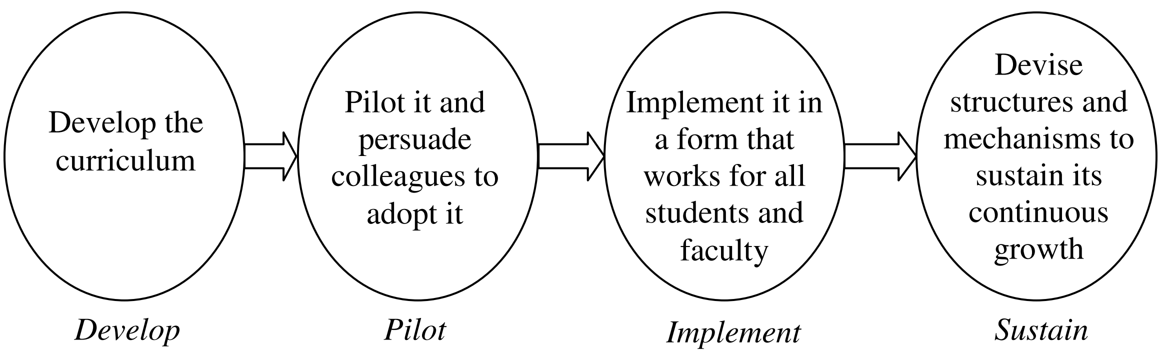

Figure 1: Foundation Coalition change model

positive assessment data to program faculty is not sufficient to ensure new practices are adopted. The paper goes on to present a number of case studies in which change was achieved through an iterative process that included institutional support as well as significant and accessible assessment data. Clark also points out the Foundation Coalition leaders regard their model as an evolving process.

Colbeck[4] draws on a broader academic tradition to develop an Institutional Process Model which she tests against experiences in the ECSEL Coalition. In this work, the processes that govern institutionalization are categorized in three separate groups: regulative (administrative rules, budgetary constraints), normative ("peer pressure," fear of "looking bad" to peers) and cognitive (being convinced that the change is "the right thing to do"). Among the conclusions in the study was the result that the cognitive processes were the strongest of the three.

This result, that cognitive processes dominate the institutionalization processes, seems to stand in contrast to the experience indicated in Clark. Perhaps resolving the two views lies in acknowledging that simply presenting a good assessment report is not enough to convince faculty that the piloted project is good, or more to the point, significantly better than the status quo. Other motivators are important as well. Haglund, from University of Wisconsin (one of the first coalition institutions)[5], affirms that "faculty members have deeply held beliefs regarding the curriculum and content of specific courses," which makes "conversation about curricula …often volatile."[5] Changing curricula, as Haglund points out, is an arduous process constrained by degree requirements, availability of suitable textbooks, and other resource and pedagogical issues. So the perception that faculty don't immediately respond to good assessment data may simply reflect the conservative nature of the academy in responding to curricular issues.

In addition to the work on institutional change models, other authors have attempted to address factors that support or hinder institutional change. For example Litzer[6] reports that affected faculty and administrators must clearly perceive value in the changes proposed.

New Elements to the Change Model

What seems to be missing from these change models is the role time plays in institutionalization. Responding to faculty prudence regarding change, an important aspect of sustaining programs (institutionalization) that must be captured in any model is the temporal aspect of engaging faculty and administration. Consistency in message over time builds confidence in faculty members that early results were not a fluke. Likewise, administrators are likely to look askance at a single report or result simply because their experience tells them that faculty are slow to adopt new methods and procedures.

Another element touched on by the Foundation model and the UWM model described by Haglund is the necessity for iteration. Haglund suggests that the continuous review philosophy of ABET 2000 and the iterative nature of the engineering design process be applied to curriculum improvement. We found it helpful to apply an even more fundamental iterative process – a research based approach, which encourages not only iteration in program implementation, but testing and re-examination of basic hypothesis and fundamental assumptions.

In the following examples, we will describe how the function of time and applying a research based approach affected our program success and institutionalization results.

The Luxury of Time

Due to the constraints imposed by funding agencies and the manner in which program development grants are administered, most program development grants follow a fairly linear and pre-determined trajectory. The proposal document is considered a roadmap of the path which will be followed throughout the grant period and the assessment program will produce data clearly indicating the degree to which the programs succeeded. Had our grant followed that trajectory, the largest programs developed through grant funding would have been considered to be marginally successful at best. It seems doubtful that the assessment data would have made a very strong case for institutionalization.

Rethinking Assumptions – A Fundamental Research Process

We intended to implement a wide array of programs, including freshman learning communities, supplemental instruction for math, and specific classes and programs for underprepared "pre-freshman" students, whom we define as engineering students at a math level below Calculus I. (Appendix A lists the grant program elements for readers who are interested in further detail.) Most of the programs we intended to implement had been well studied in the literature, so we began our project with some likely assumptions. Many of our assumptions proved to be well founded and are not discussed in this paper.

Other assumptions proved more problematic and prompted us to deepen our assessment rigor; they are listed below.

1. Math is a major obstacle for many potential engineering students.
2. Students who start their engineering studies at higher math levels (Calculus I or Calculus II) succeed (are retained) at a higher rate than students who start at lower math levels.
3. Well designed, high quality math supplemental instructions programs will significantly increase math success for students.
4. Integrated enrichment programs such as pre-freshman and freshman engineering learning communities, internships and residential college will benefit students and enhance retention.
5. Yearly university retention reports will be an adequate method to assess retention results.

In the first year, we closely followed the *Develop* and *Pilot* stages of the Foundation Model in Figure 1. One of our first challenges was measuring retention of our pre-freshman and freshman level students to ascertain program success. We quickly saw that assumption #5 was inaccurate, as university measures of retention were inadequate. University retention statistics focus on fall semester-to-fall semester retention of full time students, classifying student level by number of credits. Our students included many part-time and non-traditional students, and many "pre-freshmen," which is not even a recognized designation in university statistics. With assistance from our university assessment staff we devised a system to effectively measure engineering student retention and academic progress through each of our engineering curricula, including pre-freshmen, non-traditional students, transfer students, part-time students, and returning students.[7] This sophisticated measuring system eventually revealed that assumption #4 was accurate, and that pre-freshman and freshman retention benefit from focused programming and curriculum.

This initial stumble in our assessment foreshadowed that we needed to spend significantly more time and effort on assessment and analysis than we expected. Measuring the effectiveness of our math supplemental instruction (SI) program also proved complicated. The effectiveness of the SI method, which has been studied in detail by University of Missouri-Kansas City[8] and elsewhere[9, 10], is commonly measured by comparing the grades earned of the SI participants to the grades earned of the non-participants. By that measure, our university's SI program was successful. If we had stopped there with this traditional program assessment method, we would have missed the most important findings of our program. It took three semesters before we collected enough data on SI results to attain statistical significance. During that time our assessment partner and project director began mining the SI data set for other correlations and clues about math learning. Their findings were surprising and led us to alter the direction and focus of the math portions of our programs.

In a detailed statistical study presented elsewhere[11], we found that the conventional wisdom about mathematics preparation and persistence in engineering programs was simply not supported by the data. In fact we found that placement in first math course (a reasonable measure of mathematical preparation) was not correlated with persistence in engineering at Boise State University. On the other hand, the variable with the highest correlation was grade achieved in the first math class (regardless of the actual level of the course taken, from developmental algebra to second semester Calculus). In another example of unexpected results, our initial attempts at assessing the efficacy of our supplemental instruction program through statistical analyses uncovered the fact that the background variation in student grades in math courses was very high. Further analysis uncovered that section-to-section variability was so high that it overwhelmed the modest gains achieved by our grant-initiated support programs.

Obviously, these results forced us to re-think the programs we've been developing to achieve our goals. Although we had intended this grant to be largely a programmatic grant not a research grant, *it was research methodology that yielded the most effective results*. In research it's important to rigorously testing fundamental hypotheses (assumptions). In doing so we found that we were off base on some assumptions. While it is true that math is an obstacle for many engineering students (assumption #1), assumptions #2 and #3 concerning student success were not entirely accurate in our particular university context. By providing supplemental support to students in math classes, we were merely nibbling away at the edges of the problem. The factors most influential to student success were outside of the control of the team.

Engage Instead of Persuade

Our early assessment results lead us to re-examine our assumptions and hence, rethink our approach to program development. Additionally, our early assumptions included some un-stated (and untested) components, the most important of which was that the best place to address challenges presented by under-prepared students was by working directly with the students themselves. The research-oriented approach that we used in refining our assessment program led us to consider the possibility of working directly with the faculty delivering the material in an effort to influence the manner in which they were teaching. This is, of course, a much more sensitive and difficult endeavor than developing a supplemental instruction program and we did not even consider this when writing the proposal. Yet, the data seemed clear, if we wanted to increase student success, we needed to engage the faculty who were in the classroom, not just the students who were taking the classes.

Our first major change was within our engineering college, adding a math tutorial component in our introductory engineering class for Calculus level students. More significantly, we redesigned the new introductory engineering class we had just implemented for Pre-calculus level students so that it became primarily a math boot camp.

Also, we re-allocated our time and energies so that we could include new activities intended to engage the mathematics faculty in a meaningful and non-threatening discussion about several topics including the importance and definition of student success in advanced college mathematics classes. To put it in the context of a well-known paradigm[12], we needed to expand our sphere of influence from merely supporting engineering students in math learning to engaging faculty members not funded on the grant and outside the College of Engineering. *Our task became not so much to persuade, as is indicated in the Foundation Model, but to engage.*

Here are some of the ways we engaged the university community to encourage them to develop their own perspectives about the value of our initiative:

- Invited (and paid for) a math professor to teach an Introduction to Engineering class
- Hosted monthly Math Learning Roundtables to instigate discussions among math and engineering faculty, undergraduates, graduate students and academic support staff
- Trained student SI facilitators on how to develop good relationships with math faculty
- Disseminated a plethora of reports and newsletters on campus on math issues
- Forged bonds between math and engineering learning community faculty
- Hosted meetings and coffee breaks with academic support and math department partners
- Held discussions with science departments who had similar student success concerns
- Applied for grants together with math, science and engineering faculty

In retrospect the consistency of the data and the persistence which we showed in engaging the stakeholders was key to making progress. New initiatives continue to be proposed from within the mathematics department that directly address many of the issues that were addressed in various assessment reports from this grant. Some of these initiatives are summarized below.

- The math department implemented a 'restart option' in which students who performed poorly on their first exam could change from Pre-calculus to college algebra (a sub-set of Pre-calculus), even though this occurs after the registrar's drop/add period.

- In fall semester 2007, the math department and College of Engineering began collaborating on a longitudinal study assessing the effectiveness of different teaching methods in Pre-calculus.

- A special 50-student Pre-calculus section for engineering students, taught in the Engineering complex and not in the Math Building, has been piloted. All the students were also in a pre-freshman learning community.

- Active discussions continue among math and engineering faculty about what concepts are most important in Calculus I and Calculus II classes.

Most of the sustained programs have been curricular changes implemented and funded by Boise State academic units – the math department and College of Engineering. Sustaining academic support programs has been more challenging, and these support programs require funding from the university academic affairs level, which has many other priorities. For example, the future of one of our centerpiece efforts, supplemental instruction in math, is on hold. The extensive assessment yielded evidence of success on the part of the participating students, student surveys indicated this was their favored method of supplemental support (as opposed to the traditional tutoring center, going to the professor's office hours, and other methods) and that it boosted their confidence in math. Yet this SI program is expensive (at least $50,000 a year to support Pre-calculus through Calculus II). Still, the tutorial services director is an advocate of this program and the associate vice president for undergraduate studies has already funded training for SI directors and plans to move forward with full-scale SI implementation when funding is available. So given another year, we may be able to report the program was sustained.

Flexibility – the Key to Success

Perhaps the most important role of the project director is allocation of resources and effort. Figure 2 shows the allocation of resources and effort embodied in the initial proposal for our initiative.

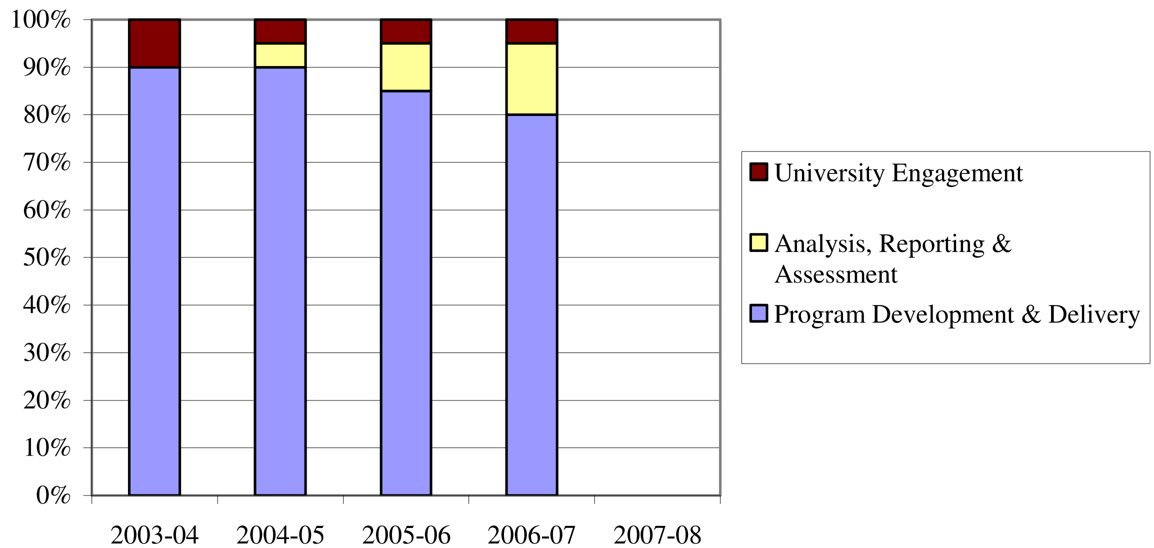

Figure 2: Analysis of the effort distribution in the initial proposal

Effort has been divided into three broad categories:

> Program Development and Delivery – support for faculty, staff and students engaged in the development of delivery of programs listed in Appendix A.
>
> Analysis, Reporting and Assessment – support for faculty, staff and students engaged in carrying out our assessment program.
>
> University Engagement – outreach activities to members of the university community, particularly engineering and mathematics faculty and related administrators.

Figure 3 shows the actual effort allocation, which we derived from retrospective analysis of our annual reports throughout the life of the grant. These figures illustrate how our director capitalized on the flexibility allowed by the granting agency and enabled our initiative to evolve from a programmatic effort to include more research-driven methodology, which we believe yielded greater long-term sustainability.

Note that the effort invested in program development and delivery, the initial focus of the grant, drops steadily from an initial portion of 80% to less than half at the grant's end. Meanwhile, the assessment and reporting portion grows throughout the life of the grant, whereas university engagement, beginning as a small portion consumes nearly one-third of the grant effort at the end of the life cycle. *It is essential to note that the low percentage of effort dedicated to program development and delivery in the fifth year is not because these programs have been discontinued. Rather, due to the investment in assessment and engagement activities, most of the programs have been sustained and are now owned and delivered by permanent staff and departments, rather than by grant-funded staff who have transitioned to other projects.*

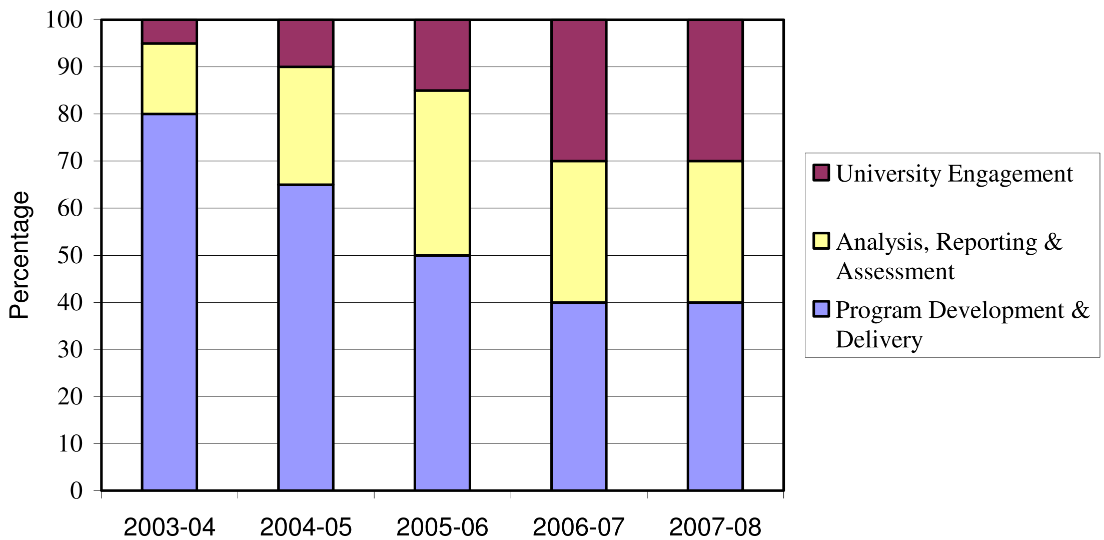

Figure 3: Actual effort distribution of our program development grant

That our granting agency gave us 1) the flexibility to re-think our basic assumptions, 2) permission to re-allocate resources as needed, and 3) adequate time (a no-cost extension for an additional year) to implement complex programs and changes were essential to the initiative's success. It should be noted that not all funding agencies allow for the flexibility that we enjoyed in this particular grant. Re-tasking 30 to 40% of the resources, as we wound up doing, and stretching the support to add a fifth year is often not allowed, or at least significantly discouraged. Yet, as we have discussed, rigorously testing assumptions can yield new directions that were not envisioned prior to the start of the grant.

Putting it all Together – An Enhanced Model

Based on our experience, we propose modifications to the institutional change model described in Figure 1. Figure 4 shows a new flow chart with the features of the model proposed by Clark but with important new features. First, there is considerable activity between the pilot stage and the full scale implementation. In our experience, it was the assessment and subsequent engagement of key members of the university community (some of whom we were not aware were stakeholders before) that forced us to re-think our approach. Typical program development grants do not allow (by time or resources) the luxury of re-thinking the entire program.

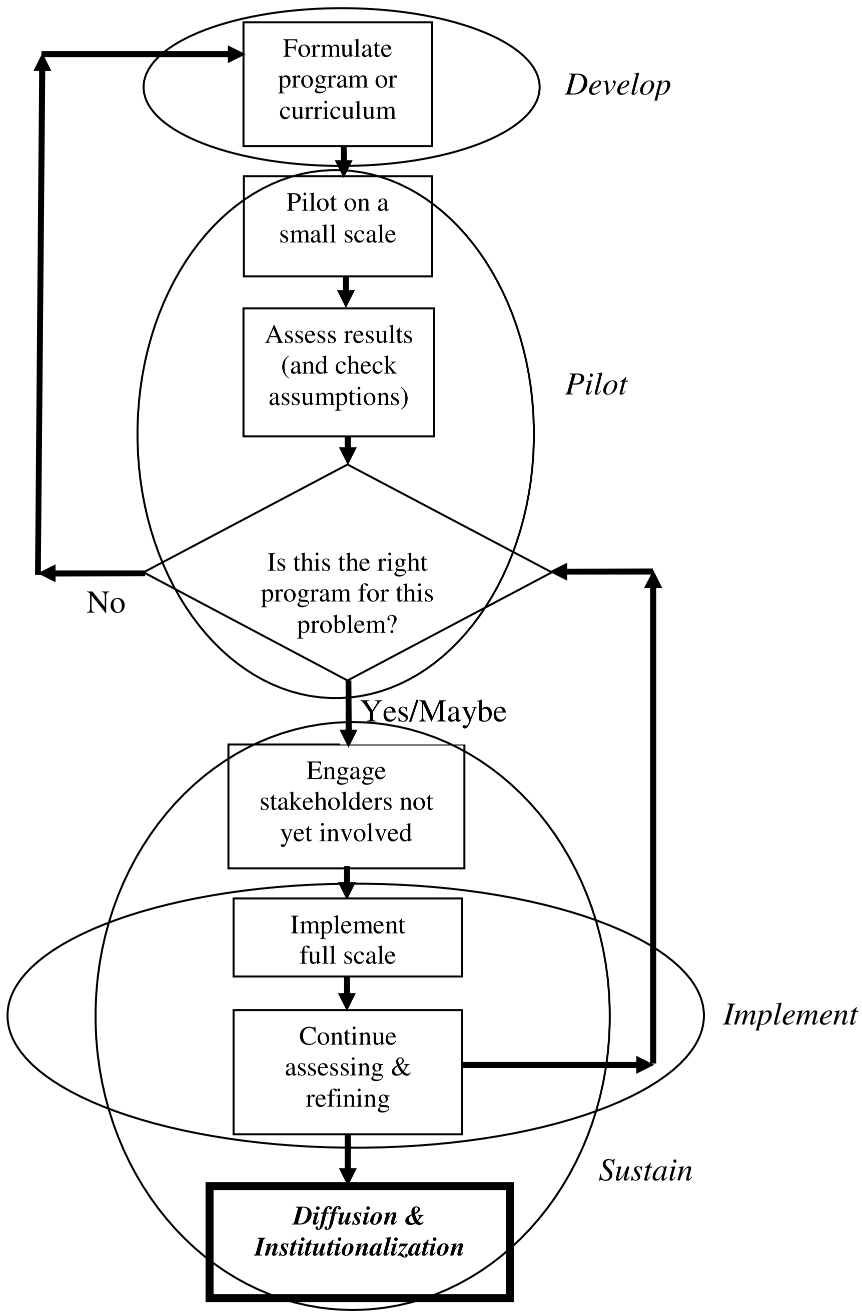

Figure 4: Enhanced change process model

It should be clear that the earlier we discover that the program isn't appropriate, the better – even if it means going back to square one and devising a new program. Once we have confidence that we know what the problem is and we've got a good program, then we can implement on a larger scale. Yet even then, institutionalization is not guaranteed. To keep the program running after the funding has run out, the faculty and the administration must be convinced that the program adds value, so the "Sustain" stage begins as soon as stakeholders are actively involved. In Colbeck's terms, we must engage the cognitive regulatory processes, convincing the stakeholders that the new program is not only a better way, but that other approaches aren't worthy of consideration. Again, our model differs from others suggested by recognizing that this process is enhanced by both time and repetition.

Conclusions and Recommendations

While the experiences described herein represent one program development grant at one school, we believe that the problems (and solutions) we encountered at Boise State University are sufficiently general to bear some discussion. The following features of this grant were essential to the success of the programs:

- The ability (permission by funding agency) to re-direct grant activities in response to assessment data.
- Flexibility in allocating resources.
- Using assessment programs to not only measure programs but to test and expose assumptions.
- Understanding that time matters – institutionalization requires time and repetition of message to fully engage the stakeholders in the institutionalization process.
- Change models should allow for 'branch points' and the ability to respond to the information uncovered by the assessment program.

Based on these features, the following recommendations for future program development grants appear to be in order:

- The standard three-year grant cycle (typically 1 to 3 years) may be too short to allow for institutionalization of the programs developed.
- Funding agencies should be flexible to the needs of the team and allow for re-allocation of resources as the research is carried out.
- The program development team must be open to the possibility that the program in which they have invested their time and energies may not be the correct program for the problem at hand.
- The program development team must be open to the possibility that the problem they perceived at the outset may not be the actual root problem.
- Keep the assessment program running as long as possible. Be consistent and persistent in presenting results, engaging stakeholders and pushing for change.

In closing, we'd like to put our conclusions in the context of budget allocations. Programs are sustained not because the million dollars of the initial grant is replaced with a million dollars from the university budget or another source. Programs are sustained because they have delivered value and engaged faculty and students.

Acknowledgements

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Appendix A – Programs Associated with $1M Initiative at Boise State University

Program	Year	Assessment Method	Institutionalization
INTEGRATED FRESHMAN ENGINEERING CURRICULUM			
New instructional modules in intro class	1-5	Progress analysis Student surveys	Permanent; ongoing continuous improvement
Learning communities	1-5	Not formally assessed	Permanent
In-class advising	2-5	# of students with advisers	Permanent
Elementary teacher education integrated	1-5	Assessment planned	Permanent
Web publication of module curriculum	5	Not yet assessed	Permanent
PRE-FRESHMAN ENGINEERING CURRICULUM			
Intro class for Pre-calc level students	2	Retention analysis Student surveys	Changed to math boot camp
Math boot camp class for Pre-calc level students	3-5	Retention analysis Math success analysis	Permanent
SUPPORT FOR MATHEMATICS			
Supplemental Instruction for Pre-calculus thru Calculus II	1-4	Grade analysis Student survey Factor analysis	On hold; planned when funding becomes available
ALEKS math software in engineering classes	3-5	Grade analysis Math success analysis	As long as it remains a useful tool
Math Learning Roundtable	2	No formal analysis	Temporary program
MATH CURRICULUM			
Pre-calculus re-start class	4-5	Grade analysis	Permanent
Pre-calculus class for engineering students	5	Grade analysis	To be decided
ALEKS math software in selected pre-calc classes	5	Assessment under way	To be decided
STUDENT SUPPORT AND ENRICHMENT			
Freshman/sophomore research internships	1-3	Retention analysis	Limited continuation by Career Center and engineering
Freshman/sophomore industry internships	3-4	Retention analysis	Limited continuation by Engineering College
NSF Scholarships	2-5	Retention analysis Reports to NSF	Continued focus on providing engineering scholarships
Engineering Residential College	2-5	Retention analysis Grade analysis	Permanent and growing
MentorNet	2-5	Student surveys	Continued as long as funding is available
EE Retention program	3-4	Retention analysis	Program ended
Student club support	2-5	No assessment	Ongoing

Appendix A (continued)			
Program	**Year**	**Assessment Method**	**Institutionalization**
OUTREACH AND RECRUITMENT			
Girls high school engineering camp	1-5	Track girls in college Student surveys	Permanent, as long as corporate funding is continued
Hispanic outreach	2-5	Monitor demographics	Via SHPE club
Girls college night	4-5	Student surveys	Permanent College of Engineering event
Middle and high school outreach programs	1-5	Database of student contacts	Permanent