Collaborative Research:
A Comprehensive Pathway for K-Gray Engineering Education

Year 3 Annual Report (Submitted July 28, 2008)

Project Description

Educating the K-Gray engineering community in today's digital world requires straightforward yet flexible access to high-quality educational resources. The goal of this project is to create and steward the *K-Gray Engineering Pathway (EP)*, a premier portal to comprehensive engineering and computing education resources within the greater National Science Digital Library (NSDL), by combining *NEEDS*' (*National Engineering Education Digital-library System's*) expertise in higher education and lifelong learning with *TE's* (*TeachEngineering's*) expertise and experiences in K-12 engineering education.

We envision the *K-Gray Engineering Pathway* as the engineering "wing" of the NSDL serving resource providers and users from a broad spectrum of constituencies: elementary, middle and high schools; two/four-year undergraduate programs; graduate and professional schools; and lifelong learners. Key stewardship goals of the *K-Gray Engineering Pathway* are to merge *NEEDS* and *TE* into a unified *K-Gray Engineering Pathway*, to significantly and sustainably grow the *K-Gray Engineering Pathway,* to align *EP*'s curricula with appropriate undergraduate or K-12 educational standards, to increase the number of *EP* content providers and users, to develop and implement interoperable quality control and review protocols for all *EP* content, and to create a nonprofit strategy and partnership for sustaining the *K-Gray Engineering Pathway*.

Project Goals, Findings for Year 3 (Oct 2007-Sept 2008)

EP substantially grew its user base, content and functionality in Year 3. Our disciplinary pages are typically in the top 10 for all major ABET disciplines under both a Google and Yahoo search. We have initiated several sustainability models that will be tested and evaluated in Year 4.

A major redesign of the *EP* website was initiated in Year 3, based on the Year 2 evaluation feedback and preliminary results from the National Academy of Engineering (NAE) study titled *Changing the Conversation: Messages for Improving Public Understanding of Engineering*. As a member of NAE's Committee on Public Understanding of Engineering Messages and co-author of the report, Jackie Sullivan worked with the *EP* team to develop a redesigned website to more effectively communicate the role, importance, and career potential of engineering to a variety of audiences, including engineering and computing faculty and students, as well as school children and their parents, teachers, and counselors. It was originally hoped that the thumbnail images used in the *EP* catalog records could be used as part of this redesign effort. One major finding was that most of the engineering images used in EP, and the related resources, were of technology and not people, whereas the NAE study emphasized the importance of displaying diverse people engaged in exciting engineering activities. In order to increase the pool of engaging images and related resources, a six-month competition for compelling messages and images was launched and advertised at professional society meetings with engineering education audiences. Voting was conducted on the EP blog launched in Year 3 as well. As a consequence the redesign took more time than expected and some of the tasks involving our public relations efforts were delayed. On the other hand, other tasks involving site functions were accomplished earlier. Although this caused a delay in our sustainability goals, we believe it will strengthen our

position next year as we now have more in-depth community resources and services that are designed to appeal to different professional societies, publishers, industry and other funding sources.

Another major finding that came out of our evaluation studies was that users had trouble finding the resources they wanted based on a simple keyword search. Very few users took advantage of the Advanced Search features. As a consequence we redesigned the site to expand the simple search on every page to include Grade/ Audience level. The search on all main pages also includes Learning Resource Type. We tailored many of our features for K-12 versus Higher Education users. We also added disciplinary and interdisciplinary pages to tailor the search and resources for different communities.

Recent evaluation studies have shown that our strength is a consistent interface with strong usability features. We are valued for our quality content that is well defined in terms of engineering and computing education. Our users value "precision" in a search over "recall". This justifies our emphasis on evaluation criteria and our review processes. In year 3 we worked hard to develop evaluation criteria, prune current resources and add to our quality content. Details are summarized by major project goals below.

Project Goals, Activities for Year 3 (Oct 2007-Sept 2008)

1. Goal 1: Merge NEEDS and *TeachEngineering* to form the *Engineering Pathway*

Year 3 Combined Objectives: Merge advanced services; user testing to refine services to all engineering-related NSDL grantees.

- Completed redesign of *EP*. The new "swoop" logo represents the many paths of engineering in a colorful, dynamic, flowing pattern. The photographic images were selected through a six-month competition to capture the excitement and diversity of

engineering and computing education and practice. Taglines were selected for the different audiences within *EP*. The homepage and general tagline is: *Turn Ideas Into Reality – Learn, Connect and Create*. The K-12 pages communicate aspirations for the future: *Shape the Future – Dream. Design. Do*. The Broadening Participation tagline motivates professional development and personal goals: *Make a World of Difference – Dream Big. Love What You Do*.

- Improved usability features were added to *EP* based on evaluation studies. For example, all main pages highlight a simple search that includes Keyword, Grade/ Audience and Learning Resource Type. All other pages have Grade/ Audience and Keywords in the upper banner. A *First Time Users* page with FAQs was added.
- Translated all new functions developed in Years 1-3 into new redesign, including search, browse, monthly themes, statistics, search, login and interoperability with NSDL. *EP* continues to be the only Pathway and NSDL grantee to have a working single sign-in with the NSDL.
- Highlighted resources were added under the left navigation menu: Editor's Choice, 100 most popular, Premier Award Winners, 100 most commented, recent submissions and a general search page on user statistics.
- Created and released a revised catalog website for Engineering Pathway K-12 resources. We limited cataloguing to a subset of the learning resource type (LRT) options available to higher education catalogers, chosen because they were more useful to K-12 educators. The resulting search page also reduced the number of optional categories available for new catalog records in order to simplify the cataloging process for users. Users are also provided with an online LRT glossary and review requirements document.
- Created and released a revised catalog website for partner collections. Some are private; others can be cataloged by any registered user (e.g, *EP*, *International Journal of Engineering Education* and *Advances in Engineering Education*).
- Updated K-12 *EP* web pages current and more robust: *K-12 Resources*, *Research Findings*, *Professional Development*, *Publish Your Curriculum*, and *Broadening Participation*. To the *Curricular Resources* page added information about JETS and their monthly newsletter, under “Our Favorite K-12 Engineering Collections".
- Updated Higher Ed *EP* web pages to include more recent events, Gordon Prize winners, disciplinary communities, engineering students and engineering competitions.
- Implemented Google and Yahoo hit-rate improvement strategies, resulting in *TE* appearing higher in the search results rankings for a variety of pertinent search strings. Almost all of the *EP* educational disciplinary pages show in a top 10 hit on both search engines.
- Provided the capability to search *EP* whenever a *TE* search is requested.
- *TE* upgrading IEEE_LOM metadata format to include a representative image.

2. Goal 2: Stewardship and Growth of the K-Gray Engineering Pathway

Year 3 Combined Objectives: Ingest K-16 content from NSDL and other providers
Year 3 Higher Education Objectives: Add 10 ABET exemplars.
Year 3 K-12 Objectives: Complete and test Living Labs; increase TE content by 25%

Year 3 Goal 2: Integrated K-Gray Activities

- *EP* has gone well above our goals in the growth of resources. A summary of the resources in *EP* is provided below by collection. Note that the ACM-Women collection became smaller after implementing quality control on the existing records.

EP Collection	Year 2	Year 3
ACM Women in Computing	1, 019	867
Advances in Engineering Education (AEE)	0	8
Broadening Participation in Computing (BPC)	16	315
Center for Sustainable Engineering Electronic Library (CSEE)	0	14
International Journal of Engineering Education	56	112
NEEDS – National Engineering Education Digital-library System	5,950	9,004
Pr2ove-it	547	547
TeachEngineering	635	685
Tomorrow's Professor	440	849
VaNTH Bioengineering, Biomedical ERC	52	54
Total	**8,715**	**12,455**

Year 3 Goal 2: K-12 Activities

- Our K-12 goal for increasing the *TE* collection content by the end of Year 3 was to have published 225 hands-on engineering lessons and 408 activities, providing content in 41 curricular units. As of the end of the third quarter (June 30, 2008), we had exceeded these goals for publishing new lessons and activities — the real "meat" of the *TeachEngineering* collection — by publishing 243 lessons and 442 activities, although aggregated into 36 curricular units (as opposed to the originally proposed 41). A sample of topics: biomedical engineering, bridges, weather and atmosphere, designing shoes, designing Viking ships, product development, energy-efficient housing, rivers, spectroscopy, etc. We are on target to add two additional units in the fourth quarter (each containing three lessons and three activities): a three-lesson middle school unit on cells and a third-grade unit on the physics of music.
- K-12 curricula were created by new external contributors, including Oregon State University's NSF-funded Rural Science Education Program, the University of Colorado at Boulder's Laboratory for Atmospheric and Space Physics (a NASA-funded program), and University of Virginia's Biomedical Engineering. We also worked this year with people at University of Maine at Orono, Drexel University and Vanderbilt University, from which we expect additional contributions to *TE* during the fourth quarter.
- Conducted a *TE Publishing Workshop* for NSF GK-12 engineering graduate student Fellows at Drexel University as they prepare their K-12 engineering curricula for

publishing in *TeachEngineering*. Their feedback led to improvement of online instructions and tools provided for external contributors via the *Submit Curriculum* website page.

- Completed the *Wind Energy Living Lab* framework. Integrated three years of wind data (speed, direction, temperature, pressure, etc.) from hundreds of US sites (from every state) into a GUI that combined Google maps with interactive links to access specific durations and types of data. Access to this US data is now middle and high school student friendly. The data are static (using purchased 2000-03 archived data) and reside in a database.
- Year 3 *Water Living Lab* development focused on real-time data harvesting from the USGS information website. Initial efforts to mine the entire website and keep a database of all their information (with a regularized mining schedule) proved too challenging due to too much data). Switching to an "on demand" search of USGS data per user request via the Water Living Lab is working well, and we are 50% complete with this task.
- On track to complete a tool to mine Water Living Lab data, as well as perform an editorial clean-up of the Wind and Water Living Labs.
- Established a relationship with Vanderbilt University's Research Experiences for Teachers (RET) Program to publish curriculum written by teachers in that program who are taught to use *The Legacy Cycle* method of instruction for creating curricular units. Aided Vanderbilt to use the *TE* templates to describe *The Legacy Cycle* when writing curricula. Their feedback led to an enhancement of the *TE* curricular unit template. During the 2007-08 academic year, all RET teachers used the *TE* lesson and activity templates when creating curricular units. During summer/fall 2008, Vanderbilt published on *TE* a unit with eight K-12 engineering lessons and four activities from this work.
- Working with NSF Engineering Education and Centers Division to sponsor an October 13-14, 2008, grantees conference in Colorado to bring together the ~24 current and past engineering GK-12 projects. One anticipated outcome is the publishing of a great amount of mothballed GK-12 engineering curricula, further growing the digital libraries.

Year 3 Goal 2: Higher Ed Activities

- Increased Higher Ed collection by 50%.
- Added new collection in partnership with ASEE (American Society for Engineering Education): *Advances in* Engineering Education (AEE). This new collection highlights significant advances in instruction, pedagogy, technology and assessment that substantially improve learning in the broadest sense.
- Added new collection: *Center for Sustainable Engineering Electronic Library (CSEE)*. CSEE is a partnership of Carnegie Mellon University, the University of Texas at Austin, and Arizona State University established the Center for Sustainable Engineering in 2005, supported by the National Science Foundation and the Environmental Protection Agency.
- Expanded the *Pr2ove-it* collection with the National Academy of Engineering to include intervention factors, outcomes assessment, evaluation and study characteristics. EP now hosts the *Pr2ove-it* collection both from within *EP* and as a standalone collection.
- In addition, *EP* has grown the number of special topics associated with the Engineer 2020 project, integrated research and education centers and other targeted topics. See these special topics in our browse page at: http://www.engineeringpathway.com/ep/browse/series/

- Increased number of cataloged ABET Self-Studies to 45. Ensured that the items collected as ABET self-study examples are indeed exemplars through the use of an informal rating process that requires a certain minimum set of ABET report items be included in the candidate self-study. The process and the minimal set of items will be formalized once reviewed by our ABET partners.
- Experimented with and observed steps performed by users who are requested to seek out ABET related materials in order to help refine the ABET related metadata fields and the way in which the metadata is associated with resources.

3. Goal 3: Align Curricular Materials with Appropriate ABET or K-12 Standards

Year 3 Higher Education Objective: 75% of ABET-aligned metadata.
Year 3 K-12 Objectives: Integrate K-12 state standards correlation; test K-12 STEM standards for initial 10 states.

Year 3 Goal 3: K-12 Activities

- Added standards alignment information to the *TE* metadata.
- Solidified a partnership with JES & Co.'s Achievement Standards Network (ASN). *TE* now receives regular updates of the ASN standards database and are working on automatically integrating these updates into our systems.
- All *TE* curricula are periodically aligned with educational standards using the Center for Natural Language Processing's (CNLP) CAT (Curriculum Alignment Tool) and SAT (Standard Alignment Tool) services.
- Started working with WGBH's standards cross-walking web service, and hope to add its results to those of SAT so that *TE* has another base for standard-curriculum alignment.
- Through integration of the ASN, CAT and SAT services the *TE* curricula are now implicitly aligned to all 50 states' K-12 science, math and technology standards. With this new version, *TE* is able to support new content contributors with curricula meeting the educational standards from any state. This version is groundbreaking; it expands the four-state (CO, MA, NC, OK) coverage of *TE* to all 50 states. As a consequence, we're expecting rapid growth of the collection contents in the next year.
- Integrating ASN, SAT and CAT into *TE* started with a comparison study of SAT and CAT performance relative to Academic Benchmarks — a private, for-pay alignment service — using a sample of *TE* curriculum documents. The results were sufficiently positive that we decided to integrate ASN, SAT and CAT into *TE*.
- Relying heavily on CNLP's SAT and CAT web services, we applied a "mining" approach; i.e., all *TE* documents are periodically submitted to CAT for alignment and the science and math standards of all states are aligned to those of all other states. Because of the size of this problem — approximately $85{,}000^2$ — SAT alignments run daily for a period of eight hours. More than 20M alignments have been collected so far. During this process, *TE* provided a great amount of feedback to the CNLP people, helping them to stabilize and optimize their services.
- The user interface was modified with facilities to browse and search (full text search) the complete ASN, and software was written for automatic integration of new ASN issues into the *TE* system. Other user interface extensions cover searching the collection by educational standard. Conducted various internal university and external teacher

evaluations test and refine the new ASN-educational standards-based *TE* system version before implementation in late Year 3.

- Creation of the final ASN-based version of *TE* included a weighted algorithm to manage all the different correlation/alignment sources results.
- Analyzed how a non-randomly selected, small group of *TE* afficionados judge the adequacy of a test set of document-standard alignments. The results show that a reliable model of overall relevance can be built (75% explained variance), but that significant variation in relevance aspects that do not map to overall relevance remains. Results presented at the June 2008 *Joint Conference on Digital Libraries* (see citation, below). The data enable a relatively precise evaluation of the recall and precision of CAT- and SAT-based curriculum searches. Additional and experimentally controlled data collection will take place in late summer 2008.
- We recognize the following organizations and people for their help in *TE* educational standards correlations: JES & Co. for working with us and making ASN available, and their willingness to fix errors and bugs (Bruce Walker and Diny Golder); and Center for Natural Language Processing (CNLP) for all their SAT/CAT work and responsiveness to error reports, and generosity in permitting us to use their tools and results (Anne Diekema and Jennifer Bailey).

Year 3 Goal 3: Higher Ed Activities

- Went well beyond goals. All of the Higher Education resources have been aligned to general ABET disciplines and criteria. Also all new resources are aligned to Pr2ove-it interventions, where appropriate. Presented conference paper for ABET-alignment titled: "ABET Alignment of Learning Resources in the *Engineering Pathway* Digital Library".

4. Goal 4: Grow Participation

Year 3 Combined Objectives: Analyze initial marketing results; implement Phase 2 of marketing plan; test and refine content provider GUI.

Year 3 Higher Education Objectives: Host initial ABET series workshop; expand communication plan with all engineering professional societies; offer targeted usage workshops.

Year 3 K-12 Objectives: Offer targeted usage workshops.

Year 3 Goal 4: K-12 Activities

- Provided a text field option for EP K-12 catalogers to note K-12 educational standards addressed by their resource(s). This allows cataloguers who have created resources that meet specific standards to identify those standards; the text field provides limited search capability, and may allow for later enhanced standards alignment EP features.
- Conducted a 90-minute *TE Publishing Workshop* for ~10 Drexel University engineering graduate student Fellows in Philadelphia, preparing them to publish their extensive GK-12 curricula in TE.
- On October 13-14, 2008, will conduct a two-day grantees conference for the ~24 NSF engineering GK-12 projects in Boulder, CO. The conference includes an instruction on how to use the TE resource, writing quality K-12 engineering curricula, the review process, the engineering message, and how-to publish curricula in TE, as well as exploring offering

TE professional development and long-term ownership and sustainability issues.

- *Testimonial:* Susan Pruet, Program Director of the Mobile Area Education Foundation, is working with middle school math and science teachers to implement TE curricula in Mobile (AL) schools. She learned about *TeachEngineering* at the spring 2007 NCTM conference, is impressed with caliber of the materials, and has been accessing TE curriculum regularly since then. They conducted their own workshop to prepare teachers to implement several TE units. Susan said they are using TE curricula as "one strategy to engage K-12 students around engineering as a 'hook' to getting them into taking the math and science needed for our ever-growing technology-dependent jobs in the Mobile area."
- *Testimonial:* Quote from Mary Beth Horton who was referred to the online *TeachEngineering* collection: "Thanks so much for making me aware of the '*TeachEngineering'* collaborative effort. To say I was WOW'd by the depth and breadth of the curriculum effort is an understatement! This will be an exceptional resource both for our volunteer engineers as they prepare for their classroom visitations, as well as educators." Mary Beth is deputy director of Business Education Compact (www.becpdx.org) in Beaverton, OR, an organization that connects the classroom and workplace with hands-on, innovative learning experiences for K-12 students and teachers. They arrange for hundreds of engineers to share their stores with kids and create excitement for the field.
- *Testimonial:* As the science specialist and magnet coordinator at Grantham Academy in Houston, TX, Deena Logan integrates four strands of engineering — civil, mechanical, biomedical and chemical — into core subject areas. She was led to *TeachEngineering* by an engineer at Texas A&M in Bryan, TX. She tells us, "The lessons are so well written and match many of our benchmark targets in our district and our national standards for math and science in Texas." She plans to use several of the lessons at her middle school — and become a volunteer *TeachEngineering* reviewer of new curricula.
- *Testimonial:* Eugene Rutz from the University of Cincinnati partnered with an all-girls high school in Cincinnati to teach an engineering course; he regularly obtains about 25% of his teaching curricula from the *TeachEngineering* digital library. Eugene designed a junior and senior course that introduces several engineering disciplines through modular-based, project-centered pedagogy. Twelve of his 23 female students from one school went on to engineering college this year.

Year 3 Goal 4: Higher Ed Activities

- Developed and deployed a new "Events in History" database to highlight important events in technology that could be linked to *EP* educational resources. The database is complete for the months of November through July. August and September will be completed in the fourth quarter of Year 3 and October in the first quarter Year 4.
- An *EP* blog was developed and deployed to further expand community participation. Most of the blog authors focus on an event in history as the starting point for the discussion. Guest bloggers include representatives from professional societies and industry. For example, the July 22 blog is from the Microsoft archivist Amy Stevenson – *Engineering Education "Today in History": Gates and Allen License Basic.*
- Expanded database-driven website of engineering professional societies. The database is organized by age and audience (K-12, student, professional pages) as well as discipline.

- Advertised *EP* digital library at major engineering education meetings: Frontiers in Education, 2007 and American Society of Engineering Education, 2008. Developed and distributed PR flyers of *EP* and NSDL. EP was also advertised as part of a full page ad in the November issue of the ASEE Prism and as half page ad in the March issue of the Prism.
- Expanded Higher Ed Disciplinary Communities with Associate Editors. There are currently 29 disciplinary communities for each major ABET-accredited computing and engineering disciplines. We also initiated 3 Interdisciplinary Communities: Engineering Diversity, Computing Diversity and Design. *EP* currently has 38 Associate Editors. See: http://www.engineeringpathway.com/ep/community/index.jhtml
- Working with the NSDL CI, we held a workshop on June 24, 2007 with general ASEE and ABET participants and the Associate Editors. Another online workshop is scheduled for August 2008.
- Held initial discussions with managers at HP to determine how *EP* may cooperate in cataloging and disseminating educational materials currently on the Tablet PC web site and how this may support sustainability efforts.

5. Goal 5: Develop and Implement a Quality Control / Review Process

Year 3 Combined Objectives: Increase number of reviews by 50%.
Year 3 Higher Education Objectives: Conduct annual higher education Premier Award.
Year 3 K-12 Objectives: Conduct inaugural K-12 Premier Award.

Year 3 Goal 5: Integrated K-Gray Activities

- All new *EP* resources are reviewed for quality, using separate criteria for K-12 and Higher Ed.
- All *EP* resources are checked for bad links twice a week. Those with questionable links are annotated with "Link to resource may not be available". It turns out most of the links are only temporarily down. Some sites are down for maintenance on the weekends, for example. Those with consistent bad links over a month are either corrected or de-accessioned.

Year 3 Goal 5: K-12 Activities

- Established a review process for incoming, newly catalogued EP K-12 resources, using existing grant partners and graduate students to evaluate based on the new criteria.
- Reviewed all *EP* K-12 catalog records submitted prior to June 2007 (most were originally from NEEDS) to ensure they met the revised requirements for quality, engineering connections and grade band appropriateness. We retained only those resources with a clear engineering connection, reducing the resources teachers must sort through to find K-12 engineering content. Of the 1,205 initial resources, 545 were removed for not meeting the K-12 criteria for an *EP* metadata record; many were resource types that were not utilized within the new K-12 framework; 427 of these continue to be searchable as an *EP* higher education resource as they were determined to be appropriate for a general public audience. An additional 118 were removed from the collection by making them “not searchable;” many of these were broken links or resources that were not engineering resources.

- To standardize the review of submitted *TeachEngineering* curricula, created three quality review rubrics — one for overall K-12 content, another for engineering content (based on the Engineering Habits of Mind), and a third for depth of engineering found in the hands-on activities.
- Solicited volunteer engineer and teacher curriculum reviewers for the inaugural National Board of *TE* Reviewers using an online website form. Three reviewers, an engineer and two teachers, each offered five hours of their time per month. In mid-May, they were assigned to review hands-on activities in preparation for publishing in the *TE* digital library, as a pilot of our new review process. They were provided rubrics from which to evaluate the curricula's quality, completeness and engineering content.
- Defined a new categorization of *TE* activities by their approach to integrating engineering as a way to help users understand what is available to them in the digital library. These categories are not meant to be rankings of the quality or value of the activities in any other sense. They include: relating science or math concept to engineering, providing engineering analysis or partial design, and engineering design. Began to explore the best way to communicate this feature into our tagging, search and user interface systems.
- Developed criteria and solicited submissions for the inaugural *Premier Curriculum Award for K-12 Engineering*. See details at the Engineering Pathway submission portal web page at: http://www.engineeringpathway.com/ep/k12/k12_PAW/2008/;jsessionid=511X5VYEQ12NHABAVRSSFEQ. Marketing and promotion included announcements in February at the 2008 International Technology Education Association (ITEA) conference in Salt Lake City, and in June at the 2008 ASEE conference in Pittsburgh, as well as ASEE K-12 Workshop registration packet flyers, session flyers, K-12 Division business meeting announcement, postcard mailings, a *Prism* ad, numerous e-mailings, e-newsletters and website pages. The submission deadline is October 15, 2008. Finalists will be selected and notified by December 1, 2008. Winner is selected and notified by February 28. The winning and finalist curricula will become part of the Engineering Pathway and *TE* digital libraries. The prize includes a $1,000 cash award. The winner will be announced at the 2009 NSTA conference in Boston, and the award presented at the 2009 ASEE conference in Austin.

Year 3 Goal 5: Higher Ed Activities

- The Premier Award Jury met and the Premier Award 2007 was announced and presented at the October 2007 Frontiers in Education conference. The 2007 Premier Award for Excellence in Engineering Education Courseware was awarded to *Arcade: Interactive Non-linear Structural Analysis and Animation*, by Kirk Martini of University of Virginia. The Finalist Candidates awarded this year are *Jeliot 3* and *JFLAP*.
- The 2007 Premier Award reviews for the winner, finalists as well as the non-winner nominations have been added to *EP*.

All new Higher Ed resources are reviewed through out RSS feed of new resources using established ingestion criteria.

- Disciplinary Associate Editors have created "Editor's Choice" reviews of their picks for

top resources.

6. Goal 6: Create a Nonprofit Strategy and Partnership for Sustainability

Year 3 Combined Objectives: Implement initial business plan components.
Year 3 Higher Education Objectives: Implement pilot web services professional society portal with ASME and ACM and evaluate.
Year 3 K-12 Objectives: Implement initial business plan components.

Year 3 Goal 6 Integrated K-Gray Activities

- Worked with NSF-CISE and ACM to develop a Broadening Participation in Computing Collection. One business model is to charge new collections a fee that gets included in the initial grant.

Year 3 Goal 6 K-12 Activities

- Pursued a conversation with IEEE representatives to explore long-term partnership ideas. At this point, IEEE is focused on establishing K-12 engineering lessons that are not educational-standards aligned, and making them available in many languages (20), so an *EP* or *TE* partnership is not a high priority to them at this time.
- Discussed partnership opportunities with Curriki but became disillusioned when their goal was merely to "scrape" *TE* and not invest in future development.
- At the October 2008 GK-12 engineering grantees conference we will sponsor, we hope to uncover opportunities for several new partnerships with past and current GK-12 institutions, and explore potential partnerships with the Engineering Education and Centers Division of NSF for *TE* and *EP* to play a more prominent role as publication avenues for division-wide grants.

Year 3 Goal 6 Higher Ed Activities

- Took over the *Pr2ove-it* collection for the National Academy of Engineering and received a modest fee to cover the costs. This fits into the business model of a fee for initiating new collections.
- Working with NSF-CCLI to develop a CCLI collection. To initiate the process a CCLI special topic has been formed. One funding model is to provide host services for NSF educational program areas. Joe Tront will be participating in the CCLI workshop on August 14-15 2008 in Washington D.C.
- Developed a value-added model for publishers of engineering and computing textbooks. Prototyped developed, deployed and tested in Spring 2008 with the John Wiley text: *Engineering Design: A Project-Based Introduction*. The student version has the outline annotated with keywords and links to EP resources. See: http://www.k-grayengineeringeducation.com/index.php/2007/01/10/engineering-design-a-project-based-introduction/. The educator's page has course websites using the text, along with sample exams and problems. See: http://www.k-grayengineeringeducation.com/index.php/2007/02/10/engineering-design-a-project-based-introduction-educator-page/**.** Both Wiley and other publishers are interested in this model and we are currently exploring a financial arrangement as a business model. Another demo will be developed with another publisher as well. The publisher value-added model will be

a major focus for our sustainability plan in Year 4.

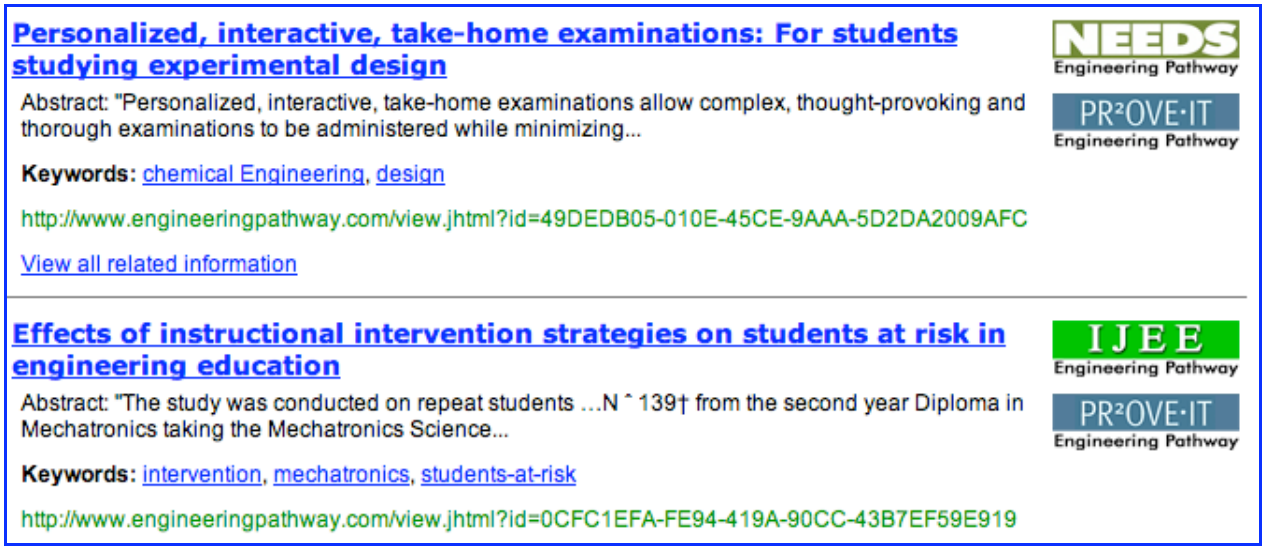
- MS report on EP business model completed. Conclusion that the publisher value-added model, along with service collection fees were the most promising directions.

7. Goal 7: Core Integration

Year 3 Combined Objectives: Expose metadata with educational extensions; update and implement revised MOU.

Year 3 Goal 7: Integrated K-Gray Activities

- Participated in conference calls, reviews and meetings of the CI/ NSDL. Made recommendations for metadata.
- *EP* added selected Events in History to the NSDL Expert Voices blog.
- Added three metadata formats to the *TE* OAI server (needs_lom, standard dc and TE_internal).
- NSDL and *EP* continued successful harvesting of the *TE* metadata. Several other groups and organizations, for example, "OER Commons," routinely harvest *TE* and *NEEDS* metadata from NSDL.
- *EP* added sets to its OAI server, along with co-branded logos for each of its collection. This added 2,457 new records to the NSDL NDR. These new collections are now available at NSDL.org through the Protocol for Metadata Harvesting (OAI-PMH) Version 2, development by the Open Archives Initiative: *ACM Women in Computing Advances in Engineering Education Broadening Participation in Computing Center for Sustainable Engineering International Journal of Engineering Education Pr2ove-It (National Academy of Engineering) Tomorrow's Professor Mailing List VaNTH ERC for Bioengineering Educational Technologies.* The new collections are co-branded with *EP* on the NSDL repository (NDR). See example search on the NDR below with co-branding with NEEDS, *P2ove-it* and *EP*. For other new collections see: http://nsdl.org/browse/?subject=New



8. Goal 8: Dissemination

Year 3 Combined Objectives: Mass marketing; PR; usage workshops.

Year 3 Goal 8: Integrated K-Gray Activities

- Provided *TE* and *EP* brochures for NSDL distribution at meetings and conferences.
- Journal publication: Hey, J., C. Newman, J. Sandhu, C. Daniels, and J.-S. Hsu, and A.M. Agogino, "Designing Mobile Digital Library Services for Pre-Engineering and Technology Literacy", *International Journal of Engineering Education*, Special Issue on Mobile Technologies for Engineering Education, Vol. 23 (3), pp. 441-453, 2007.
- A feature on *TE and EP* was published in the ASEE *Prism* magazine, "Click. Build. Learn: A Digital K-12 Engineering Curriculum Expands with an Emphasis on Quality and Fun," Teaching Toolbox, in September 2007.
- October 2007 presentation on the aspects of quality courseware development, illuminating the Premier Award quality criteria was given by Tront to the over 400 participants at the Premier Award luncheon at the Frontiers in education conference.
- November 2007, ASME Congress 2 papers on EP presented and published in the proceedings:
  - Datta, E. and A.M. Agogino, "Mobile Learning and Digital Libraries: Designing for Diversity", 2007 (ISBN 0-7918-3812-9).
  - Wu, J.-L., and A.M. Agogino, "ABET Alignment of Learning Resources in the Engineering Pathway Digital Library", 2007 (ISBN 0-7918-3812-9).
- Conducted a 90-minute *TE Publishing Workshop* for ~10 Drexel University engineering graduate student Fellows in Philadelphia, preparing them to publish their curricula in TE. From their feedback, initiated changes to our templates and instructions for new contributors.
- Presented a *TE* poster at the K-12 Session of the yearly IBM University Day in Research Triangle Park, NC on October 30, 2007.
- At the November 2007 NSTA regional meeting in Denver, presented a Friday-evening exhibit booth and a Saturday-morning *EP K-12 / TE* workshop, "Using *TeachEngineering.org* — A Free Teacher Resource," for science teachers.
- Presented a 50-minute session on *TE* to an enthusiastic audience of teachers at the February 2008 International Technology Education Association (ITEA) in Salt Lake City. Also announced the inaugural Premier Curriculum Award.
- Conducted a 50-minute workshop, "Making Science Real with the Free *TE* Resource," at the March 2008 annual NSTA Conference in Boston, and staffed the NSDL Pathways booth.
- At the June 2008 American Association for Engineering Education, announced the Premier Curriculum Award and invited submissions at the Saturday K-12 Engineering Workshop and the Tuesday evening K-12 Division business meeting.
- Towards creating a partnership with the Boston Museum of Science to become the western US professional development providers, ran an inaugural Engineering is Elementary Workshop in Boulder. Several additional Engineering is Elementary Workshops were conducted by co-PI Martha Cyr in Worcester, MA, during summer 2008. All workshops were promoted on the EP professional development resources page.
- To promote *EP*, contributed brief articles highlighting EP K-12 resources for the monthly JETS' (Junior Engineering Technical Society) *PreEngineering Times* online newsletter

during the 2008-09 school year. Also provided a *TE* activity write-up for the JETS E-Week poster.

- Provided numerous K-12 engineering activity curricula write-ups from *TE*, for ASEE's revamped online *Go Engineering* monthly newsletter, which now provides K-12 engineering activities for teachers.
- Gave Eric Mann of the College of Education at Purdue University permission to include our *TeachEngineering* work in his K-12 engineering presentations for the November 2007 Gifted Education Research Institute (GERI) National Association for the Gifted Conference.
- Developed and hosted a joint *TE* and the Center for Natural Language Processing (CNLP) CAT/SAT poster for the NSDL Pathways annual meeting, highlighting our collaborative work on educational standards alignments.
- Agogino introduces *EP* in Presidential Talk at Northwestern University, "Educating Engineers for a Flat World: Implications Across the Academy," April 22, 2008.
- CDs containing the Premier Award winners, the finalist candidates, the Premier Award criteria and guidelines for developing quality courseware were distributed. Five hundred CDs were distributed at the 2007 Frontiers in Education conference; three hundred were sent to each of the engineering deans on the ASEE Deans Mailing list; 180 CDs were distributed at the ECE Department Heads Association meeting in April; approximately 200 CDs have been distributed at various other national and international conferences and workshops; over 200 CDs have been sent to faculty and students who have requested them through the EP web site.
- Reitsma presents paper titled, "Exploring Educational Standard Alignment: In Search of 'Relevance,'" was presented at the *Joint Conference on Digital Libraries* in Pittsburgh in June 2008.
- Agogino and Smith hold an interactive session the *Joint Conference on Digital Libraries* in Pittsburgh in June 2008. The session focused on *EP* and its *Broadening Participation in Computing* collection.
- Tront presented session on *Using Educational Digital Libraries* at the Indo-US Engineering Faculty Leadership Institute in Mysore, India, June 2008.
- Agogino presented two sessions on *Using the Engineering Pathway* at the Indo-US Engineering Faculty Leadership Institute in Mysore, India, July 2008.
- Agogino is working with ASME to launch the Design Interdisciplinary Community at the August 2008 Design Engineering Technical Conference in New York.
- Joe Tront will be participating in the CCLI workshop on August 14-15 2008.
- On October 13-14, 2008, will be conducting a two-day conference for the ~24 NSF engineering GK-12 PIs in Boulder, CO. The conference includes an instruction on how to use the TE resource, writing quality curricula, the review process, the engineering message, and how-to publish curricula in TE, as well as exploring offering TE professional development and long-term ownership and sustainability issues.

9. Goal 9: K-Gray Engineering Pathway Evaluation

Year 3 Combined Objectives: Selected evaluation tasks; NSDL-wide evaluation; Advisory Committee meeting.

- Improved the filtering mechanism for the rudimentary *TE* user metrics to obtain "clean hits" and more easily run monthly reports. During the 12 months preceding this report (July 07-June 08), the *TE* digital library website received 413,235 hits (average of 34,436 per month) from 60,214 different IP addresses, for an average of 6.86 hits per IP address. These numbers reflect "clean" hits, that is, the reported visits do not include any hits from the partnering institutions, testing or experimental events. These numbers also do not include any visits by harvesting and data mining robots, e.g., googlebot, msnbot, inktomi, NSDL metadata harvesting, Engineering Pathway, etc. Also, these numbers include only "serviced" pages (e.g., searches, document renderings, etc.); they do not include any isolated requests for non-rendered documents or images. Of note is that during seven of the 12 months, the NSDL search IP was the largest hitter, bringing in 3.30% of the hits for those months.
- *EP* website continue to enjoy linear growth in its user base. It was at close to a million hits for the month of June 2008 and over 300,000 page requests. One-third of the visitors arrived at *EP* through search engines.
- Maintained and posted web statistics at: http://stats.smete.org/full/
- Participated in the NSDL Omniture webtracking program.
- During the Fall 2007 semester a team of five graduate students in Nancy Van House's Berkeley information systems course conducted a *TeachEngineering* / *Engineering Pathways* K-12 user needs and usability project. From teacher feedback described in the final 40-page report delivered in April 2008, many user interface changes have been made or are under review. Note: the previous year the same class did a review of *EP* Higher Education resources thatled to significant improvements in the *EP* site.
- The National Academy of Engineering's K-12 Engineering Education Committee is conducting an in-depth analysis of K-12 engineering education materials. Their review includes evaluation of the *TeachEngineering* digital library [in progress].
- Conducted numerous internal university and external teacher evaluations towards refinement of the new ASN-educational standards-based *TeachEngineering* system version before implementation in late Year 3.
- *S*ecured funding from the Agilent Technologies Foundation to conduct a detailed web metrics analysis of *TeachEngineering* user logs in Year 4 — to delve deeper into TE user metrics to investigate how the collection is being used and how it can be tuned to improve the user experience.
- After performing Academic Benchmarks test alignment of a sample of *TE* activities to the science and mathematics educational standards of six states, later in Year 3 discontinued use of this vendor because of the unavailability of unrestricted and programmatic access as well as prohibitive cost. Instead, we explored CNLP and WGBH tools, as described elsewhere in this report.

10. Other Reporting Categories:

- **Training and Development.** EP training workshops were held at the AAAS Annual meetings in 2008 and at a number of other venues. More detail on additional Year 3 training and development activities is provided in Goal 8 activities and in the workshop list below.
- **Outreach Activities.** See Goal 8 activities and presentations and workshops list.
- **Contributions within Discipline**. Our project covers engineering, computer science and

technology. Also see all activities and findings.

- **Contributions to Other Disciplines**. We also cover areas in applications of math and science, as well as education and technology literacy.
- **Contributions to Human Resource Development.** All of the work in the project tasks and goals are related to education or increasing the number and diversity of engineering students, faculty and professionals.
- **Contributions to Resources for Research and Education.** The portal provides links to scholarship in engineering education and related fields. We host several collections that focus on engineering education research, including the Pr2ove-it collection and the International Journal of Engineering Education. Also see list of publications.
- **Contributions Beyond Science and Engineering.** This project provides a portal and workshops to support technology literacy and professional development in K-12.
- **Collaborators and Partners**. See: http://www.engineeringpathway.com/ep/about/contacts.jhtml
- **Publications and Presentations**. See Goal 8 activities and list below.

Journals

1. Hey, J., C. Newman, J. Sandhu, C. Daniels, and J.-S. Hsu, and A.M. Agogino, "Designing Mobile Digital Library Services for Pre-Engineering and Technology Literacy", *International Journal of Engineering Education*, Special Issue on Mobile Technologies for Engineering Education, Vol. 23 (3), pp. 441-453, 2007.

Conference Proceedings, Press and Books

2. Mathias-Riegel, Barbara. "Click. Build. Learn: A Digital K-12 Engineering Curriculum Expands with an Emphasis on Quality and Fun," Teaching Toolbox, American Society for Engineering Education *Prism*, Vol. 17, No. 1, September 2007, pp 44-47. See http://www.prism-magazine.org/sept07/tt_01.cfm
3. Datta, E. and A.M. Agogino, "Mobile Learning and Digital Libraries: Designing for Diversity", ASME Annual Congress, 2007 (ISBN 0-7918-3812-9).
4. Wu, J.-L., and A.M. Agogino, "ABET Alignment of Learning Resources in the Engineering Pathway Digital Library", ASME Annual Congress, 2007 (ISBN 0-7918-3812-9).
5. Reitsma, René F., Byron Marshall, Michael Dalton, and Martha Cyr (2008) "Exploring Educational Standards Alignment: In Search of 'Relevance,'" *Joint Conference on Digital Libraries*, Pittsburgh, PA, June 2008 PDF © ACM (2008).
6. Agogino, Alice and Michael Smith, "Broadening Participation in Computing with the K-Gray Engineering Pathway Digital Library", interactive poster session at the *Joint Conference on Digital Libraries*, Pittsburgh, PA, June 2008 PDF © ACM (2008).
7. "Support for Mobile Learning Using Tablet PCs", International Conference on Mobile Learning, Joseph Tront, Jane Prey, Amman, Jordan, April 14-16, 2008

Presentations and Workshops

8. Conducted a 90-minute *TE Publishing Workshop* for ~10 Drexel University engineering graduate student Fellows in Philadelphia, on September 14, 2007, preparing them to publish their curricula in TE. From their feedback, initiated changes to our templates and instructions for new contributors.

9. *TE/EP* poster at the K-12 Session of the yearly IBM University Day in Research Triangle Park, NC, on October 30, 2007.
10. At the November 2007 NSTA regional meeting in Denver, presented a Friday-evening exhibit booth and a Saturday-morning *EP* K-12 / *TE* workshop, "Using *TeachEngineering.org* — A Free Teacher Resource," for science teachers.
11. K-12 team presented a 50-minute session on *TeachEngineering* to an enthusiastic audience of teachers at the February 2008 International Technology Education Association (ITEA) in Salt Lake City. Also announced the inaugural Premier Curriculum Award.
12. K-12 team conducted a 50-minute workshop, "Making Science Real with the Free TeachEngineering Resource," at the March 2008 annual NSTA Conference in Boston, and staffed the NSDL Pathways booth.
13. Alice Agogino introduced *EP* as a resource for commenting on the NRC *Beyond Bias and Barriers* report during her talk on "Women and Men in the Globalizing University: Mapping Gender in University Data," International Alliance of Research Universities (IARU), Yale University, April 21, 2008.
14. Alice Agogino introduced *EP* in Presidential Talk at Northwestern University, "Educating Engineers for a Flat World: Implications Across the Academy," April 22, 2008.
15. Joe Tront presented session on *Using Educational Digital Libraries* at the Indo-US Engineering Faculty Leadership Institute in Mysore, India, June 2008.
16. AliceAgogino introduced *EP* as a resources while giving a keynote talk on the Engineering 2020 project and a paper titled "Longitudinal Study of Project-Based Learning Course in New Product Development", Technion, Israel, July 6, 2008.
17. Alice Agogino presented two sessions on *Using the Engineering Pathway* at the Indo-US Engineering Faculty Leadership Institute in Mysore, India, July 2008.
18. Agogino is working with ASME to launch the Design Interdisciplinary Community at the August 2008 Design Engineering Technical Conference in New York.
19. Joe Tront will be participating in the CCLI workshop on August 14-15 2008.
20. On October 13-14, 2008, K-12 team will be conducting a two-day conference for the ~24 NSF engineering GK-12 PIs in Boulder, CO. The conference includes an instruction on how to use the TE resource, writing quality curricula, the review process, the engineering message, and how-to publish curricula in *TE*, as well as exploring offering TE professional development and long-term ownership and sustainability issues.
21. Invited Presentation: Effective Use of Tablet PCs in Engineering Education", Carnegie Mellon Qatar faculty, Doha, Qatar, 18 attendees, April 20, 2008.
22. Invited Presentation: Using Tablet PCs in Elementary Education – Teacher Certification Workshop", Carnegie Mellon Qatar campus, Doha, Qatar, 30 attendees, April 20, 2008.
23. Invited Presentation: "Effective Use of Tablet PCs in Engineering Education", ECE Department Heads Association, San Diego, CA, March 18-21, 2008.
24. Invited Workshop: "Using OneNote to Improve Notetaking and Foster Collaboration", 2008 HP Teaching with Technology Conference, LaJolla, CA, February 18-19, 2008.
25. Invited Workshops: "Tablet PCs in Engineering Education & Research" Joseph Tront and Jane Prey, (two workshops – limited to 15 participants each), EDUCAUSE Learning Initiative Annual Meeting, San Antonio, TX, Jan. 28-30, 2008.
26. Workshop: "Selecting and Evaluating Digital Learning Materials for Engineering and Pre-Engineering Education", Joseph G. Tront, Alice Agogino, Brandon Muramatsu, ASEE 2007 Annual Conference and Exposition, Honolulu, HI, June 23, 2007.

Websites

27. NEEDS (National Engineering Education Digital-library System), http://needs.org
28. *TeachEngineering*, http://TeachEngineering.org
29. *Engineering Pathway*, http://EngineeringPathway.org
30. Peer Reviewed Research Offering Validation of Effective and Innovative Teaching, *www.pr2ove-it.org*