

# Collaborative Research: A Comprehensive Pathway for K-Gray Engineering Education Year 1 Annual Report (June 28, 2006)

## 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 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, Activities and Findings for Year 1

- ◆ **Goal 1: Merge NEEDS and TeachEngineering:** Interoperate metadata, develop integration plan, design unified user interface and define basic services.
  - Harvested *TE* resource metadata through its OAI server and stored them in the *EP* repository using the *NEEDS* metadata subset of IEEE LOM. *TE* currently exposes 15 NSDL Dublin Core metadata fields ([http://ns.nsdlib.org/nsdl\\_dc\\_v1.02/](http://ns.nsdlib.org/nsdl_dc_v1.02/) [http://ns.nsdlib.org/schemas/nsdl\\_dc/nsdl\\_dc\\_v1.02.xsd](http://ns.nsdlib.org/schemas/nsdl_dc/nsdl_dc_v1.02.xsd)). Several of these deploy controlled vocabulary sets that are different from the ones used in *NEEDS*. Cross-walking tools were developed to provide mappings between these different vocabulary sets for *TE* metadata digestion. Harvested *TE* resource metadata are now available for searching on *NEEDS* and the *EP* prototype portal.
  - Registered the engineeringpathway.com (and .net and .org) domains and developed an *EP* prototype portal site at <http://www.engineeringpathway.com>.
  - Implemented a framed-in search page on the *EP* prototype portal that allows users to search over metadata from multiple engineering collections that *EP* harvested using the *NEEDS* metadata subset of IEEE LOM.
  - Implemented a news page on the *EP* prototype portal that announces events and conferences in the engineering education community. Developed a web submission form to solicit engineering related events from our users. New submissions reviewed through a review process before being officially posted.
  - As part of the experiment to gauge user interests in "cross-referencing" and "pass

through traffic" between *NEEDS* and *TE*, *NEEDS* highlighted related *TE* resources on the March/April "Learning Everywhere" (mobile learning) theme page ([http://www.needs.org/needs/public/thematic/archive/0206\\_MobileLearning](http://www.needs.org/needs/public/thematic/archive/0206_MobileLearning)).

Month (2006)	Number of "pass throughs" from NEEDS to TE
January	57
February	73
March	57
April	43
May	50
June	34 (to date)
Total in 2006	314

- Developed a survey for soliciting feedback on digital library services on the *EP* prototype portal. Expect different needs from different communities within engineering education. Customized survey will also be sent out by email for each of the communities targeted. Results from the surveys will be used to guide the design of services in *K-Gray Engineering Pathway*.
- ◆ **Goal 2: Stewardship and Growth of the K-Gray Engineering Pathway:** Perform curricular gap analysis, develop 20 ABET exemplars, ingest Engineering 2020, de-accession, and increase *TE* content by 30%.
  - In 3<sup>rd</sup> Q, exceeded the Year 1 goal of increasing K-12 *TE* content by 30%. Through creation and publishing six new curricular units, 52 new lessons, and 126 hands-on activities, K-12 contents were increased by 55%.
  - With partner Colorado teachers, completed a gap analysis comparing curricula available in *TE* with what is actually being taught in schools to address science standards in grades 3-8. *TE* developed a detailed plan to create curricula to fill most of the identified gaps by the end of 2007. The analysis indicated that the following topic areas needed to be addressed:
    - For upper elementary grades — solar system, weather and magnetism
    - For middle school grades — basic chemistry, ecology (including photosynthesis, animal classification, cell structure and food webs), human body, weather (including air masses, oceans and global climate change), space exploration and geologic rock cycles.
  - A Massachusetts-based K-12 gap analysis was done to assess content coverage in relation to the state technology/engineering curriculum standards. A plan to address the curricular gaps has not yet been developed.
  - Eleven partners external to the *TE* team and not part of any existing collection(s) have agreed to make relevant content available for adding to the collection.
  - Developed GIS-based interface and data structures for two Living Labs – *Engineering Our Water* and *Wind Engineering*.
  - *NEEDS* is using ABET accreditation disciplines to tabulate number of records in each category and identify areas with the largest gaps. (expected completion in 4th Q)
  - *NEEDS* established and executed a de-accessioning policy for the cataloged resources.

Most of the de-accessioned resources so far are the ones that no longer exist on the Internet. Resources for which no replacement link can be found are then marked non-searchable and are made inaccessible to regular users. *NEEDS* has de-accessioned about 100 resources following this policy.

- *NEEDS* continues to host other collections with access in the *EP* prototype portal
  - ACM Women Collection
- *NEEDS* continues to maintain and add resources to sub-collections with access in the *EP* prototype portal
  - Women in IT
  - Gender equity
  - Black and African American Scientists & Engineers
  - Service Learning
- *NEEDS* hosted a new collection with access in the *EP* prototype portal
  - Center for Sustainable Engineering (established and collection owners from CMU are populating)
- *NEEDS* harvested new collections with access in the *EP* prototype portal
  - KMODDL (Kinematics Models for Design Digital Library; harvested from Cornell)
- *NEEDS* added new sub-collections with access in the *EP* prototype portal
  - Mobile Learning
  - Engineer 2020
  - Raising Above the Gathering Storm
  - MEMS/Nanotechnology (to be completed 4<sup>th</sup> Q)
- Cross-walking tools developed by *NEEDS* for importing metadata from other collections that expose standard NSDL Dublin Core metadata.
- Joe Tront met and corresponded with ABET administrators George Peterson, Dan Hodge, and Gloria Rogers to discuss ways in which the project could develop exemplars of ABET materials to be used by departments in various stages of preparing for ABET reviews. These discussions have led us to develop a focus group session to identify the attributes of ABET-relevant materials. We plan to include current ABET evaluators and board members in the focus group and hope to assemble the group in early fall 2006. The group will discuss criteria for including ABET-related materials as well identify possible sources of material. We expect to ask some subset of the focus group to act as reviewers of candidate materials once they are gathered. The reviewers will assist in determining whether the collected materials are appropriate for inclusion and may be asked to make appropriate comments or suggestions on how they might be used.
- Joe Tront has also entered into discussions with Sheri Shepperd about the possible use of 50 ABET case studies provided to the Carnegie Foundation by participating colleges of engineering. Sheri will provide Joe Tront with the contact information for the participating colleges and Joe Tront will contact them to request that the *EP* be allowed to use some of the case studies for inclusion as exemplars or exemplary practices. Assessment instruments, course materials, and other ABET-related tools will be requested from the identified colleges.

- Conducted preliminary explorations of the current *NEEDS* content to informally identify the amount of ABET-related content already held in the collection. The results indicate that a more formalized and possibly automated procedure is needed to identify these materials. Also, an initial minimal web search has been performed to identify ABET-related materials. Some materials were identified though their quality was varied. Further work needs to be done to identify an effective broad search strategy. A more focused source of materials may come from the proceedings of the ASEE Annual Conference and the Frontiers in Education Conference. However, not all schools participate in publicizing their ABET best practices and tools in these conferences. Further contact with schools and ABET examiners are expected to identify a broader set of materials.
- ◆ **Goal 3: Align Curricular Materials with Appropriate ABET or K-12 Standards:**  
Work w/ *Align to Achieve* and *Teachers Domain* to acquire K-12 standards alignment database and map, ABET metathesaurus and indexing.
- Implemented and released standards-based searching for *TE* using state-to-national correlations. The searches use state-to-state and state-to-national standards correlations/alignments to allow for inter-state standards mapping and standards-based curriculum searches.
  - Used the University of Syracuse's Center for Natural Language Processing's (CNLP) CAT tool to compare standards assigned to *TE* activities with those suggested by CAT. We created a database to log similarities and differences, and sent the results to CNLP. Initial results were encouraging as very few additional standards were suggested by CAT. We added relevant standards to "My Selections" in CAT to have it learn what standards are appropriate, but the program seems to have some glitches in its *learning* component.
  - Engaged in several conversations with JES & Co regarding building upon their education standards correlation work. The status of their standards mapping is such that *TE* has offered to be a beta test site to achieve early access to standard correlation information. Release of the standards correlation information by JES & Co is scheduled for later summer 2006. In anticipation, we have obtained a JES & Co license for use of their *ASN K-12* standards database and we are examining their metadata for how we might use it to compare *TE* cross-correlations to their database.
  - Spoke with WGBH in Boston to discuss application of their K-12 standards alignment tool to *EP*. They seem interested in working with *TE* (they use the JES & Co standards, too), but we still need to work out the details. We have contacted WGBH to get the ball rolling for testing standards alignment with their system.
  - Developed ABET disciplinary thesaurus for higher education.
  - Indexing higher education collections in *NEEDS* by ABET accreditation disciplinary thesaurus using computational linguistics and hand coding (to be completed 4<sup>th</sup> Q).
  - Collected documents from ABET's website as well as ABET self-study documents from several universities including UC Berkeley, Virginia Tech and the Carnegie Foundation. Use these documents to develop first round of automatic metathesaurus generation for engineering general criteria (a)-(k).

- ◆ **Goal 4: Grow Participation:** Work with ASEE to develop a marketing plan, develop initial professional society MOUs, design a GUI for outside content providers, and develop a communication plan with all engineering professional societies.
  - In making the *Engineering Pathways* the publication site of choice for engineering colleges nationwide, obtained firm commitments from 11 new K-12 curriculum providers. Working with these new partners to publish 30 new external lessons or activities by the end of 2<sup>nd</sup> Q of Year 2. Obtained publication commitments from Drexel University, Purdue University, University of South Carolina, University of Maine, University of Colorado at Boulder/Mechanical Engineering, Johns Hopkins, North Carolina State, University of North Carolina at Charlotte, Tufts University, Michigan Technological University, University of Oklahoma and Oregon State University. Many of these programs are funded through NSF's GK-12 program, and are excited about the potential to publish their curricular results through the *TE* dissemination venue.
  - A draft *TE* Marketing plan was created by ASEE in 3<sup>rd</sup> Q, to be revised in 4<sup>th</sup> Q.
  - No changes to the content provider GUI have yet been made; however, to aid in publishing of external K-12 curriculum *TE* created authoring guidelines and manuals and Lesson and Activity templates.
  - Worked with the University of South Carolina as the beta external contributor to *TE* to publish a new activity on forces. They characterized the experience as positive and plan to extensively publish their content in *EP*.
  - Working with University of Virginia seniors to publish their Engineering Teaching Kits (ETKs) during the 2006-07 school year.
  - Some new contributors have expressed interest in *TE* authoring workshops on preparing curricular content (templates), and the *TE* publishing process.
  - *NEEDS* has established a procedure to send monthly email out to authors whose resources have received more than 20 hits.
  - Working with NSF science and engineering centers in MEMS/Nano educational resources. (to be completed in 4<sup>th</sup> Q)
  
- ◆ **Goal 5: Develop and Implement a Quality Control / Review Process:** Unify procedures for tiered reviews of content, develop criteria for a new K-12 Premier Award, and develop rapid repair tools.
  - Reviewed and awarded 2005 Premier Award at the ASEE/IEEE Frontiers in Engineering Education Conference in November 2005. Issued call for 2006.
  - No progress has been made towards developing criteria for a K-12 Premier Award, as it is premature to do so before external contributors have published in *TE/EP*. The K-12 awardees will be selected from among external contributors, and more GUI work is required to facilitate publishing before the external curriculum nomination and publishing process is widely advertised.
  - *NEEDS* has been checking broken links of cataloged records daily since September 2004. Links that are detected broken are disabled immediately and an email report is sent to the administrators automatically. Periodic email is sent to authors.
  - *TE* introduced a "broken link" indicator in all rendered *TE* curricula. When one renders

a document that contains broken links, those links are now “highlighted” with a small, unobtrusive gray “broken link” symbol.

- All *TE* curriculum owners are notified daily about improperly linked documents and broken links.
- ◆ **Goal 6: Create a Nonprofit Strategy and Partnership for Sustainability:** Explore models for sustainability and conduct market research.
  - Initiated a *Women in IT* series in partnership with the National Center for Women and Information Technology (NCWIT) and the Association of Computing Machinery. With funding from CISCO systems, launched an awareness campaign with NCWIT in Fall 2005 that featured our *Women in IT* series.
  - Investigated nine engineering collections and several professional societies in February 2006. Found that there are four types of potential partners, each with a different needs, areas of focus and potential for revenue generation:
    - *Collection partners:* Own original collections (e.g., Center for Sustainable Engineering Education Materials, ATEEL– Advanced Technology Environmental Education Library). Will add to collection and community development. May be able to charge for a monthly theme announcement for their collection, coupled with harvesting or interoperability of their metadata as part of their current grant or funded mission.
    - *Portals partners:* Own metadata of a focused subject area such as GROW, DELESE, etc. Will add to collection and community development. No new revenue expected other than to reimburse for costs of special services.
    - *NSF Engineering Research Centers:* List cross-disciplinary education and research intern opportunities and databases (e.g., PEER ,CAEFF, VaNTH BET). . Will add to collection and community development. May be able to charge for a monthly theme announcement for their collection. Revenue stream possible to develop seamless portal into the *EP* from their website.
    - *Professional society partners* – Greatest potential for revenue. Will add to collection and community development. May be able to charge for a monthly theme announcement for their collection. Revenue stream possible to develop seamless portal into the *EP* from their website, such as was done with NCWIT (National Center for Women in Information Technology). Collaborate on professional news, educational and employment opportunities (e.g., ASEE, [iCivilEngineer.com](http://www.civilengineer.com)). ASME's Education Board voted to work with *EP* on a pilot to be showcased at their November 2006 annual congress.
- ◆ **Goal 7: Core Integration:** CI needs analysis, formalize CI agreement, continue to expose metadata for CI harvesting, ingest selective CI-NSDL repository metadata, and explore use of IVIA and Fedora.
  - *NEEDS* and *TE* continue to expose Dublin Core metadata through their OAI servers (<http://www.needs.org/servlet/oai2> and <http://www.teachengineering.com/cgi-bin/OAI-XMLFile-2.1/XMLFile/tecollection/oai.pl>) for periodic harvesting by NSDL Core Integration (CI) initiative.
  - *NEEDS* developed a REST-based search service based on the protocol proposed by

NSDL CI (<http://search.comm.nsd.org/cgi-bin/wiki.pl?CornellSearchService>). This service allows other digital libraries and services to perform targeted harvesting or federated searching from their own sites. *TE* uses this search service as well as NSDL's search service to provide references to related resources based on initial user queries.

- Spoke with the NSDL access management group at Columbia University at the 2005 NSDL annual meeting concerning single sign-on policies and methods. We had one follow-up conference call and several email communications after that with them to understand how their proposed single sign-on system works and how to implement it. We've received the *Identity Provider* package from Rob Lane and obtained the standard *Shibboleth Service Provider* package from Internet2 ([shibboleth.internet2.edu](http://shibboleth.internet2.edu)). We are in the process of installing the softwares and configuring a prototype system for testing. Expect to provide single sign-in from NSDL users by 4<sup>th</sup> Q.
- Status on collaborating with NSDL-wide web metric collection effort:
  - *NEEDS* implemented and began usage tracking with Omniture as part of the NSDL-wide effort on March 1, 2006<sup>1</sup>. Currently *NEEDS* has three pages tracked by Omniture: *NEEDS* homepage, Premier Award page and the advanced search page.
  - *TeachEngineering* also decided to implement Omniture. While exploring compliance with University of Colorado's IRB (of record), it was decided (in collaboration with Mick Khoo from CI) that Colorado would modify its IRB to include sharing of non-personally identifiable data with CI for Omniture purposes. We are in the process of evaluating the *TE* Intellectual Property Policy to see if it needs modification to include his data sharing data.
  - *EP* prototype portal tracked with Omniture as well.
- ◆ **Goal 8: Dissemination:** Develop marketing plan, awareness and promotion, and user studies.
  - A *TE* link was added to the ASEE *EngineeringK12 Center* website lesson plans page ([http://www.engineeringk12.org/educators/hands\\_on\\_learning/websites.htm](http://www.engineeringk12.org/educators/hands_on_learning/websites.htm)). In addition, banner links were added on other ASEE pages (which ones???) and a *TE* link was added to the bi-monthly edition of ASEE's *Go Engineering* electronic newsletter.
  - We released full-text searching of *TE* documents using the *Lucene* open source search engine.
  - Further *TE* improvements implemented during Year 1:
    - PDF printing and saving, supported in *MyTE*.
    - Enhanced editorial facilities (i.e., expanded capabilities for bullets, images, nested lists, etc.) during summer 2006.
    - Provided template entries for the inclusion of videos, audios and java applets in *TE* curriculum.
  - *TE* gave a presentation at NSTA (National Science Teachers Association) in Connecticut. Gave a real-time overview of the site and had individuals from the audience request what they wanted to see/try. This appeared to be a very effective way for people to "explore" without requiring individual computers. According to the survey results, the teachers who attended the presentation want us back next year.
  - *TE* featured a poster session for the NSF National Science Board's winter meeting at the University of Colorado at Boulder.

- *TE* began work on an NSF-funded NAE project to create a gender equity extension service to support the grades 6-14 engineering education community. An NAE “train the trainer” gender equity training workshop was attended by two *TE* team members. with an eye towards making sure that we include gender equity approaches and strategies in our *TE* resources and workshops.
  - The U.S. Dept. of Ed/FIPSE encouraged us to submit a *TE*-inspired proposal. We have started formulating a proposal for a three year grant. Each partner has professional development workshops and teacher activities. For instance, *TE* held a workshop for Providence Day School in Charlotte, NC in May 2006
  - A paper for the America’s Conference on Information Systems (AMCIS) covering a technique for visualizing an information space (such as *TE*) and the relevance of any of its items (lessons, activities, etc.) was accepted (Reitsma, R., Trubin, S. (2006) Weight-proportional Information Space Partitioning Using Inverse Multiplicatively Weighted Voronoi Diagrams. Proceedings AMCIS 2006, Acapulco, Mexico).
  - A similar paper was accepted for publication in the interdisciplinary journal *Information Visualization*. (Reitsma, R., Trubin, S. (in press) Information Space Partitioning Using Adaptive Voronoi Diagrams. Information Visualization).
  - Hey J., C. Newman, J. Sandhu, C. Daniels, J.-S. Hsu, and A.M. Agogino, "Designing Mobile Digital Library Services for Pre-Engineering and Technology Literacy", to appear *the International Journal of Engineering Education*, Special Issue on Mobile Technologies for Engineering Education, 2006.
- ◆ **Goal 9: K-Gray Engineering Pathway Evaluation:** Evaluation plan, form/hold Advisory Committee meeting.
- *NEEDS* participated in LibQUAL digital library evaluation project in Fall 2005.
  - *NEEDS/TE* participated in a survey on NSDL projects' evaluation practices.
  - The advisory board has been formed consisting of John Prados and Barbara Waugh as co-chairs with Norman Fortenberry, Randy Hinrichs, Jack Lohmann, and Lilian Wu as members. The board held its inaugural meeting in Chicago June 20, 2006 and was brought up to speed on the operations of the project. The board was asked to have a focused discussion on: 1) quality control of materials in the library, and 2) a model for sustainability of the project. The discussion has led us to several viable suggestions that we will begin to pursue them this summer. The board plans to have a face-to-face meeting at a minimum once a year, and to have one or two online meetings during the meant time. We will further the initial discussions on quality and sustainability and report back on the results during the next reporting period. We expect to task the board with action items to support the explorations of library materials review and discovery and development of sustainability opportunities. The board is enthusiastic about moving forward with these tasks.
- ◆ **Other Reporting Categories:**
- Training and Development (see Goal 8 activities)
  - Outreach Activities (see Goal 8 activities)

- Contributions within Discipline (see all activities and findings)
- Contributions to Other Disciplines (see all activities and findings in relation to related math and science)
- Contributions to Human Resource Development (all of the work in this project are related to education or increasing the engineering pipeline)
- Contributions to Resources for Research and Education (links to scholarship in engineering education)
- Contributions Beyond Science and Engineering (supports technology literacy)
- Publications and Presentations (see Goal 8 activities and list below)

## Journals

1. Hey J., C. Newman, J. Sandhu, C. Daniels, J.-S. Hsu, and A.M. Agogino, "Designing Mobile Digital Library Services for Pre-Engineering and Technology Literacy", to appear *the International Journal of Engineering Education*, Special Issue on Mobile Technologies for Engineering Education, 2006.
2. Reitsma, R., Trubin, S., "Information Space Partitioning Using Adaptive Voronoi Diagrams," *Information Visualization*, in press.

## Conference Proceedings, Books

3. Agogino, A.M., L. Jamieson, G. Kalonji, D.F. Ollis, H.V. Poor, S.E. Powers, and C. Rodgers, "Integrating Education, Research, and Outreach: Exemplars from the NSF Distinguished Scholars Program," Extended Abstract in *Proceedings of the Frontiers in Education Conference*, ASEE/IEEE, Session T1A (October 19-22, 2005, Indianapolis, IN).
4. Teng, X., J.G. Tront, B. Muramatsu, and A.M. Agogino, "Best Practices in the Design, Development and Use of Courseware in Engineering Education," *Proceedings of the Frontiers in Education Conference*, ASEE/IEEE, (October 19-22, 2005, Indianapolis, IN).
5. Reitsma, R., Trubin, S., "Weight-proportional Information Space Partitioning Using Inverse Multiplicatively Weighted Voronoi Diagrams," *Proceedings of AMCIS*, 2006.

## Presentations

6. Agogino, A.M., "Engineering Education - Present and Future", panel, National Science Board Workshop on "Engineering Workforce Issues and Engineering Education: What are the Linkages", M.I.T., October 20, 2005.
7. Agogino, A.M., "Women in Engineering in the Year 2020: Possible, Probable, and Preferable Scenarios," Stanford University, March 9, 2006.
8. Agogino, A.M., "Technology, Pedagogy and Design: Global Visions for the New Century", June 1, 2006, University of Michigan.

## Websites

9. NEEDS (National Engineering Education Digital-library System), <http://needs.org/needs/>
10. TeachEngineering, <http://teachengineering.com>
11. Engineering Pathway, <http://engineeringpathway.com>