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Maintaining an Engineering Portfolio: Motivation, Tactics, and Strategies for Life-Long Learning

The paper is a brief summary of the development of "portfolio thinking" in an engineering program for which the author is the internship coordinator. It is a summary of work in progress and invites discussion, other examples, and further development of ideas that can be useful in engineering education to improve the concept and use of engineering portfolios.

The Evolution of "Portfolio Thinking"

Expectations and guidelines for student portfolios have evolved over the last decade as more professional attention has been given to the nature and purpose of a portfolio as part of student work in engineering. Key motivators that have improved professionalism in portfolios include increased attention to issues of accreditation and ethics and to the requirement of life-long learning as a professional obligation. These elements of "portfolio thinking" usually reside well within the bounds of engineering education. [1, 10, 12]

However, as the world becomes more complicated, knowledge and experience beyond the technical must be exhibited by an engineering professional. Increased awareness of the importance of fields outside engineering – those academic subjects usually grouped under the general heading of liberal education, humanities, or (generally) optional courses outside engineering – has contributed to the improved quality of portfolios and to their perceived value as documentation of past accomplishments, benchmarks of current expertise, and planning for future professional development in a changing world. [3, 6, 7, 9]

Table 1 summarizes the "evolution" of portfolio thinking in the program for which the author is the internship coordinator. This is not a unique paradigm, but it may serve as a useful overview for future "portfolio thinking."

Table 1. "Portfolio" Thinking

Stage of Portfolio Thinking	Primary Emphasis For Content	Perceived Purpose For Portfolio	Base of Knowledge or Required Expertise
1 Basic	Archive	Save examples of work	Facts and practice for doing a specific job
1,2 Employment	Job search	Qualifications for specific jobs	Skills demonstrated for a job search; know the market.
1,2,3 Professional	Engineering qualifications	Assessment and proof of professional accomplishment	Overall competency and credibility to meet engineering professional standards.
1,2,3,4 Life-long learning	Big Picture/ Long term Planning	Understand the present; predict the future. Identify next steps	Appreciate the past, meet the present, prepare for the future.

The "stages" are cumulative. Note also a parallel to Bloom's taxonomy, from the level of facts and information (Bloom's levels 1 and 2) up through application, analysis, synthesis, and evaluation (Bloom's levels 3-6). [2]

Basics: Challenges and Opportunities for Useful Portfolios:
A "portfolio" – that is, an organized collection of relevant and significant examples of work relevant to one's job goals – is typically a part of student work. For example, a portfolio may be the product of an internship or other special program and may be required as part of a final assessment at graduation. However, at the undergraduate level, the portfolio tends to "die" once the immediate task has been accomplished. Portfolios as a long-term investment in professional growth have not been widely valued in engineering once the right job has been attained and a sense of employment security has set in.

However, "security" is now not necessarily the guaranteed benefit of any job. This has been a difficult lesson for the engineering profession. "Portfolio thinking" can be useful for continued professional growth and as an antidote to obsolescence.

An un-scientific real-world survey collected following representative comments from practicing engineers: [11]

"Engineers don't do portfolios…"
"I have a big folder on my desk – everything goes in there…"
"My company doesn't let me save anything from my job…."
"I interviewed three students last week – one of them brought a portfolio.…"

These are not particularly effective ideas for portfolio development. A recent discussion with an Industry Advisory Board for the program with which the author is affiliated suggested that in the "real world," portfolios are seen only as job-search tools. The message was that "portfolio thinking" for this group of professionals was stuck at levels 1 and 2 on Table 1. This is a severe limitation on "portfolio thinking." [11]

A glance at the professionals outside of engineering who do make good use of portfolios is useful. These groups include such professional groups as Educators/Teachers, Consultants, Artists (and related areas), Entrepreneurs, Writers, and Communicators. In addition, numerous businesses have found that a portfolio of past projects for future clients is a useful contribution to credibility. A web search on "portfolios" is useful as is a review of most Education departments, which usually require a teaching portfolio as part of the process of "teaching teachers."

Several warnings are relevant for professional portfolios – and these warnings are based on actual examples. A professional portfolio is NOT a scrapbook. The same level of professionalism and best practice apply to portfolios as to any other professional communication; the standards for the professional *résumé* provide some good general guidance for portfolio content: both require excellent overall design and organizational planning, and both must avoid content that violates the formal and informal rules for personal information under employment and privacy regulations.

Constraints on portfolio content may also reflect well-understood professional limitations that most professionals already work with: intellectual property, confidentiality, and issues of financial interest.

Accreditation and ethics will continue to provide an enriched view of what a portfolio should include. For the academic portfolio, students and professionals should be familiar with ABET (criteria a – k) and ethics as summarized in the NSPE Code of Ethics and other examples of professional ethics codes. A powerful strategy for better "portfolio thinking" is to leverage the requirements of *accreditation* and of *ethics* to improve engineering portfolios (for students and professionals). [1, 4, 14, 15]

However, portfolios are not just a "student issue." Effective "portfolio thinking" helps to manage the transition from *student* to working *professional*. For the *student*, a portfolio may represent only one of a number of assignments to be completed and then forgotten. For the *professional*, "portfolio thinking" defines the tasks of life-long learning and can motivate continued professional development.

The Liberal Education Component

"Liberal Education" in engineering curriculum tends to mean the few non-engineering courses that can be included in an already busy and crowded schedule. The problem is that many elements of professionalism need the "liberal education" perspective in order to be meaningfully understood by engineering students. [3, 5, 8, 15, 16]

Writing courses, particularly those that emphasize "writing across the curriculum," can provide a "one stop" shop for improved "portfolio thinking." For example, Leonard J. Rosen's *Academic Writer's Handbook* is not an engineering book but is used in some technical writing courses.

Rosen includes four chapters on the major areas of academic work: humanities, social sciences, natural sciences, and business. His important accomplishment is to define the content, goals, significance, and "rules of the game" for these areas. He discusses the rules of proof, definition of expertise, methods of research, and typical approaches to writing about these areas. He does not include engineering as a special field, and since engineering is a specialized and complex field, that is understandable. However, in a technical communication class with an engineering focus, the opportunity for making the connections can be the basis for writing and discussion; connections can then be established between "thinking across the curriculum," other elective courses outside of engineering, and the experiences and accomplishments documented in an engineering portfolio. [13]

Table 2 suggests some possible connections "across the curriculum."

The professional engineering portfolio has value as a checklist of one's current professional status, as a guide for future professional development, and as documentation of continuing growth and life-long learning. For example, if a student discovers significance gaps in demonstrable experience, it is a message that there should be a future effort to gain more experience. In fact, no one has "everything"; a key to professional development is to identify areas for continued or improved expertise.

Next Steps

Challenges for engineering educators remain, however, to encourage the maintenance of a portfolio as a long-term investment of intellectual and professional effort. As the world becomes

more complicated, engineers, first as students and later as professionals, should come increasingly to value knowledge and experience about life the specific realm of engineering practice as well as the contributions of other fields in liberal education.

Table 2. Portfolio Thinking "Across the Curriculum"

Area and representative specific knowledge	Challenge: Engineering Student attitudes	Opportunity: Connections to Engineering	Portfolio Thinking: Examples that might be included
Humanities (art, literature, music, religion, languages, cultures)	"all opinion" "no connections" "avoid if possible"	Global issues. Toleration of ambiguities. Understanding cultural impact, Ethics in general.	International travel/study abroad; languages; design for beauty; art and photography; creative writing. Engineering and aesthetics. "Engineers without borders."
Social Sciences (economics, sociology, psychology,	"not technical" "not scientific" "avoid if possible"	Critical thinking about social impact; Economics of engineering; demographics; human behavior; understand quali-tative research. Ethics and society.	Experience with a variety of people: volunteer work; outreach to public and community organizations; work with elderly, youth, sick, culturally and economically diverse groups of people. Examples of qualitative plus quantitative research. Examples of impact on society. Market research. "Engineers without borders."
Natural Sciences (physics, chemistry, biology, earth sciences, astronomy)	"emphasis on physics and math" "theory not useful" "avoid others"	Relationship of theory and application; earth sciences and pollution, sustainability; biology in bio-medical engineering. Ethics and science.	Examples of work that helps define the differences between theory and application; examples of pure research; "scientific" impact of engineering on ecosystems. Theoretical and scientific work in non-engineering environments.
Business (a complex field incorporating all of the above)	A duality: "avoid business"/ "plan to get an MBA"	Complex business decisions determine engineering project success. Ethics and business.	Examples of work with accounting, budgeting, project management, executive and financial decision making; quality versus cost decisions; production efficiency. Marketing examples.

The author will present examples from current student portfolios and invites discussion, suggestions, and ideas that will help build and maintain portfolios as a life-long professional investment and valued contribution to engineering education.

References

1. ABET. Criteria and Program Assessment. http://www.abet.org

2. Bloom, B, et al. *Taxonomy of Educational Objectives*. New York: Longmans Green, 1956.

3. Carliner, S. E-Portfolios. *ASTD*, May 2006. 71 – 74.

4. Carlson, P. Teaching a Course in the Ethics of Human Communication. 29th ASEE/IEEE Frontiers in Education, 1999. 12d6 – 18.

5. Cohn, E., and Hibbits, B. Beyond the Electronic Portfolio. *Educause Quarterly*, 4, 2004. 7 – 10.

6. Hansen, E. Technological Expertise in Liberal Education. 36th ASEE/IEEE Frontiers in Education, 2006. S1H-17 - 22

7. Heywood, J. Think…About How Others Think: Liberal Education and Engineering. 37th ASEE/IEEE Frontiers in Education, 2007. T3C-20 -24.

8. Jablokow, K. Engineers as Problem Solving Leaders: Embracing the Humanities. *IEEE Technology and Society*, Winter 2007. 29 – 35.

9. Love, D. et al. Portfolios to Webfolios and Beyond: Levels of Maturity. *Educause Quarterly*, 2, 2004. 24 – 37.

10. McNair, L. et al. Work in Progress: Using e-Portfolio to Define, Teach, and Assess ABET Professional Skills. 36th ASEE/IEEE Frontiers in Education, 2006. T1J-13 – 14.

11. Personal correspondence, email, interviews by the author.

12. Richerson, S. et al. A Portfolio Approach to Learning Professional Skills. 37th ASEE/IEEE Frontiers in Education, 2007. F3B-1 – 4.

13. Rosen, L. *The Academic Writer's Handboo*k. NY: Pearson Longman, 2006.

14. Stephan, K. Engineering Ethics Education in the US. 30th ASEE/IEEE Frontiers in Education. 2000. S1F-7.

15. Williams, J. Using Audience Accommodation for Effective and Ethical Communication, 30th ASEE/IEEE Frontiers in Education, 2000. S1F-6

16. Williams, J. The Engineering Communication Portfolio. IEEE 2001. 342.