CDIO Syllabus Survey:
Systems Engineering an Engineering Education for Government

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ABSTRACT

During the spring of 2010, approximately 300 hiring managers working for the US Navy participated in the CDIO survey sampling the desired engineering skills and proficiencies for their workforce of over 30,000 scientists and engineers. The survey results will support engineering education reform initiatives spanning engineering schools across the country, particularly those in which the Navy directly invests. Sponsors sought an opportunity to send a clear “demand signal” to the academic community to promote engineering education reforms and help them align their programs with projected workforce needs. This application is novel in several regards. First, the survey collected data spanning a very large government agency employed in the development of high technology systems. Secondly, data was sought regarding the desired attributes of both new-hires, direct from undergraduate programs, and mid-career individuals, to better distinguish the attributes sought from graduate programs serving the US Government. Finally, adaptations of the traditional CDIO survey method were implemented, several of which were beneficial, yielding interesting results, and at least one which was problematic.

KEYWORDS

CDIO survey, graduate attributes, government engineers, industry stakeholders

BACKGROUND

The US Navy expects to hire 4-5% of all engineers graduating from U.S colleges and universities over the next several years, principally into civilian jobs in systems development. Hence, the Navy will likely be the nation’s single largest employer of new engineers, and a dominant stakeholder in engineering education curriculum and standards for the foreseeable future. Just as engineering enterprises expect their customers and stakeholders to help them understand their requirements, engineering organizations have a responsibility to ensure that their requirements are known and understood by the nation’s engineering schools.

A little background emphasizes the importance of this activity. In the mid-90s, accreditors charged U.S. engineering schools with re-orienting their programs to ensure student competency in traditional engineering science subjects, as well as in “soft skill” areas like teamwork, communication, and successfully working in modern engineering enterprise organizational models. Accreditation criteria deliberately provided institutions with latitude regarding the relative importance of these additional skills, directing institutions to act in concert with their stakeholders to identify institutional emphases. Unfortunately, the intended reforms largely stalled short of the original goal due in part to a lack of clear stakeholder direction and engagement– success has been hindered by an incomplete/unclear demand signal. ASEE’s recent study, *Creating a Culture for Scholarly and Systematic Innovation in Engineering Education*, charges industry to increase its connections with Education and explicitly support curriculum development: “Encourage engineering line personnel to participate in benchmark surveys, serve as adjunct faculty, and other activities that connect line personnel with engineering programs." [1]

In recognition of this "demand signal shortfall", the Education committee of the Navy's Chief Engineers commissioned a survey of Navy Systems Command (SYSCOM) engineers and leaders to gain insight on the professional expectations and career progression of Navy engineers, as well as an understanding of the role of formal education in their development. The Department of the Navy's five engineering SYSCOMs provide the total life cycle development, acquisition and engineering support. The Naval Sea Systems Command (NAVSEA) procures and supports ships and shipboard systems. The Naval Air Systems Command (NAVAIR) procures and supports aircraft and aerial weapons. The Naval Facilities Command (NAVFAC) provides shore base infrastructure engineering and maintenance. The Naval Space Warfare Command (SPAWAR) procures and supports space assets and fleet communications. The Marine Corps Systems Command (MARCORSYSCOM) procures and supports ground equipment for the US Marine Corps.

According to Jesse McCurdy (AIR-4.0A), chief civilian engineer for the Naval Air Systems Command, "The reforms intended by ABET 2000 appear to have stalled... Industry bears a large part of the responsibility, for want of a clear, persistent demand signal. Industry then bears the cost, as we must then complete the education necessary for engineers to contribute in today's enterprise."[2] Engineering education is changing, but not at the pace required by industries daunted by the well-publicized graying of their engineering workforce. [3, 4] The U.S. Navy is among the largest of those enterprises.

Vacancies created by baby-boomer retirements, and President Obama's direction to rebuild the government's acquisition workforce, compel the Navy to hire almost 3,000 engineers per year over the next several years. Of those, 800 will be commissioned officers, 400 each from the Naval Academy and civilian campuses. The systems commands seek three times that number for civil service positions performing research, systems development, acquisitions, test and evaluation, and maintenance support. Most of those jobs entail the newest of new technologies; some find new ways to keep old ships afloat.

"Consequently, the Navy's a dominant stakeholder in engineering education curriculum and standards for the foreseeable future. Just as we expect our customers and stakeholders [the fleet] to help us understand their requirements, we have a responsibility to ensure that our requirements are known and understood by the nation's engineering schools."[2] As most complex engineering projects should begin with a clear identification of customer requirements, engineering the engineering education should likewise begin with defining the desired product attributes, in this case the new-hire engineer.

The U.S. accrediting body, ABET, together with industry, initiated this reform of undergraduate engineering education in the mid 90s with a shift to an outcome based assessment (student learning), in lieu of measuring inputs (budgets, student-to-faculty ratios, syllabi). Programs are tasked to establish program objectives with their stakeholders, against which program success is to be measured and improved. Requirements continue to seek student competency in traditional engineering science subjects, but with a heightened emphasis of "soft skill" areas like teamwork, communication, and successfully working in modern engineering enterprise organizational models. These professional skills requirements appear as "ABET criterion 3, a through k." Programs are required to demonstrate that their graduates have acquired:

a) an ability to apply knowledge of mathematics, science, and engineering
b) an ability to design and conduct experiments, as well as analyze and interpret data

c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d) an ability to function on multi-disciplinary teams
e) an ability to identify, formulate, and solve engineering problems
f) an understanding of professional and ethical responsibility
g) an ability to communicate effectively
h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i) a recognition of the need for, and an ability to engage in life-long learning
j) a knowledge of contemporary issues
k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Note that these describe undergraduate program objectives because the undergraduate degree is the terminal degree required for licensure as a Professional Engineer in the United States.

Accreditation criteria deliberately provided institutions with significant latitude regarding the relative importance of these additional skills, directing institutions to act in concert with their stakeholders to identify particular institutional and program emphases. While latitude is delegated to programs to determine the relative emphasis, no mechanism is suggested and many programs furthermore find the guidance and criteria lacking sufficient detail for program design.

THE CDIO SURVEY INSTRUMENT

CDIO stands for Conceive, Design, Implement and Operate, and hence expresses the theme of designing engineering education around the theme of the product life cycle. CDIO attempts to systems engineer the engineering education.

Figure 1 depicts the foundational goal of the CDIO initiative.[5] Engineering faculty members from the first half of the last century typically brought industry experience into academia. The progressive advancement of the engineering sciences crowded the professional skills of the engineering workplace out of both the faculty and the curriculum, as the unintended consequence of warranted improvements in scientific rigor. Today, improvement in both axes warrants reform of the design of engineering education programs and faculties.

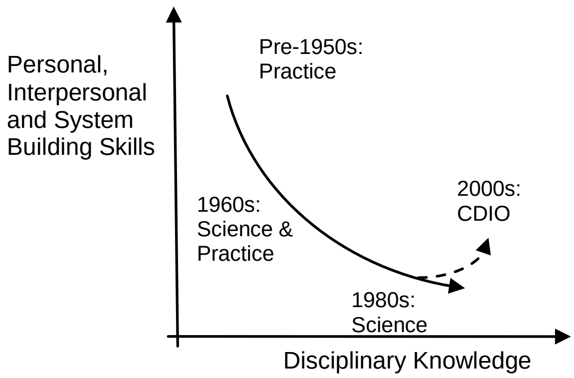

Figure 1. Evolution of Engineering Education

In 2000, MIT joined with three Sweden universities to publish the CDIO syllabus, as a general template for undergraduate engineering education which was then vetted internationally by both academia and industry. Crawley demonstrated that the CDIO syllabus satisfies all of the criteria of ABET 2000, providing more detail while amplifying the industry-desired skills not captured in criterion 3(a-k).[5] In some countries, such as Sweden, the CDIO syllabus has since been embraced as the construct for all engineering accreditation. The syllabus has since seen one substantial revision, in 2010 [6]. The syllabus has seen significant U.S. endorsement recently, from NAE President Charles Vest and past-ASEE president Sherri Shepherd, as well as major direct support from defence sector corporations such as Boeing, General Electric, Lockheed-Martin, Orbital Sciences, and Raytheon.

US Navy involvement began in 2003 when the Naval Academy's Aerospace Engineering program embraced the CDIO syllabus, motivated by several reasons:

1) the syllabus well described the kind of work done by USNA graduates who enter Navy SYSCOMs;
2) the syllabus, through a survey instrument, provided a direct means for stakeholder priorities to be identified as program design requirements;
3) the syllabus provided a model for flowing program objectives down to course content and activities; and
4) the syllabus's scope compelled embracing contextual engineering education, whereby technical skills and knowledge are developed simultaneously with professional skills such as communications and teamwork.

The USNA Aerospace Engineering program reorganized around the CDIO construct in 2003. Consequently, the survey was then administered to a limited set of aerospace stakeholders in NAVAIR, NASA and industry, with about 20 total respondents, resulting in program adoption and redesign. In the recent several years, programs within many prominent U.S. engineering colleges have embraced the CDIO framework, including Duke, Penn State, Georgia Tech, University of Michigan, Purdue, Embry-Riddle, Stanford, and the Naval Postgraduate School, each of which contribute substantially to the Navy workforce.

At the second level of detail, the CDIO syllabus captures the following desired student skills.

Table 1. CDIO Skills (Level 2)

1. Technical knowledge and reasoning
    - 1.1. Knowledge of underlying sciences
    - 1.2. Core engineering fundamental knowledge
    - 1.3. Advanced engineering fundamental knowledge
2. Personal and professional skills and attributes
    - 2.1. Engineering reasoning and problem solving
    - 2.2. Experimentation and knowledge discovery
    - 2.3. System thinking
    - 2.4. Personal skills and attitudes
3. Professional skills and attitudes
    - 3.1. Interpersonal skills: teamwork and communication
    - 3.2. Teamwork
    - 3.3. Communications
4. Conceiving, designing, implementing and operating systems in the enterprise and societal context
    - 4.1. External and societal context
    - 4.2. Enterprise and business context
    - 4.3. Conceiving and engineering systems
    - 4.4. Designing
    - 4.5. Implementing
    - 4.6. Operating

The syllabus has four levels of detail [6], identifying the desired skills of graduating engineers across the full spectrum of their work lives, and providing stakeholder ratified requirements to specific programs, via a survey instrument, based on the peculiar work demands of those stakeholders. Navy SYSCOM engineers and leaders recognized and affirmed the value of these skills in our workplaces. Though, these listed skills are not equally critical, nor would we expect their development to be uniform at the point of hire. Furthermore, organizations will continue to develop each requisite skill once an engineer joins a team and works in particular contexts. Several of these skills will mature only over several decades of work.

In recognition of this “demand signal shortfall”, the Systems Engineering Education Committee of the Navy’s Systems Engineering Stakeholders Group commissioned an effort to survey SYSCOM engineers and leaders to gain insight on the professional expectations and career progression of Navy engineers, as well as an understanding of the role of formal education in their development. In 2010, approximately 300 hiring managers participated representing NAVAIR, NAVSEA, NAVFAC, SPAWAR and MARCORSYSCOM. The survey results sought to support engineering education reform initiatives spanning engineering schools across the country, particularly those in which the Navy directly invests. This was a hoped for opportunity to send the Navy’s “demand signal” to the U.S universities to influence their engineering education reforms and help them align their programs with their projected workforce needs.

The survey and syllabus was designed by a international consortium of engineering schools, led by Professor Ed Crawley from the Aero/Astro department at MIT, and is meant to be applicable to all engineering disciplines [4]. In the CDIO’s consortium’s baseline survey, as administered by several dozen institutions, stakeholders are asked to rate the desired proficiency of new-hire engineers on a five-point scale, in each of the CDIO skill areas. Some programs conduct this survey solely at level-2 on the scale, and others conduct the survey at level-3. The five point scale is:

1. To have experienced or been exposed to (minimal experience/limited exposure)
2. To be able to participate in and contribute to (some familiarity/ability to participate and contribute)
3. To be able to understand and explain (knowledgeable/experienced enough to understand and explain)
4. To be skilled in the practice or implementation of (skilled in the practice or implementation)
5. To be able to lead or innovate in (capable of leading and/or innovating)

In the graphics below, these five levels will be represented by “Exposure”, “Contribute”, “Explain”, “Practice”, and “Lead & Innovate.” Commonly, respondents have been asked to rate themselves in each skill, prior to rating the desired new hire. This has been shown to provide a calibrating effect on the results, calming the tendency to inflate the desired skill level of the new hire.

The SYSCOM survey reported below modified MIT’s baseline survey in three ways, in hopes of further refining the clarity of the information to engineering program architects. First, respondents were also asked to rate the desired skill levels at four career marks, vice the two typically asked, to now include the new high school graduate and the mid-career engineer, as well as the new hire and the senior executive engineers. The high school data was requested by SYSCOM leaders responsible for K-12 outreach. It was therefore possible that for some skills, no exposure would be warranted prior to undergraduate matriculation, and the option was provided for “No prior exposure,” a feature not present in prior surveys. The mid-career data was sought by those funding graduate school programs. Secondly, respondents were additionally asked to indentify whether they thought the particular skill would be best developed in an academic or work environment. Finally, the survey queried the workplace demand for various mathematical skills.

The survey spanned solely the 2.x, 3.x and 4.x skills, which represent the y-axis (ordinate) of Figure 1 above, omitting the 1.x technical skills. This permits the results to be generalized to the work of any engineering discipline (e.g. Electrical, Mechanical, Chemical). Furthermore, professional skills such as writing, should not be viewed as prioritized against the fundamental technical studies, but a separate dimension pursued in concert with the technical skills. Advocates of such contextual learning have demonstrated that both professional and disciplinary can be developed simultaneously through integrated learning experiences that are deliberately designed with such goals.[6]

RESULTS

Survey Demographics

Tables 2-6 characterize the survey's respondents. Note that some columns total greater than 100% because some respondents responded 'yes' to more than one category (e.g. masters and PhD, or test pilot school plus a masters degree). These results should not be presumed to represent the demographic of these commands, but simply characterize survey participants. The Naval Air Systems command participated more strongly than others, attributable to its leadership's strong personal appeal. Results later show little variation between the commands. Hence this imbalance does not compromise the validity of our findings. In general, survey participants were middle-to-late career engineers, slightly less than half of whom held post-graduate degrees in science and engineering. A similar number had additional education in business or administration, with 22% holding degrees in these fields. The 30% who have business or management course work short of a degree are likely attributable to the congressionally-set educational requirements for acquisition professionals, such as certificate programs in Systems Engineering and Program Management.

Table 2. Parent Command

NAVAIR	71%
NAVSEA	23%
SPAWAR	4%
NAVFAC	4%
Other	1%

Table 3. Respondent Career Band

Early career (<10 years since Bachelor's degree)	3%
Mid-career	40%
Late-career (>25 years since Bachelor's degree)	57%

Table 4. Respondent Undergraduate Degree

Mechanical Engineering	15%
Civil Engineering	4%
Electrical/Computer Engineering	31%
Aerospace Engineering	13%
Naval Architecture/Ocean Engineering	1%
Computer Science/ IT	6%
Industrial Engineering	3%
Other science or engineering	21%
Neither a science nor engineering undergraduate degree	4%

Table 5. Respondent Postgraduate Education

No post-graduate education in these fields	35%
Some post-graduate education in these fields	21%
Test Pilot School or comparable professional program	7%
Masters Degree in Engineering	30%
Masters Degree in Science or Math	8%
M.D./D.V.M.	0%
Ph.D./ Dr. Eng/ Sc.D.	4%

Table 6. Postgraduate Education in Business and Administration

No formal education in these fields.	52%
Some formal education short of a M.S. (e.g.- DSMC)	26%
A Masters in business or administration	22%
A PhD in business or administration	0%

Desired Proficiency Results

The bulk of the survey asked respondents to rate the desired proficiency of engineers at four stages in their development: graduating from high school, new hire, mid-career, and senior engineering team leadership (executive). Results are depicted in Figure 2 for each of those four stages.

One of the first questions was whether a significant difference could be identified between the expectations of hiring managers in the Navy's diverse systems commands. Diamonds indicate the response of NAVAIR managers; asterisks depict NAVSEA responses, and the boxes depict that of the other commands whose sizes are much smaller. The solid line depicts the averaged response of all respondents. Due to the similarity of the work, it's not surprising that no significant difference is noted between the responses from NAVAIR and NAVSEA. The responses of the other systems commands are biased lower. The results identify educational program priorities; consequently, the relative level of various skills is more important that their absolute value. Since the shape of the curves from the other commands follows the NAVAIR and NAVSEA priorities, the commands can be considered to be looking for identical relative distribution of skills. Hereafter, the averaged desired proficiencies will be considered as representing the coherent Navy demand.

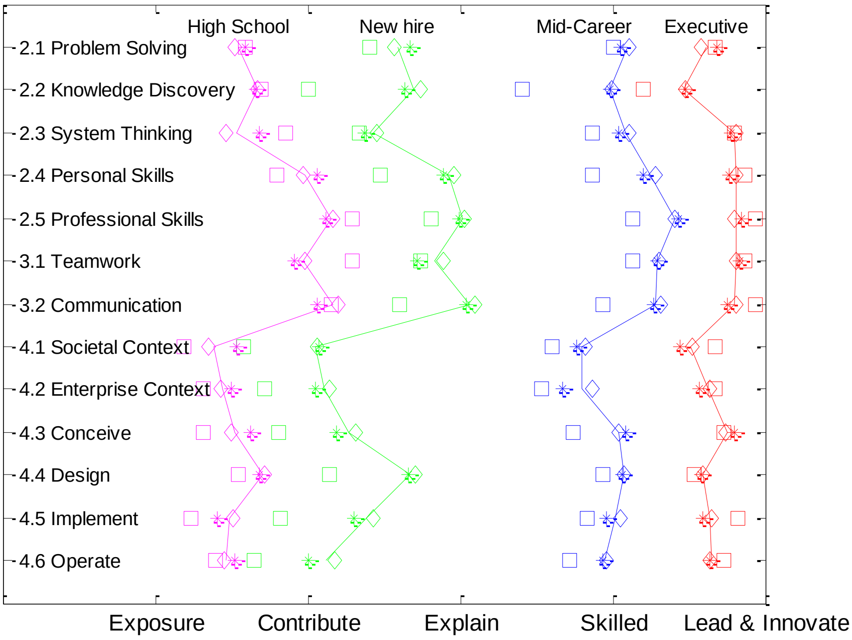

Figure 2. Desired Engineering Skill Proficiencies

The data exhibited almost uniform standard deviations across all skills and career levels (+/- one skill level). The uniformity suggested uniform confidence in the applicability of scores, and that data is omitted.

Figure 3 rank-orders the skills for the new-hire and mid-career engineer, the two bands of interest to engineering educators. Undergraduate program leaders should note the prominence of skills such as Communication, Personal and Professional Skills, Teamwork and Knowledge Discovery. Undergraduate program design must account for the purposeful development of these skills if they're to suitably equip students for contribution to this workforce.

Similarly, graduate program leaders should note the prominence of teamwork and communications, skills not commonly emphasized in an engineering masters degree. Shifts in emphasis between the new-hire and mid-career engineer are also interesting, with three skills promoted significantly between these two benchmarks: Teamwork, Problem Solving and Systems Thinking. Hence the market demand for mid-career development signals areas that may deserve heightened emphasis in graduate programs seeking to serve this constituency.

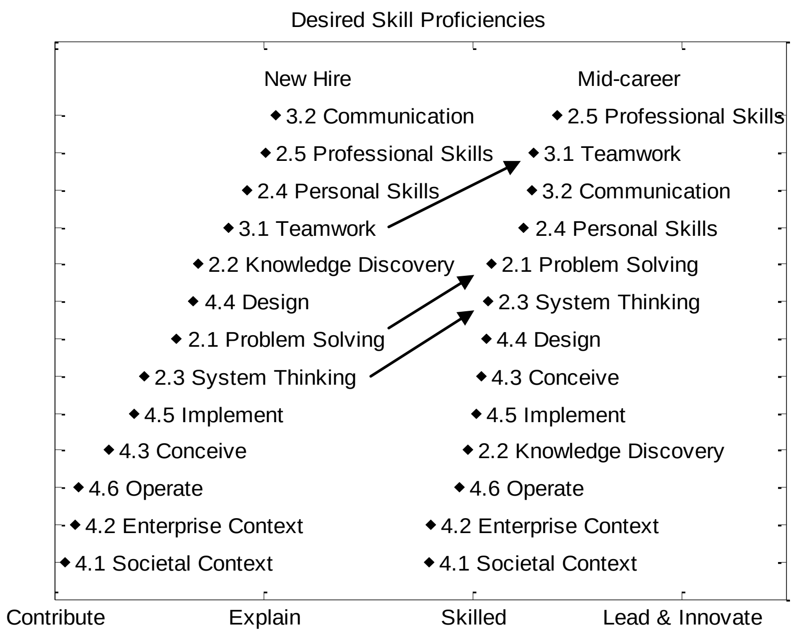

Figure 3. Rank-ordered Engineering Skill Proficiencies

Skill Development Locus

As a correlating measure, the survey asked where respondents expected the mid-career engineer to have developed each of the CDIO skills. The goal was to assess the locus where managers expected development to occur. The results depicted in Figure 4. The center diamond indicates the average of respondents' answers, and the bar indicates ± 1 standard deviation. Importantly, none of the skills will be matured in solely an academic or work context, implying an expectation that *every* skill should receive at least some exposure in academic setting, while recognizing that *every* skill will be further matured in the work setting. Second, only two skills appear to the left of the center, 'Knowledge Discovery' and 'Communication', indicating that there's a strong expectation that educational programs will place significant emphasis on these skills. "Design" appears barely right of the meridian, indicating that hiring managers likewise expect new hires to have substantially been exposed to design prior to entering the government workforce. An alternative explanation is that design skills aren't typically matured in the context of the SYSCOMs' work. The prior results rebut this interpretation, given the high expected design competence of mid-career and executive level engineers.

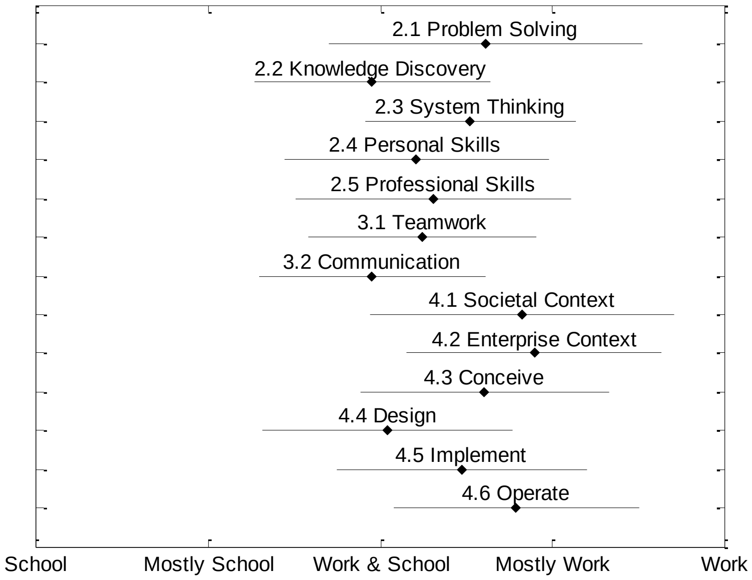

Figure 4. Skill development locus

Those skills have been reordered in Figure 5 in descending order of the emphasis for academic institutions. As several natural breaks occurred, the skills were grouped as "deserving focused academic emphasis", "deserving deliberate academic development", and "deserving academic exposure". The emphasis is reassuringly similar to the skills that floated to the top of our rank-ordered skills from Figure 3.

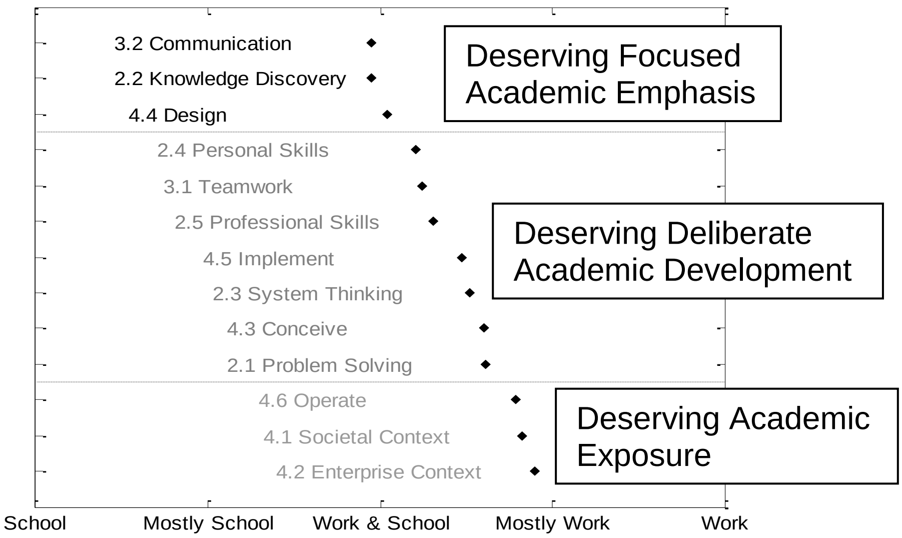

Figure 5. Skill development locus

Mathematics Competency

Engineering faculty routinely bemoan the mathematical proficiency of today's engineering students, which they perceive to have slipped significantly over recent decades. A variety of causes are attributed in the literature, to include premature placement in calculus while in high school, and a premature or over-reliance on technological tools (such as advanced calculators) [1].

Survey respondents were asked to rate the frequencies with which particular math domains are utilized in their SYSCOM workplace. Results are depicted in Figure 6, the diamonds indicating the average across all respondents, and the horizontal bar indicating the standard deviation. Probability and statistics lead the list, a topic typically required only by EE undergraduate programs. The foundational domains of calculus and differential equations appear last on the list. A glance at the ME, EE and Aero programs of eight prominent East Coast engineering schools revealed that ¾ of those 24 programs require a programming course; ½ require courses in Probability and Statistics; ½ require linear algebra; and only ¼ require numerical methods.

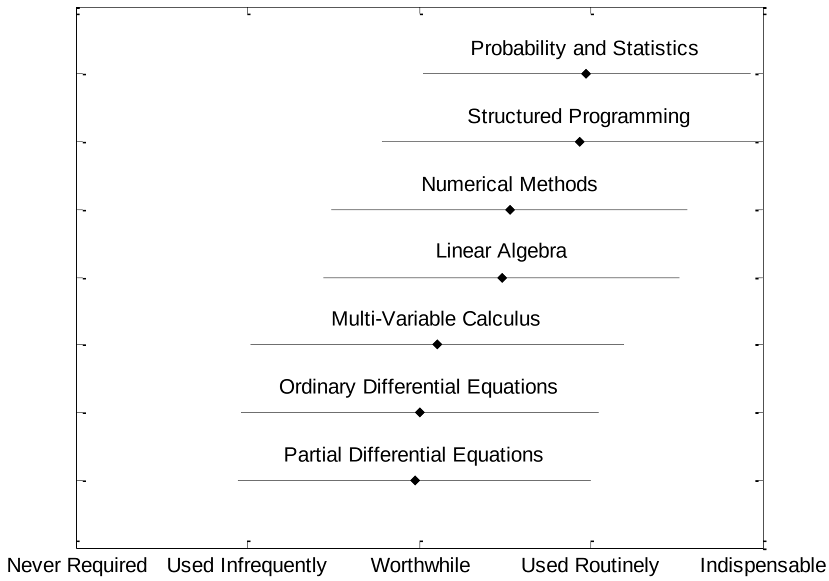

Figure 6. Workplace Dependence on Math Skills

The design space for undergraduate engineering programs is very tight, and other demands have squeezed "advanced" math topics out of many programs. Calculus and ordinary differential equations (ODEs) are considered foundational for the study of both physics and most engineering science, and hence ubiquitous, yet survey respondents indicate that those skills are the least commonly used in the workplace. Some undergraduate programs require one additional semester of math, beyond the four semesters of calculus and ODEs, yet those other topics appear most likely to be used in the Navy's engineering workplace, and the choice might be left to the student. Consequently, programs serving Navy engineering organizations at the undergraduate and graduate level should ensure engineering students have the opportunity for formal mathematics beyond the basic four semester calculus/ODE sequence, and that the application of math to upper-level courses emphasizes those skills that managers indicate will be most used in their workplace.

Survey Mechanics

Conduct of the CDIO survey in other settings asked respondents to grade the desired proficiency of both their respected peers and new hires. We and others had found that asking respondents to first assess their peers had the desirable effect of calibrating respondents so that they did not inflate the desired attributes of new hires. Once they candidly admitted they themselves were not '5' down the list, a reasonable score would result for the new hire.

In this edition of the Syllabus Survey, other stakeholders asked for two other benchmarks, the post-secondary student and the mid-career engineer. The proficiency score of "0: no exposure" was added to permit the post-secondary student to be graded at that level for some skills. After the survey was complete, we realized that we had asked respondents to characterize four career milestones using a scale with only 6 possible increments. The insertion of another career milestone above and below the new-hire appeared to bound the new-hire results, such that the highest scores were not has high, nor the lowest scores as low, as those observed in previous editions of the survey conducted by USNA with a similar constituency, albeit smaller. For example, the highest rated skill, "Communications" dropped from a competency level of 3.4 to 3.1. Conversely, the lowest ranked skill, "External Context", rose from a score of 1.6 to 2.0. Significantly, the ranked order of skills changed very little, with Figure 2 above capturing almost the identical order observed in the 2003 survey conducted by USNA Aerospace. Consequently, we do not believe that the scores can be legitimately compared with other editions of the CDIO Syllabus Survey, as conducted by other institutions, or our own legacy results. The post-secondary results proved of little value and should not have been solicited; they diluted the value of the primary study concern and added to the respondent's effort. The mid-career data is of interest, and yielded worthwhile insight. If it's to be repeated by other institutions, they should allow for a half-point scale. Importantly, since the application of the data is principally in the relative emphasis received in an academic program's design, the above defect does not invalidate the survey's use in rank-ordering a curriculum's targeted skills, as we've done above.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions apply to undergraduate engineering programs serving the Department of the Navy. Foremost, soft skills development such as communications and teamwork rank in criticality with traditional technical skills such as problem solving, and deserve similar focused attention. Second, the survey results point to appropriate weighted emphasis for program design. Visiting committees, program administrators, and institutional leadership should ensure their program design addresses the demand signal represented by these results. Finally, most programs neglect the math skills development that supervisors indicate are most commonly applied in their workplaces. Departments should openly deliberate program mathematics requirements in light of the above findings.

The following conclusions apply to graduate programs serving the Department of the Navy. First, the survey affirms the importance of research and project work, as captured by the high rating assigned to Knowledge Discovery. This affirms traditional elements of graduate level study, such as thesis research or capstone design experiences. Of import however, many skills not emphasized in graduate programs deserve pointed emphasis to include the non-traditional elements of communications, teamwork, and systems engineering. These two are also sought from the Masters experience, with academic development complementing the workplace development of these skills.

Results of this study are not necessarily generalizable to other large engineering enterprises, but may be representative of the needs of government engineering agencies worldwide whose work is paired with industry partners. The Navy's engineering workforce is engaged in work that's distinct even from their defence-industry partners. It does however represent the application of the CDIO syllabus survey to a very large engineering enterprise with a significant stake in US engineering education.

REFERENCES

[1] Jamieson et. al., *Creating a Culture for Scholarly and Systematic Innovation in Engineering Education*, American Society for Engineering Educators, June, 2009.

[2] Jesse McCurdy (NAVAIRSYSCOM AIR-4.0B), CDIO syllabus survey cover letter to NAVAIRSYSCOM engineering supervisors, June, 2010.

[3] National Academy of Engineering. *The Engineer of 2020: Visions of Engineering in the New Century*. Washington, DC: National Academy Press, 2004.

[4] National Academy of Sciences, National Academy of Engineering, Institute of Medicine. *Rising Above the Gathering Storm, Revisited: Rapidly Reaching Category 5*, The National Academies Press, Washington, D.C.

[5] Crawley, E. F., Malmqvist, J., Östlund, S., & Brodeur, D. R. *Rethinking engineering education: The CDIO approach*. New York: Springer, 2007.

[6] http://www.cdio.org/knowledge-library/cdio-syllabus. [accessed 31 Mar 2011]

[7] E.F. Crawley, R. J. Niewoehner, Jean Koster. "North American Aerospace Project: Adaptable Design/Build Projects for Aerospace Education," *AIAA Aerospace Sciences Meeting*, Orlando, FL, Jan, 2011.

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The survey was conducted on-line using the imbedded survey tools of the Sharepoint software on the NSERC (Naval Systems Engineering Resource Center), accessible solely to Navy clients. The survey was approved by OPNAV (OPNAV Report Control Symbol 3540-7) and the Naval Academy Institutional Research Board (USNA Assurance Number #DoD N-50042, and HRPP Approval # USNA.2009.0019-IR-EM2-A).