Implementing the NEET Ways of Thinking at MIT and Assessing their Efficacy

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Work in Progress
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Abstract

Industrial and societal needs for engineering education have transformed in the past decades while traditional undergraduate engineering education has remained largely unchanged. In Fall 2016, the Dean, School of Engineering, Massachusetts Institute of Technology (MIT) chartered the New Engineering Education Transformation (NEET) program with the aim of educating engineers to design and build the "new machines and systems" that will address major societal needs and challenges of the 21st century. NEET alumni will be prepared to work as entrepreneurs, innovators, makers, and discoverers, through learning and practicing the NEET Ways of Thinking: cognitive approaches that help students think, plan, and learn more effectively and efficiently on their own and within teams. Student enrollment in the program steadily increased from 28 in Fall 2017, through 52 in Fall 2018, to 83 in Fall 2019, making the program significantly larger than most new academic programs in the past, and larger than many majors. Starting in Fall 2018, NEET began to pilot the Ways of Thinking (WoT) through cross-school initiatives at MIT, where faculty and colleagues in the School of Humanities, Arts and Social Sciences and the School of Architecture + Planning began leading efforts jointly with engineering faculty to develop short modules. There were 25 such modules implemented starting Fall 2018, Spring 2019 and Fall 2019, specifically in Ethics, Creative Thinking, Critical Thinking, and Self-learning. We describe how those modules were developed and piloted, how their efficacy was assessed, what were the lessons learned from their implementation, and implications for the future. One of the key findings is that the Ways of Thinking should be more integrated into the students' project work in NEET. We conclude by describing our plans for further integration of the Ways of Thinking into NEET, including their rigorous assessment to optimally inform academic program design.

I. Introduction

In this paper, we set out to describe the incorporation of the NEET Ways of Thinking (WoT) into the New Engineering Education Transformation (NEET) program at the Massachusetts Institute of Technology (MIT), focusing on undergraduate engineering education. This paper is divided into the following four sections: first, we provide a snapshot of the NEET program. Next, we describe the evaluative assessment already carried out on the pilot implementation of four of the twelve Ways of Thinking in NEET, including lessons learned from the pilots and analyze and present implications arising from our learning. We then outline our future plans and intentions for continuing to pilot these four, and other Ways of Thinking. We conclude with a reaffirmation of the direction taken by the NEET pilots and a summary of next steps.

II. A Snapshot of the NEET Program

A. Why MIT Decided to Embark on the New Engineering Education Transformation Program

Present-day industry seeks employees with skills that go beyond the technical skills acquired in a standard engineering program, the so-called "non-technical" skills, some of which are normally not acquired during traditional undergraduate education [1], [2]. The need for students to acquire those skills is reflected in a paper produced by the Organization for Economic Cooperation and Development (OECD) [3] and the US National Research Council [4]. More specifically in higher engineering education, the student outcomes [5] of the Accreditation Board for Engineering and Technology (ABET) also list some non-traditional skills.

Charles Vest, former MIT president who subsequently served as president of the National Academy of Engineering, has said that as engineering science evolved through World War II, it continued to move engineers away from practical engineering [6]. Researchers have claimed that undergraduate engineering curricula should equip alumni with the thinking skills required for facing current and future challenges, even in favor of content knowledge [7], [8]. For any higher education institute to be able to deliver this new education to its students, it must develop strategies for action, and not just 'visions' which in themselves do not lead to

substantial lasting change [9]. Following an MIT-NEET commissioned global benchmarking study [10], NEET has recognized the impending need to provide students with more opportunities for practical engineering and help them acquire those thinking skills. In Fall 2016, the Dean, School of Engineering, Massachusetts Institute of Technology (MIT) chartered the New Engineering Education Transformation (NEET) program with the aim of educating engineers to design and build the "new machines and systems" that will address major societal needs and challenges of the 21st century.

B. Background

This section describes the background and contents of the New Engineering Education Transformation (NEET) program at MIT.

In Fall 2017, MIT's School of Engineering launched the first two pilots of the NEET program. The goal of NEET is to prepare students to become future entrepreneurs, innovators, makers, discoverers, and leaders [7].

NEET is voluntary and though it does not fulfill any requirements toward an engineering degree as prescribed by MIT, it is mapped to those requirements so that it is minimal additional load for students in the program. Students enter as sophomores and after successfully completing the entire three years of the program (as well their major), receive a NEET Certificate. As of the start of Fall 2019, there were 163 students across sophomore, junior and senior years who had registered for NEET, with the first cohort of students in their senior year about to complete the program at the end of the current academic year. Though it is far too early to come to meaningful conclusions for the medium to longer term, the initial response is encouraging as can be seen in Table I.

Table I. Student Enrollment in NEET Program – Fall 2017, 2018 and 2019

Year enrolled in NEET (class)	N Students at the beginning of each term	As a % of students studying for an engineering major
Fall 2019 ('22)	83	~ 17%
Fall 2018 ('21)	52	~ 9%
Fall 2017 ('20)	28	~ 5%

These are significantly larger numbers than those typical for many new academic programs in the past, and larger than the enrollment in many majors.

NEET is based on the following four principles:

1. Our education should focus on preparing our students to develop the new machines and systems that they will build in the middle of the 21st century.
2. We should help our students prepare themselves to be makers, discoverers or positioned along this spectrum, and we should teach engineering fundamentals as a foundation for careers in both research and practice.
3. We should build our education around the way our students learn best, engaging them in their learning, and implementing pilots to understand the desirable balance of classroom, project, and digital education for the digital natives.
4. In view of the speed of scientific and technological development, we should teach students how to think more effectively, and how to learn more effectively on their own.

There were three fundamental artefacts that emerged from the evidence gathering, analysis, discussions, and deliberations in the first phase of NEET [7]: what we have termed as the project-centric curricular construct; the concept of cross-departmental pathways that we have termed as “threads”, and; the “NEET Ways of Thinking”, cognitive approaches such as creative thinking, critical thinking and systems thinking that can help individuals think and learn more effectively on their own throughout their lifetime. The five threads being piloted are the following:

- **Advanced Materials Machines**: Explore the novel materials, technologies, and processes that will define the future of fabrication and manufacturing.
- **Autonomous Machines**: Design, build and deploy electromechanical systems, electronics, software, and autonomy algorithms for real-world robots.
- **Digital Cities**: Prepare to plan and build the cities of the future by immersing scholars in the emerging intersections of computer science and urban planning.
- **Living Machines**: Discover, build and engineer living systems for broad applications in biotechnology and medical devices.
- **Renewable Energy Machines**: Combat climate change by designing and building green energy production, conversion, storage, and transmission systems.

Earlier papers have already dealt with the thinking behind the NEET initiative, its goals, strategy, progress till mid-Spring 2019, initial student feedback and response, the project-centric approach and community development in two of the threads, and how it is connecting with industry [7], [8].

C. Student Projects in NEET

Figure 1 provides a schematic of NEET's project-centric approach.

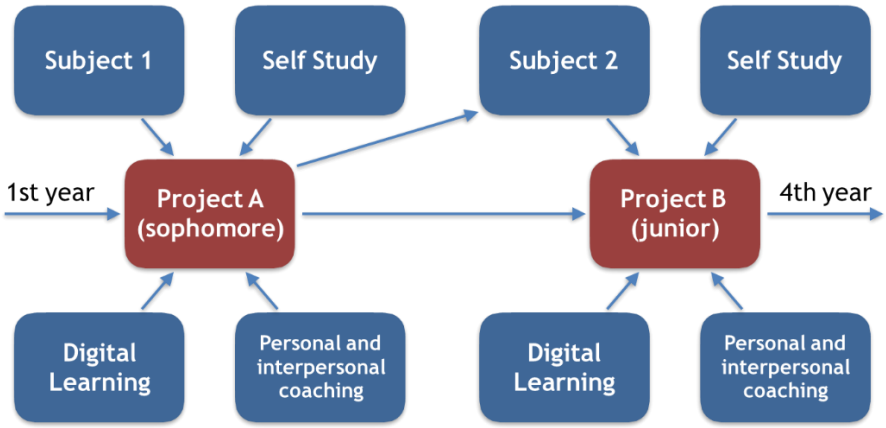

Figure 1. The New Engineering Education Transformation program process

Arrows represent input of knowledge and competencies into projects or subjects.

Most of the students' time in NEET is taken up by engineering projects of varying scope and difficulty. The program also includes guest speaker sessions and more traditional lectures and lab lessons to impart students with the STEM knowledge and skills required for doing project work in their respective domains. Students begin in sophomore year doing individual or pair-based projects, continue into junior year doing projects in small teams of 3–5, and end in senior year doing projects in larger teams.

During projects, students conceive, design, develop, implement, and test machines and systems for solving problems taken from the real world. NEET offers MIT's undergraduate engineering students an opportunity to choose one of five application domains (threads) of 21st century engineering systems and then engage in projects within that domain. A project – the conceiving, designing, and testing of one system or one solution to a problem – may take one semester or an entire year.

Figure 2 is a schematic representation of the stages of a typical project in NEET. In practice, the process of carrying out a project is not linear; for example, while developing a solution it

might become apparent that changes need to be made to the design. However, this schematic representation is useful for purposes of curricular and instructional design.

Figure 2. Generic stages of a typical project in NEET

'Conceive Solution' may be instructor- or student-directed, depending on the thread and year in the program.

D. Ways of Thinking in the New Engineering Education Transformation Program

The Ways of Thinking are those cognitive approaches, both traditional and non-traditional, which NEET aims to imbue in its undergraduate engineering students. They were formulated based on a dedicated global benchmarking study commissioned by NEET [10], interviews with more than 40 senior managers in industry (see Appendix), surveys of more than 40 MIT alumni, discussions with MIT students, faculty and academic leadership, and inputs gleaned from thought leaders and previous research on this topic, all detailed previously [7]. There are twelve NEET Ways of Thinking: Self-Learning; Making; Discovering; Interpersonal Skills; Personal Skills and Attitudes; Creative; Systems; Critical; Analytical; Computational; Experimental; and Humanistic. The definitions for the Ways of Thinking can be found on the MIT-NEET website[1]. At MIT, it is mandatory for students to take eight semester-long subjects in humanities and social sciences. Students told us that they did not want to take semester-long classes covering the Ways of Thinking, which they viewed as additional humanities classes. This necessitated the creation of new interactive content which we have termed as 'modules'.

The formal incorporation into the program of the Ways of Thinking began in Fall 2018. Resource experts from other schools in MIT came forward to develop standalone modules for specific Ways of Thinking, tailor them to specific project classes and deploy them during two-hour time slots. A single exception to this approach was the involvement of the Creative Way of Thinking experts in co-instruction on one project class which was shared by the junior year of two different threads in NEET. The modules developed were as follows:

[1] https://neet.mit.edu/about/ (see bottom of page)

- Ethics (Personal Way of Thinking) --- Department of Linguistics and Philosophy, School of Humanities, Arts and Social Sciences and the Gordon Engineering Leadership (GEL) program, School of Engineering
- Creative Thinking --- Department of Architecture, School of Architecture + Planning
- Critical Thinking --- Program in Science, Technology and Society, School of Humanities, Arts and Social Sciences
- Self-learning --- MIT Library

We believe that this is more sustainable than engineering faculty taking classes in these WoTs, since the resource experts will keep building on new knowledge in those WoTs, much of it created through their research and scholarship.

Table II summarizes the various sessions that were taught to students by Ways of Thinking experts in NEET during Fall 2018 and Fall 2019. A–D refer to the four threads in which the Ways of Thinking were taught. In thread A, four sessions were taught in Fall 2018 and Fall 2019; in thread B there were ten sessions (including one class co-taught with the regular instructor); in thread C there were six; and in thread D there were five (including one class co-taught with the NEET instructor). The fifth thread has not yet had any Ways of Thinking sessions. In total, 25 sessions were taught to students by experts during Fall 2018 and Fall 2019.

Table II. Ways of Thinking Sessions in NEET – Fall 2018 and Fall 2019

Way of Thinking	Fall 2018	Fall 2019	Total N sessions
Creative Thinking	-	Sophomore (A, D) Junior (B) Senior (B)	4
Ethics (Personal)	Sophomore (A, B, C, D) Junior (A, B, D)	Sophomore (A, B, C, D) Junior (B)	12
Critical Thinking	-	Sophomore (B, C) Junior (B, C) Senior (B, C)	6
Self-learning	-	Sophomore (B, C, D)	3
Total N sessions	7	18	25

Table III outlines the learning objectives for three of the above Ways of Thinking: Ethics (Personal), Critical Thinking, and Self-learning. Each session with each Way of Thinking had

its own list of expected learning outcomes, depending mostly on which year in the program (sophomore, junior, or senior) the session was taking place.

Table III. Learning Objectives of Three of the NEET Ways of Thinking

Way of Thinking	Learning Outcomes
Ethics (Personal)[a]	Develop a sense of proximity between their engineering work and ethical issues. Recognize when an engineering decision has ethical implications. Employ ethical reasoning to navigate engineering decisions. Assess the impact of engineering decisions on personal and societal contexts.
Critical Thinking[b]	Conceptualize seemingly closed autonomous systems as heteromated socio-technical systems with submerged human choices. Actively recognize the benefits and costs of different forms of expertise. Recognize and respond to the competing politics of technical systems and choices.
Self-learning[c]	Recognize specific contexts in which knowledge exists, knowing that it does not exist in a vacuum. Identify different kinds of information and environments within which types of knowledge exist. Use appropriate tools and strategies to locate and use information sources for learning. Identify unsolved problems and use that to articulate what else they need to know or understand. Develop and vet their ideas and theories about a research problem to guide their work. Understand social biases and how they impact and influence knowledge and innovation. Recognize larger societal and historical implication of their work and the work of others in their field. Realize their own agency and develop strategies and practices that influence equity in accessing and benefitting from human knowledge

[a] MIT Dept. of Linguistics and Philosophy, [b] MIT Program in Science, Technology, and Society, [c] MIT Libraries.

III. Evaluative Assessment of Incorporating the Ways of Thinking into NEET

Evaluative assessment was carried out for the Fall 2018 Ethics sessions, by way of questionnaires handed to students at the end of each session. We also received anecdotal feedback from students for sessions of other Ways of Thinking. In future, we intend to progress to evaluative assessment for all four Ways of Thinking, as described below in

Section IV on 'Future Plans and Intentions for Incorporating Ways of Thinking into NEET'. As Table IV shows, student feedback on the Ethics sessions was overwhelmingly positive.

Table IV. Student Feedback on Ethics Sessions, Agreement with Statements – Fall 2018

Statement	Sophomore (*N* = 17)		Junior (*N* = 25)	
	M agreement[a]	*% high agreement*[b]	*M agreement*[a]	*% high agreement*[b]
This seminar session has inspired me to further develop my sense of moral responsibility	4.3	82	4	78
...has helped me to be able to envision ways in which an engineer can face conflicting pressures on the job	4.5	94	4.1	78
...has helped me to be able to test whether decisions I make as an engineer align with my values	4.2	82	3.8	67
I believe it is worth MIT engineering students' time to participate in this session	4.7	94	3.8	78

[a] Level of agreement with statement, from 1–5 in whole numbers, [b] score of 4 or 5 out of 5. Results are given herein as provided by a formal report made by the Ethics experts for a different body from NEET. Source: MIT Dept. of Linguistics and Philosophy (9.30.2019). Integrating Ethics Education into New Engineering Education Transformation (NEET). *d'Arbeloff Fund Final Report*.

Students were also asked to provide free form comments and feedback. It was here that some constructive comments appeared alongside the positive ones. Table V summarizes the themes of these comments.

Table V. Student Feedback on Ethics Sessions, Free Form Comments and Feedback Fall 2018

Themes Identified in Students' Comments	Sophomore (*N* = 17)	Junior (*N* = 25)
Positive	General sense that the session was worthwhile and enjoyable Session helped students make connections between ethics concepts and real-world engineering scenarios Session inspired students to think more deeply about ethics; to explore ethics further going	Session engendered sense that ethical implications are proximal to students' own work as engineers Students benefited from group work

	forward	
Constructive	Session felt too short or abbreviated Session wasn't as personalized for individual learning needs as students desired	Session competed with time sensitive, end-of-term assignments Session wasn't as dynamic as it could have been

A. Key Lessons Learned

1. In most domains and in most years, the Ways of Thinking were not taught explicitly outside of the dedicated sessions. On the whole, the Ways of Thinking experts recognized the need for integrating their material into project syllabi and specific stages of projects.
2. Some sessions of different Ways of Thinking included the same topics. For example, the Creative and Self-learning sessions both looked into stakeholder management.
3. Resource experts from different departments and disciplines may use the same terms differently. For example, the Critical and Ethics ('Personal') Ways of Thinking experts both used the word 'critical thinking' but gave them different meanings.

B. Implications for Future Plans

1. Examples of ethical situations need to be more specific to the thread domain, e.g., for the Autonomous Machines thread, to autonomy and robotics.
2. Some of the sessions were constrained to 60 minutes, and others to 90 minutes. Going forward, thread instructors should ideally allow 90 minutes of classroom time.
3. The 90-minute version of the session includes substantive coverage of a common set of "moral lenses" that can be used to evaluate specific decisions. This coverage includes time to provide examples of decision testing, and to debate/discuss the decision testing with students. Student feedback points to the need to include this content in the sessions.
4. In future years, sessions should be scheduled earlier in the term at times that do not compete with other student assignments.

5. In future seminars, instructors will include more dynamic presentations. Additional group work, which students expressed liking, may also help in this regard.

IV. Future Plans and Intentions for Incorporating the Ways of Thinking into NEET

This section outlines (1) Ways of Thinking sessions planned for Spring 2020, (2) our intentions for integrating the Ways of Thinking into projects, (3) coordinating the Ways of Thinking across threads, and, (4) how we intend to assess the efficacy of these incorporation efforts.

A. Sessions Planned for Spring 2020 semester

The Ethics and Creative Ways of Thinking sessions will continue to take place in spring 2020. We also intend to add a new Way of Thinking session on teamwork, which is part of the Interpersonal Way of Thinking. Table VI shows the Ways of Thinking we plan to pilot in Spring 2020, together with previous years, for comparison.

Table VI. Ways of Thinking Sessions in NEET – Fall 2018 to Spring 2020

Way of Thinking	Fall 2018	Fall 2019	Spring 2020 (planned)
Creative Thinking	-	Sophomore (A, D) Junior (B) Senior (B)	Sophomore (B)
Critical Thinking	-	Sophomore (B, C) Junior (B, C) Senior (B, C)	-
Teamwork (Interpersonal)	-	-	Junior (A, C) Senior (B)
Ethics (Personal)	Sophomore (A, B, C, D) Junior (A, B, D)	Sophomore (A, B, C, D) Junior (B)	Junior (A, C) Senior (B)
Self-learning	-	Sophomore (B, C, D)	-
Total N sessions	7	18	7

B. Integrating Ways of Thinking into NEET Projects

Since teaching all the Ways of Thinking in every stage of the project is an impossibility in terms of time, instructor expertise and resources, we chose a mixed approach for future integration of the Ways of Thinking. This first involves priming students by way of a

standalone session, similar to what has already been done in Fall 2018 and Fall 2019, but possibly shorter in duration. Then, during the project itself, we will identify together with the class instructors what stages during the project have maximum potential impact. These are stages where an activity for facilitating a particular Way of Thinking could potentially produce the best learning outcomes. For example, we would argue that the Creative Way of Thinking would have the most impact on the design stage of the project, whereas the Critical Way of Thinking would have the most impact on the 'implement and test' stage. During those points in the project, we would introduce activities with experts and also design and develop tools for instructors and students to use without need for expertise. These tools would be designed and developed by the NEET team in collaboration with the Ways of Thinking experts and thread instructors, and thereafter included in the project syllabi.

Figure 3 shows our suggestion for incorporating the Ways of Thinking in specific project stages for maximum impact on learning outcomes.

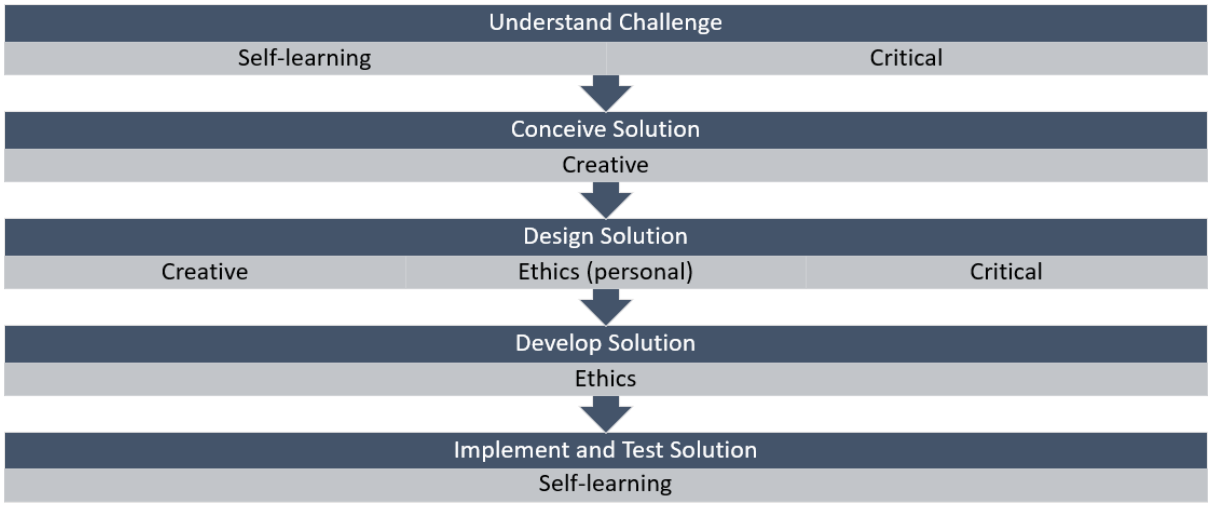

Figure 3. Example of Ways of Thinking integrated into syllabus in each project stage

C. Coordinating Ways of Thinking Across Threads

We intend to coordinate the incorporation of Ways of Thinking across thread years, so that within each thread there will be a similar progression of Ways of Thinking being introduced. For example, since most sophomore years do not engage in teamwork, we intend to introduce the Interpersonal Way of Thinking in the junior year. Other Ways of Thinking, such as Making, are important to introduce right away in the first semester of the sophomore year. This coordination would build a "just-in-time" progression for NEET students across three

years, help the NEET team to design tools, activities, and syllabi, and allow for better knowledge sharing across threads.

D. Assessing the Efficacy of Integrating Ways of Thinking into Projects

In future semesters, we intend to further develop and integrate assessment across threads. The assessment can be carried out on any combination of the following: person (perceptions, attitudes, and so forth), process (cognitive or physical), product (artefact/machine), and environment (curriculum, methods, instructors, classroom, and so forth). We also plan to carry out interviews and questionnaire studies with NEET alumni to compare their development of the Ways of Thinking with alumni who did not participate in the program. Table VII summarizes our future intentions for assessment in NEET.

Table VII. Potential Assessments in NEET

Type of assessment	Assessor	Intended purpose	Potential assessment instrument
Self	Student	To facilitate self-regulated learning	Reflection journal/form
Formative	Instructor	To guide learning in real-time	Mini quiz
Summative	Ways of Thinking resource experts	To evaluate the outcomes of intervention versus its objectives	Ways of Thinking self-report questionnaire
Evaluative	Program assessors	To evaluate the success of the program versus its objectives	Attitudes questionnaire

V. Conclusion and Next Steps

In this work-in-progress paper, we described piloting of the NEET Ways of Thinking – cognitive approaches that students require to become entrepreneurs, innovators, makers, and discoverers --- in the New Engineering Education Transformation (NEET) program. Four of the twelve Ways of Thinking have already been piloted and the lessons learned are helping guide future design and implementation.

We intend to begin integration of the Ways of Thinking, including facilitation and assessment, into specific stages of students' projects and into the syllabi of the various project classes. This integration will require a cross-School approach and close collaboration of the NEET team with Ways of Thinking resource experts from the Schools of Humanities, Arts and Social Sciences, Architecture + Planning, and Management, as well as with NEET thread faculty and instructors, to achieve an optimal mix of approaches. We expect that with time and as more of the Ways of Thinking become integrated into the program, the thread instructors themselves will gain basic expertise in guiding the teaching of the Ways of Thinking.

With project-centric curricula and non-traditional skills increasingly being recognized as being essential to engineering education worldwide [10], we intend to continue designing, developing and implementing more Ways of Thinking into NEET and in a more integrative manner, to better prepare students for the challenges they will face in employment, entrepreneurship or graduate studies.

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Appendix – Interviews with Senior Managers in Industry

Table A. Interview with Senior Managers in Industry – Expected Proficiency

Expected Proficiency How competent do you expect a graduating MIT engineer to be in each of these areas? **Interviewee name/company:_____** **Interviewed by: [Interviewer name]** **On:** **Consent form sent?** ***Please rate each of the 11 competencies listed below, in terms of Expected Proficiency (0-5):*** **Expected Proficiency** 0. To have essentially no knowledge of 1. To have experienced or been exposed to 2. To be able to participate in and contribute to 3. To be able to understand and explain 4. To be skilled in the practice or implementation of 5. To be able to lead or innovate in
Making – Innovating, by inventing and bringing about solutions that have never before been in existence: conceiving (understanding needs and technology, and creating concept), designing, implementing, and operating products and systems that deliver value
Discovering - Advancing the knowledge of our society and world by exploring, identifying, and generating new learning, often by conducting research that employs scientific methods and leads to new fundamental discoveries and technologies
Interpersonal Skills – Engaging with and understanding others: communicating, listening, dialog and emotional intelligence, working in and leading teams, collaboration and networking, advocacy, and leading change
Personal Skills and Attitudes – Initiative, judgment and decision making; responsibility and urgency; flexibility and self-confidence; acting ethically and with integrity; social responsibility; dedication to lifelong learning
Creative Thinking – Forming something new and somehow valuable, for example by focusing thought, incubating new ideas, illuminating them in conscious awareness, and verifying
Systems Thinking – Predicting emergence of the whole by examining of inter-related entities in context, in the face of complexity and ambiguity, for homogeneous systems and systems that integrate multiple technologies

Critical and Metacognitive Thinking – Assessing the worth or validity of something that exists, by analyzing and evaluating information gathered from observation, experience, or communication
Analytical Thinking – Working systematically and logically to break down facts and resolve problems, identify causation, and anticipate results, often by applying theory, modeling, and mathematical analysis
Computational Thinking – Using computation to understand physical, biological, and social systems by applying the fundamental constructs of computer programming (abstractions, modularity, recursion), data structures, and algorithms
Experimental Thinking – Conducting experiments to obtain data: selecting measurements, determining procedures to validate data, formulating and testing hypotheses
Humanistic Thinking – Developing and exploiting a broad understanding of human society, its traditions, and institutions: knowledge of human cultures, human systems of thought, the social, political, and economic frameworks of society; and modes of expression in the arts

Note: 'Self-learning' is not listed in Table A. It was added subsequent to this survey as the twelfth Way of Thinking.

Open-ended Questions

1. Why do you hire MIT engineering students?
2. What are their strengths compared to students from other good technical universities?
3. What skills and competencies do they need to strengthen?
4. When you are hiring, are you hiring for current projects or immediate needs, or are you hiring for future project needs based on trends in technology?
5. How do you expect new engineering hires to commonly learn new skills and competencies?

Findings

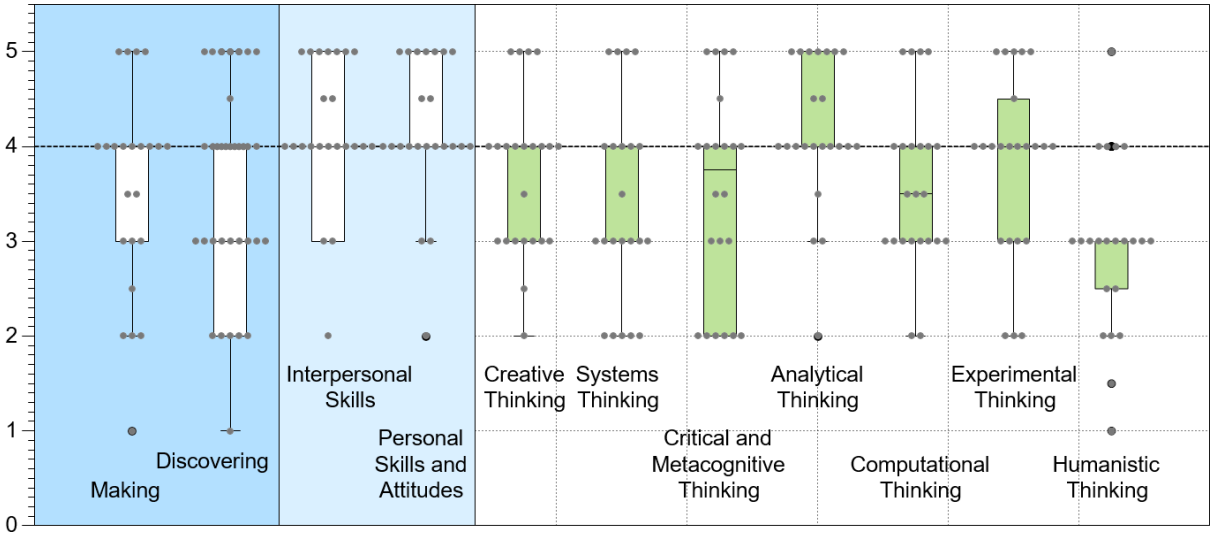

Figure A. Senior managers' ratings (0=low to 5 = high) of a graduating MIT engineer's expected proficiency in the Ways of Thinking

Figure B. Word cloud of senior managers' responses to the first open-ended question, "Why do you hire MIT engineering students?"

Figure C. Word cloud of senior managers' responses to the second open-ended question, "What are their strengths compared to students from other good technical universities?"

Figure D. Word cloud of senior managers' responses to the third open-ended question, "What skills and competencies do they need to strengthen?"

Figure E. Word cloud of senior managers' responses to the fourth open-ended question, "When you are hiring, are you hiring for current projects or immediate needs, or are you hiring for future project needs based on trends in technology?"

Figure F. Word cloud of senior managers' responses to the fifth open-ended question, "How do you expect new engineering hires to commonly learn new skills and competencies?"