

## **Using Science to Support and Develop Employees in the Tech Workforce — An Opportunity for Multidisciplinary Pursuits in Engineering Education**

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# Using Science to support and develop employees in the tech workforce - an opportunity for multi-disciplinary pursuits in engineering education

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## Introduction

The majority of students who choose to major in engineering do so to become a part of the community of practice of professional engineers (Johri & Olds, 2011), meaning that they want to have adequate exposure to what a career as a professional engineer could potentially be as part of their college experience. However, according to Jonassen (2014), engineering graduates are not well trained to contribute to the workplace due to the complexities associated with engineering work. Stevens, Johri, and O'Connor (2014) described engineering work as that which involves complexity, ambiguity, and contradictions. Since developing the skills for innovation involves analysis of complex, ambiguous, ill-defined, real-world problems (Daly, Mosyjowski, & Seifert, 2014; Newell, 2010), students must have an opportunity to, at the very least, be exposed to multi-disciplinary teams. This emphasis on the need for exposure to multi-disciplinary problem solving holds true not only for undergraduate engineers in training, but also for graduate students focused on engineering education.

This paper draws from experiences of a multi-disciplinary research team studying researching talent management in the tech industry, including an engineering education research scientist, Industrial Organization (IO) psychologist, economists, and program and product managers to present lessons from leading with science to understand, inform, and better employee experiences at a large private technology company. Through examples of two types of analyses that the multi-disciplinary team has taken on (i.e., conducting experiments and content validation research), we exemplify how projects in industry leverage multi-disciplinary expertise. Finally, we provide recommendations for educators teaching engineers as well as training engineering educators to help understand how multi-disciplinary teams come together in the engineering workforce.

The purpose of this paper is two-fold: we want to highlight some typical roles within multidisciplinary teams in the tech workforce, by highlighting composition of one such team working on talent management, and also provide recommendations for undergraduate learners in STEM to understand how teams leverage a multitude of expertise in diverse domains to provide the best solutions.

## Multi-disciplinary teams and Talent Management Research

Schneider (1987) in his seminal paper in *Personnel Psychology* explains that employees' thoughts, attitudes and behaviors, are what make organizations. When organizations exist in particular environments and have particular technologies, they need people with particular kinds of competencies (Aldrich, 1979). In this paper, we draw from our experiences to provide an

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example of a multi-disciplinary team conducting talent management research within the tech workforce of the 21<sup>st</sup> century, and describe some of the typical roles one may find at similar tech teams that engineers and engineering educators may join.

Talent management research refers to research on the people that make up organizations. A typical employee life cycle is illustrated in Figure 1 below. An employee journey begins when they are recruited and hired by an organization. This is typically followed by a selection process in which an organization interviews the candidate, comes to the determination that they are the right fit for the role, and makes a financial offer that the candidate accepts. The employee then goes through the onboarding process, in which they are introduced to their work environment and organizational culture (Cable, Gino, & Staats, 2012.) After the initial onboarding phase, the employee continues to develop within their role, learning technical skills required for the job and building relationships with their supervisor, teammates, and fellow employees (Kurtz & Bartram, 2002.) As the employee develops their technical and interpersonal skills aligned with the role, they will differ in terms of the engagement (Rich, Lepine, & Crawford, 2010) they experience in connection to their roles, as well as their performance within the role (Doer et al., 2004.) They may undergo engagement assessments to measure their feelings of connection to their work and performance management practices to measure their aptitude for the work. At some point, employees may begin exploring opportunities inside or outside the organization, and will experience changes to their organizational commitment (Meyer & Allen, 2001) and turnover intentions (Bothma & Roodt, 2013.) Concurrently, organizations may attempt to retain their employees, often with a focus on high performers (Hausknecht & Rodda, & Howard, 2009.) At some point it is likely that the employee separates from the organization, and may once again become a potential candidate to recruit.



**Figure 1: Stages in an employee lifecycle.**

Note that HR products are involved in all of these stages of employees' life cycle within the company. An HR product can be a website that helps new hires navigate the activities they must complete when they first join the company, or a website that allows managers to collect the input they need to put one of their direct reports up for a promotion. Research in human resources

often aims to understand how employees interact with these products, what are their customer needs and pain points, and how to improve their experience.

This research is often conducted by multi-disciplinary teams, which consist of people from different backgrounds and who have experience with different research methodologies. Table 1 below lays out typical roles on a multi-disciplinary science team engaged in talent management research.

<b>Role</b>	<b>Primary Task</b>	<b>Example of Key Contributions</b>
Program Manager	Employee Listening Instruments (e.g., surveys and focus groups)	Idea initiation (e.g., Analyze employee sentiment to propose a program to improve an outcome.)
Data Scientist	Modeling, Analysis, Predictions	Idea Validation (e.g., Explore existing data and identify trends or patterns that support the proposal.)
Business Intelligence Engineer	Analysis	Dashboard Development (e.g., Works with Product and Program to build ongoing product health dashboards and metrics)
Data Engineer	Build Pipelines	Scale (e.g., Propose avenues to scale data collection)
Research Scientist / Behavioral Economist	Mixed Methods Research; Causal inference or Experimentation	Experimentation and Evaluation (e.g., Define success, Validate content, Where applicable, conduct randomized experiments to evaluate the impact of an intervention.)
Applied Scientist	Productionization of Research	Implementation (e.g., Work to Productionize models into Product to support interventions )
Software Developers and Product Managers	Product Development	Development (e.g., Incorporate science into product for initiative to reach employees)

**Table 1: Typical Roles on Multi-disciplinary Talent Management teams**

In industry, science projects may start with research scientists taking the lead on diving deep to understand the customer’s problems. In some cases this information is obtained through voice of the customer surveys or focus groups. In the human resources space, voice of the customer surveys are often tied to HR products and employees fill them out after interacting with the experience.

Scientists work together with product managers to identify the root causes of customer pain points. Through that research, Product then design interventions or product features that can address them. In this stage, research scientists can collaborate with applied scientists,

economists, and data scientists depending on the action that is being taken in the product experience. In all cases there is engineering work required to make the desired changes, integrate the product with additional features, or setup the infrastructure to pilot new experiences.

These product innovations are accompanied by an evaluation plan to measure the causal effect of the changes or new features on the outcomes of interest. The goal of the evaluation plan is typically to determine if the customer problem has been solved, which is often the definition of success. Economists and data scientists typically lead the causal inference part of the science workflow.

It is not always required to have all of the steps listed out above to introduce an intervention for employee journeys. For example, if the product/program manager has a clear intervention designed to be tested out, then economists can start to design and implement the experiments without the idea generation stages. However, as a multi-disciplinary science team, it is often the case that people rely on each other's expertise, conduct research studies and productionize science to improve employee's talent outcomes as a collective effort.

In some cases the product generated by the project itself generates a new cycle of innovation on behalf of employees. When the product is a completely new feature, there is an opportunity to restart the innovation cycle by measuring its impact and making adjustments where needed. In these cases the multi-disciplinary effort again leverages different areas of expertise. Research Scientists can propose new psychometric measures, and use qualitative research to redefine "success". Data Scientists and Business Intelligence Engineers can validate the new measures and link them to more established employee outcomes. Applied Scientists and Data Engineers can work on the model innovations and scalability while still allowing for monitoring of engagement and metrics collection. Economists can design the evaluation plan, taking as input the new definition of success, and ensuring that the evolution of metrics can be measured in a causal way. Program/Product and Software Engineers can then continue to focus on future iterations to the product, ensuring a continuous cycle of innovation.

### **Case One: Experiments and the Employee Experience**

As highlighted above, it is important to evaluate the interventions that are implemented to solve customer problems. In some cases it is possible to use randomized experiments to pilot these solutions. A randomized experiment, also known as Randomized Control Trial, or A/B test, is an evaluation strategy that assigns participants into treatment and control groups randomly. The randomization design is necessary to isolate the intervention as the cause of changes between two groups (e.g., treatment and control), and not to some other co-occurring variation. Without randomization, these differences could be driven by other factors, such as characteristics of participants in these groups, different environments or context that they face, among other things.

Tech companies have for decades favored A/B tests to understand adoption choices by customers. They also conduct experiments to determine the most effective approaches for managing people and maintaining a productive environment. An example is Lazear (2000) who studied the impact of piece rates on productivity. The study estimated a 44% overall improvement in productivity due to piece rates by gradually implementing a new compensation

scheme. Around 22% of this was due to greater effort (the incentive effect), and the remaining 22% reflected sorting (better new hires) or potentially some other factors. Workers hired after the new scheme was implemented were on average 28% more productive than the ones hired in the old regime.

Experimentation is an effort that requires collaboration among Science, Product, and Engineering teams which means it is typically multi-disciplinary in nature. Experiments typically have three phases: the pre-experiment planning, the implementation and monitoring, and the post-experiment analysis. During the pre-experiment planning, Science, Product, and Engineering work together to translate the business problem at hand into testable hypothesis, make ethical and legal considerations and submit the research proposal for review if applicable, define the details of the intervention, design the randomization, define the metrics to be captured, etc. The input of Engineers is especially important in defining how the intervention will be implemented, which randomization design is feasible, and how metrics will be collected and share with the Science team. The implementation of the experiment itself is usually owned by the Engineering team, whereas the conditions of the experiment (e.g., treatment allocation and ongoing monitoring) are managed by the Science and Product teams. The post-experiment analysis involves Economists, Data Scientists, and Research Scientists, who need to collaborate with the Business Intelligence and Engineering teams to access metrics associated with the experiment and, if applicable, output the desired results in a scalable way.

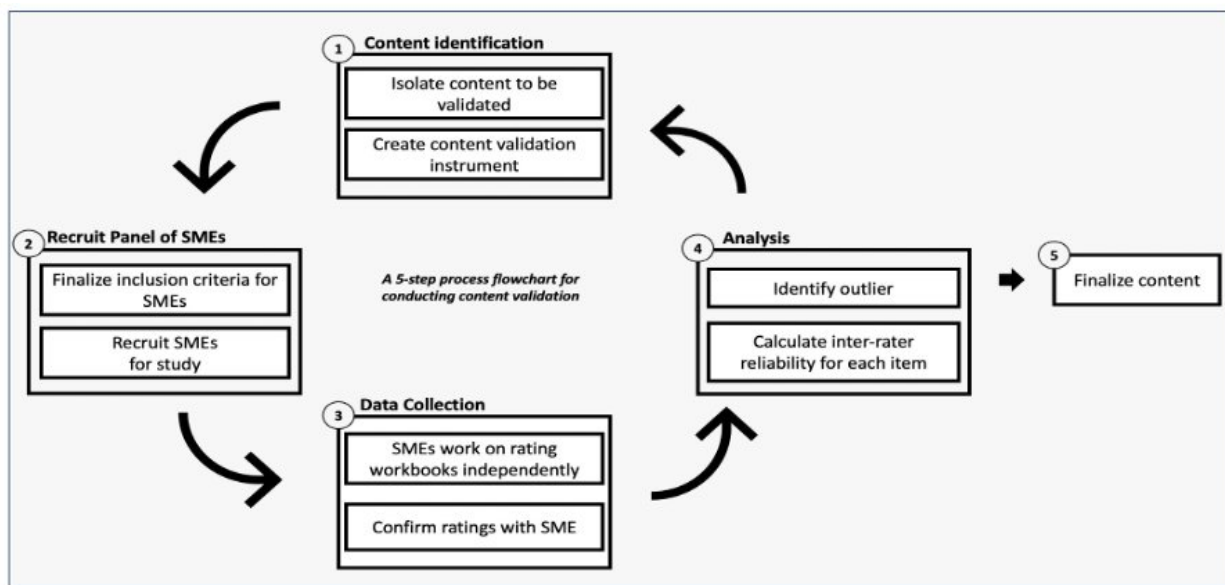
Another note on the importance of multidisciplinary teams in this context is to have diverse perspectives on the research design. For example, in the case of randomization, the design ensures that one cannot cherry pick who receives a treatment. But still the concern that treatment assignment will not enhance conscious or subconscious biases, ethical and legal risks must be adequately debated. One ethical/legal concern is whether not receiving the intervention will prevent the employee from accessing an input or feature that is necessary for their work. Another ethical/legal concern is whether certain demographic groups are more or less likely to engage with the intervention, and how that could enhance existing disparities. Tech companies mitigate these risks by having mechanisms to review the ethical and legal concerns of randomized experiments before their implementation. These mechanisms then include additional roles, e.g., lawyers, ethicists, etc. to weigh in on the projects, thus further expanding the scope of an already multi-disciplinary endeavor.

### **Case Study Two: Content Validation of Documents for High Stakes Employment Decisions.**

Content validation can lay the foundational work to establish additional validity and reliability claims that improves the quality of content and assessments and any decisions or inferences made using them. Psychology of decision-making investigates why and how decisions regarding personnel are made. In a tech organization, content is artifact that reflect how decisions regarding talent (e.g., onboarding, promotions, evaluations) may be driven. Content validation exercises pave the way for addressing the psychology behind personnel decision-making at tech companies, by examining artifacts and content that employees regularly rely on to make high stakes decisions in the workplace.

Validity is the degree to which evidence and theory support the interpretations of content for proposed uses of content. Two primary forms of validity that have been well supported by institutions such as The Principles for the Validation and Use of Personnel Selection Procedures and the Uniform Guidelines on Employee Selection Procedures, in addition to legal precedent, are *content and criterion validity*. Content validity is the concept that selection measure content must appropriately sample the job content domain. That is, the KSAs represented in hiring instruments must be aligned with the actual KSAs of the job. Generally content validity is established through a job analysis, which often involves receiving information from subject matter experts regarding the importance and frequency of critical incidents related to the job (Gatewood, Field, & Barrick, 2016.) Criterion validity is the relationship between performance on selection assessments and performance on the job, generally measured with correlations between each, or a regression when there are multiple selection inputs (Gatewood, Field, & Barrick, 2016.)

Content validation is an iterative process. Depending on the content under consideration, content validation projects can take anywhere between one quarter to several quarters to complete. The cyclical process of validating content is represented diagrammatically in Figure 1.



**Figure 2: Overview of the iterative steps in the Content Validation Process**

Developed content goes through several iterative steps for it to be valid. First, content is identified and a validation instrument is created. Second, a panel of subject matter experts are recruited who then work together or independently to rate the content. Once data is collected, ratings are confirmed across SMEs and outliers are identified. Content with ratings that are outliers are isolated, and the validation process is repeated by modifying the content and consulting with SMEs. Once rating on all content pass a pre-decided threshold for inter-rater agreement, the content is finalized and ready to be used and interpreted.

### **Recommendations for Educators**

### **1. Include more multi-disciplinary exposure to engineering students.**

Early exposure to a breadth of disciplines could help prepare engineering and engineering education students to pursue careers in areas that are multi-disciplinary in nature, such as Talent Management Science. Exposing students to these disciplines will give them an prepare them to work collaboratively to approach a problem, contribute value to the team, and help guide the team towards a shared objective. This exposure may also improve their problem solving abilities and critical thinking skills in general, since they will learn to look at the problem from different angles before choosing a suitable path forward.

### **2. Encourage internships.**

Internships are a great way to prepare students for careers on multi-disciplinary teams. One benefit is to allow students to learn if they like and think they can thrive in that environment. The second is to already start acquiring the necessary skills to succeed in these positions early on. Internships which have a component around rotation across teams, also allow students to gain wider appreciation of how different positions interact, before having to dive deep into one role. On completion of junior-year internships, students can then bring back acquired skills to their final year classes, capstone projects, and interactions with career development professionals as they prepare to attain their first position after graduation.

### **3. Exposure to Multiple Avenues to Develop Cross-functional Communication Skills**

A non-trivial challenge in projects that involve combining expert knowledge across different backgrounds is around verbal and written communication. Each field has their own theories, jargon, and unique perspectives on the same problem. It is helpful if educators can include courses that help students effectively present their ideas not only to peers with similar backgrounds but also to peers who come from different backgrounds and have varying levels of technical depth, e.g., explaining technical concepts to non-technical stakeholders.

### **4. Engage in Career Exploration and Early Progress Towards Career Preparedness**

Vital to career success is finding the right match, which is usually a function of extensive career exploration, that students may be under-estimating their preparedness towards (e.g., Carrico, Matusovich and Bhaduri, 2023). People move across different science roles based on their interests, and on changes in the workforce. It is critical to engage in exploration of career trajectories, aside those that are more traditionally sought. Knowledge of transferable skills also plays an important role since some roles in the tech industry may have significant overlap with one another. Going through a career counselling session around the subtle nuances of the different roles in the industry can significantly help students find their true passion.

## **Concluding Thoughts**

Engineering education does not end in universities since engineers continue to learn, advance, and develop as professionals in the workforce. This presents an opportunity for engineering education research within tech companies to better understand, and consequently equip, employees through their career journeys from onboarding onto teams to exiting teams and even exploring new roles. Research, in such contexts, is often mixed methods, with large, often global, multidisciplinary teams working to solve for challenges at the intersection of organizational psychology, professional development, careers choices and trajectories, science, product



development, and emerging technology.

## References

American Educational Research Association. (2018). *Standards for educational and psychological testing*. American Educational Research Association.

Binning, J. F., & Barrett, G. V. (1989). Validity of personnel decisions: A conceptual analysis of the inferential and evidential bases. *Journal of Applied Psychology*, 74(3), 478–494. <https://doi.org/10.1037/0021-9010.74.3.478>

Bothma, C. F., & Roodt, G. (2013). The validation of the turnover intention scale. *SA journal of human resource management*, 11(1), 1-12.

Cable, D. M., Gino, F., & Staats, B. R. (2013). Reinventing employee onboarding. *MIT Sloan Management Review*.

Carrico, C., Matusovich, H. M., & Bhaduri, S. (2023, June). Preparing Engineering Students to Find the Best Job Fit: Starting Early with the Career Development Process. In *2023 ASEE Annual Conference & Exposition*.

Doerr, K. H., Freed, T., Mitchell, T. R., Schriesheim, C. A., & Zhou, X. T. (2004). Work Flow Policy and Within-Worker and Between-Workers Variability in Performance. *Journal of Applied Psychology*, 89(5), 911.

Daly, S. R., Mosyjowski, E. A., & Seifert, C. M. (2014). Teaching Creativity in Engineering Courses. *Journal of Engineering Education*, 103 (3), 417- 449. doi:10.1002/jee.20048

Gatewood, R., Feild, H. S., & Barrick, M. (2015). *Human resource selection*. Cengage Learning.

Hausknecht, J. P., Rodda, J., & Howard, M. J. (2009). Targeted employee retention: Performance-based and job-related differences in reported reasons for staying. *Human Resource Management: Published in Cooperation with the School of Business Administration, The University of Michigan and in alliance with the Society of Human Resources Management*, 48(2), 269-288.

Johri, A., & Olds, B. M. (2011). Situated engineering learning: Bridging engineering education research and the learning sciences. *Journal of Engineering Education*, 100(1), 151-185.

Jonassen, D. (2014). *Engineers as Problem Solvers* Cambridge Handbook of Engineering Education Research: Cambridge University Press.

Kurz, R & Bartram, D (2002) Competency and individual performance: Modelling the world of work. In Robertson, Callinan & Bartram (Eds.) *Organizational Effectiveness – The Role of Psychology*. Wiley.

Lazear, Edward, P. 2000. Performance Pay and Productivity. *American Economic Review*, 90 (5): 1346-1361.

Meyer, J. P., & Allen, N. J. (2001). Organizational commitment. *Personnel psychology and human resource management: A reader for students and practitioners*, 289-342.

Rich, B. L., Lepine, J. A., & Crawford, E. R. (2010). Job engagement: Antecedents and effects on job performance. *Academy of management journal*, 53(3), 617-635.

Schneider, B. (1987). The people make the place. *Personnel psychology*, 40(3), 437-453.

Stevens, R., Johri, A., & O'Connor, K. (2014). Professional Engineering Work Cambridge Handbook of Engineering Education Research: Cambridge University Press.