Board 100: Work in Progress: Developing a Body of Knowledge to Illustrate Advanced Manufacturing Competency and Identity

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Abstract

In this theory-driven work in progress, we: 1) provide the history and justification for a Body of Knowledge (BOK) in the context of technician education and professionalization; 2) detail our method for creating an advanced manufacturing (AM) BOK; and 3) share subsequent steps to vet and validate the AM BOK with the AM community. We conclude with an examination of a BOK's potential impacts on and contributions to AM's dynamic evolution and maturation as a technical field. The imperative for this paper is that technical fields like engineering and information technology have developed BOKs to guide their practitioners, employers, educators, and researchers to a common set of material understandings. These understandings establish social norms and cultural expectations for a professional field. AM also encompasses specific knowledge, skills, and dispositions, yet currently has no prevailing BOK. As one of the fastest growing technical fields, AM education and professional identity construction requires an articulation of what it means to practice AM and how AM practitioners enact the field's competencies. Because BOKs are also valuable to guide curriculum, employer expectations, and professional advancement, we explored ways to create an AM BOK and assembled an initial BOK that we are currently testing through research and community engagement.

Motivation and Background

Advanced manufacturing (AM) is a fast growing, dynamic, and economically instrumental industry sector. In response, many community colleges and undergraduate-serving institutions have established technician education programs to prepare future workers to support AM vitality and innovation. However, in the rush to couple market and training demands, stakeholders have not agreed upon a definition of the field. Without a central notion of AM, core competencies and professional identities of AM workers are likewise unclear [1].

As AM stakeholders and participants work toward a unified understanding of the field, a Body of Knowledge (BOK) is be an important step in defining the profession and its necessary competencies [2]. A BOK is a collection of essential concepts, terms and activities within a profession or subject area; it contains structured knowledge that is used by members of a discipline to guide their practice or work [3, 4]. BOKs proscribe the knowledge in a particular area that an individual is expected to have mastered to be considered or certified as a practitioner [5]. Though BOKs are grounded in the breadth of a profession's norms and practices, they also reflect the current state of the profession's identity. BOKs are dynamic, and must be systematically distilled and monitored as collection of activities and outcomes representing a profession's most current values, constructs, models, principles and instantiations. This monitoring entails continuous discovery and validation work by members of the profession with a goal of self-reflection and reproduction of the profession [6]. BOKs, then, are competency taxonomies that are specific but inclusive; updated and refined, i.e., "curated," as profession changes; and guide, but not dictate, professional education, professional learning, and assessment. Professionals are not meant to master the breadth of the competencies in a BOK, but focus on the depth of content that allows them specialize.

Many theories address professional identity development. What a professional knows and how a professional defines him or herself are inextricably linked, particularly in the engineering field [7]. Because BOKs can function as roadmaps to acculturation, as Figure 1 illustrates, a BOK is a key element in the model of a profession [8].
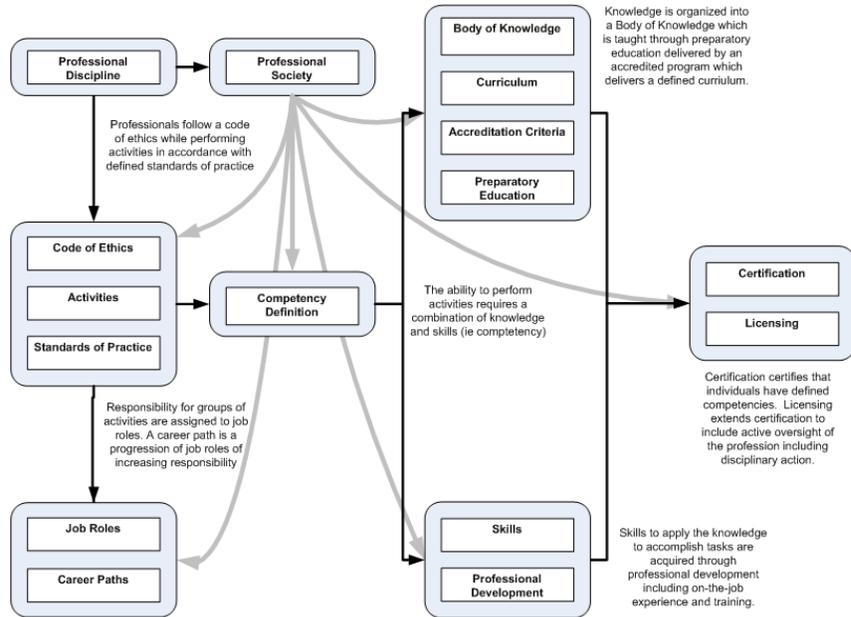

Figure 1. Model of a profession [6, p.6]

As Figure 1 illustrates, through professional societies, professional disciplines follow a code of ethics and have standard of practice that guide their activities in job roles and elaborated career paths [9, 10]; competencies define and are defined by these activities. Professional societies foster active research efforts to advance the state of the profession's knowledge. The resulting knowledge is distilled into a clearly defined core BOK that reflects the knowledge, methods, and practices that define the content of the profession. The BOK guides curriculum models that support the establishment and improvement of educational programs and accreditation criteria to assure the quality and suitability of the preparatory education. This content guides the preparatory education in which the learner gains knowledge and skills necessary be employed in an entry level position as well as the professional development required for learners to remain effective workers.

In addition to formal education, professional models also encompass certifications and licensing as emblems of competence. With the support and promotion of professional societies, industry input is blended with current skill needs to provide a means to express competency through practice (e.g., apprenticeship or experience). These mechanisms are consistent with the BOK and validated by a community of professional peers.

Body of Knowledge Development Process

AM will thrive as a field with a strong base of professionals who share a common set of ethics and knowledge based on a BOK. An AM BOK, in the context of a professional model like the one depicted in Figure 1, will also ensure that formal learning frameworks and industry competencies mutually reinforce. To this end, we are developing an AM BOK to test and refine in the context of a large-scale triangulation of AM program syllabi, job posting content, employers' preferred entry-level competencies, and new professionals' on the job experiences. To conduct this analysis, we need a "lingua franca," or central vocabulary of competencies, that will allow us to compare these various data sets. We have developed and are currently enacting the BOK development process illustrated in Figure 2.
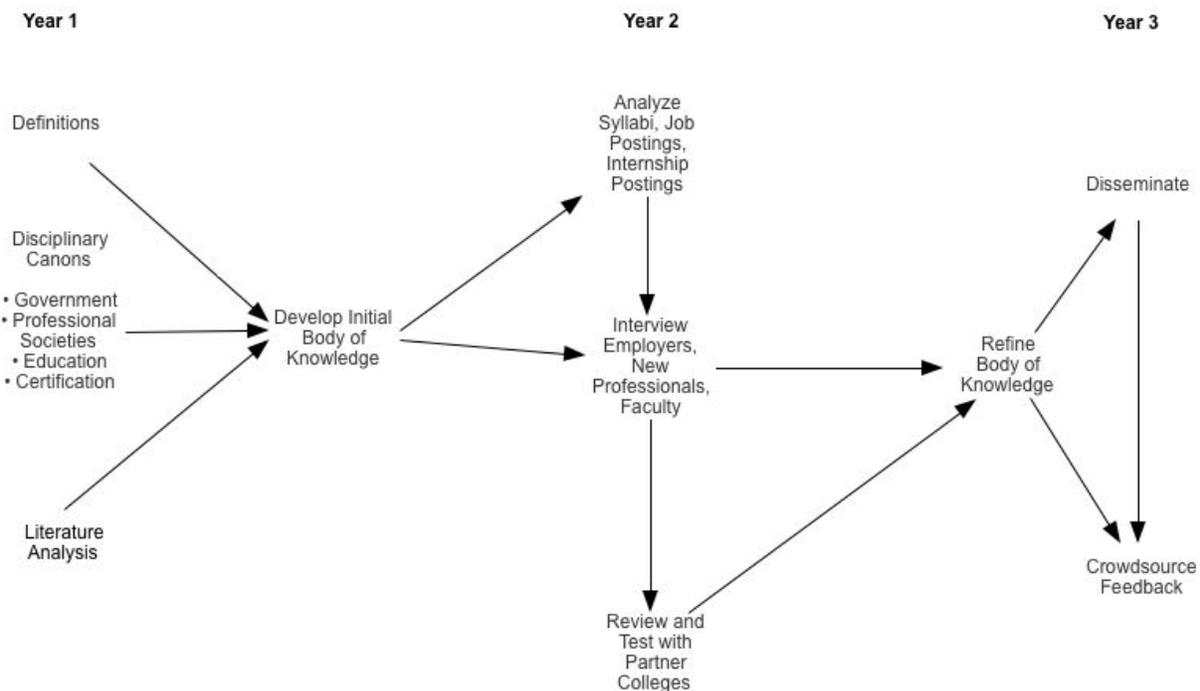

Figure 2. Body of Knowledge development process

As Figure 2 suggests, in Year 1 of the development process, we are reviewing definitions of AM and determining their variability and breadth. In this process, we are culling AM disciplinary canons, or key governmental, professional, educational, and industry source documents to surface desired competencies. Our BOK preparatory step in Year 1 also included a large-scale analysis of scholarly literature to discern knowledge, skills, abilities, and dispositions credited to effective AM professionals. These data sets are being distilled into an initial BOK that we will test in initial syllabi analyses and review with our study participants and partners. We will refine the BOK to reflect feedback. We are conducting the analyses using Natural Language Processing to associate the textual data with the BOK competencies; from the result, we will generate potential new competencies using open and axial coding of text that does not match the BOK. We will add these potential competencies after vetting them through our educational and industry partners.

In Year 2, we will repeat the syllabi analyses and also use the BOK to analyze job and internship posting content. We will also use the BOK to analyze new professional, employer, and faculty interview data. We will also compare the analyzed data sets to one another to ensure that the BOK analyses allow for comparison. Once we have again reviewed our results with our partners and participants, we will further refine the BOK and disseminate it to the BOK community. We will not only disseminate our BOK development process and content via scholarly channels, but also crowdsource feedback by sharing the BOK in a way that interested parties can comment.

Initial Body of Knowledge Development Results

To date, we have "seeded" our initial BOK with the competencies defined in the U.S Department of Labor (DOL) competency model [11] featured in Figure 3. For the purposes of this project, the DOL competency model is considered canonical.
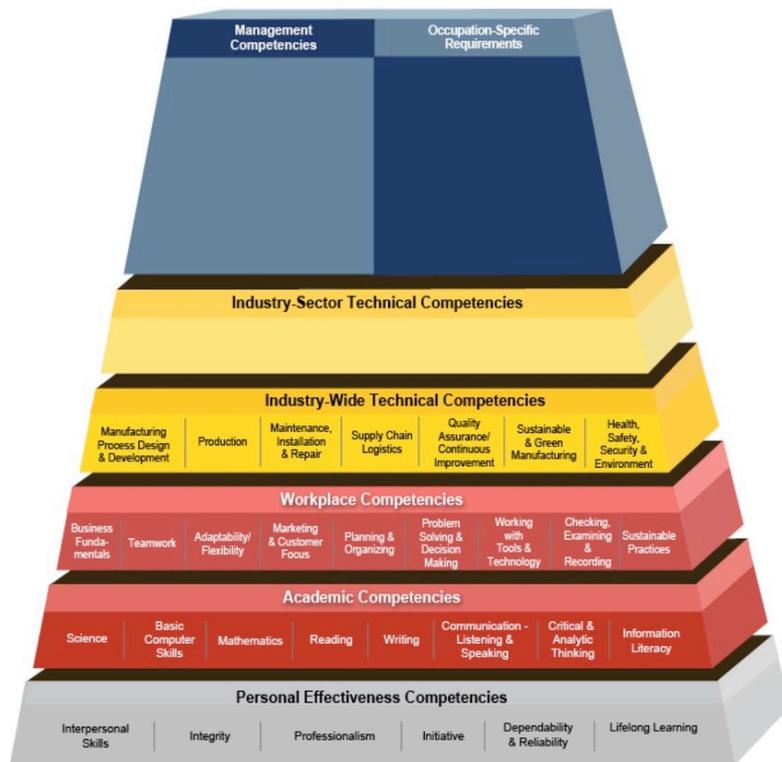

Figure 3. Advanced Manufacturing competency model [9].

As Figure 3 suggests, the Advanced Manufacturing Competency Model contains tiers of skills, knowledge, and abilities essential for successful performance in the industry. At the base of the model, the competencies apply to a large number of industries. As a reader moves up the model, the competencies become industry and occupation specific. The DOL also makes detailed model competencies available in text form [12], and we used that content to start our initial BOK. Our study participants have reviewed this initial BOK and agreed that its content was a good foundation upon which to build with additional information gleaned from other sources,

Concurrent with this early BOK development, we have been conducting AM definition analyses and further reviewing canonical documents and relevant scholarly literature. We have compiled syllabi and job postings as well as begun to gather interview data. These inputs will allow us to identify additional competencies for the BOK.

Significance of This Work

Professional identity is characterized by "a constant becoming" that defines who we are by: "the ways we participate and reify ourselves; our community membership; our learning trajectories (where we have been and where we are going); reconciling our membership in a number of communities into one identity; and negotiating local ways of belonging with broader, more global discourse communities [13]." In this way, professional identity and professional practice as "mirror images of each other" [13], but with no agreed-upon definition, the emerging and dynamic field of AM lacks a means for reflection. A BOK, developed, tested, and refined with in the AM community, will act as a mirror and allow AM worked to not only be educated to perform AM competencies but also to embody and enact lives as vested members of the AM profession.

Acknowledgement

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