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Augmenting Traditional ME Curriculum with Digital Badge Microcredentials

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Augmenting traditional ME curriculum with digital badge microcredentials

Digital badges and microcredentials were initially the vision of educational technology thought leaders and visionaries and have been promoted as a potential alternative to traditional credentialing. Recent years have seen more mainstream adoption of digital badges offered by traditional higher education institutions, MOOC providers like EdX, and large companies such as Walmart and IBM. The Department of Mechanical Engineering at The Pennsylvania State University has been offering microcredentials since 2018 and as of Spring 2021 has awarded over 210 individual badges. In this paper we provide a brief overview of the contemporary microcredentialing landscape, describe our pedagogical framework and infrastructure for designing and implementing digital badges within Mechanical Engineering, and highlight key findings from learning analytics and student experiential data.

I. The Current Landscape of Digital Badges and Microcredentials

What are digital badges?

Digital badges exist at the intersection of advances in educational technology, a growing societal interest in alternatives to formal university credentials, and an increasing awareness of open educational resources [1]. Digital badges are images typically displaying information such as the badge name and the issuing organization. They are also clickable and can embed detailed metadata about the badge including things like learning competencies and individual learner work products. Because of this, digital badges have been promoted as being more informative than a traditional transcript. When they are produced using a certified interoperable platform enabling them to be shared across platforms, digital badges become open badges [2].

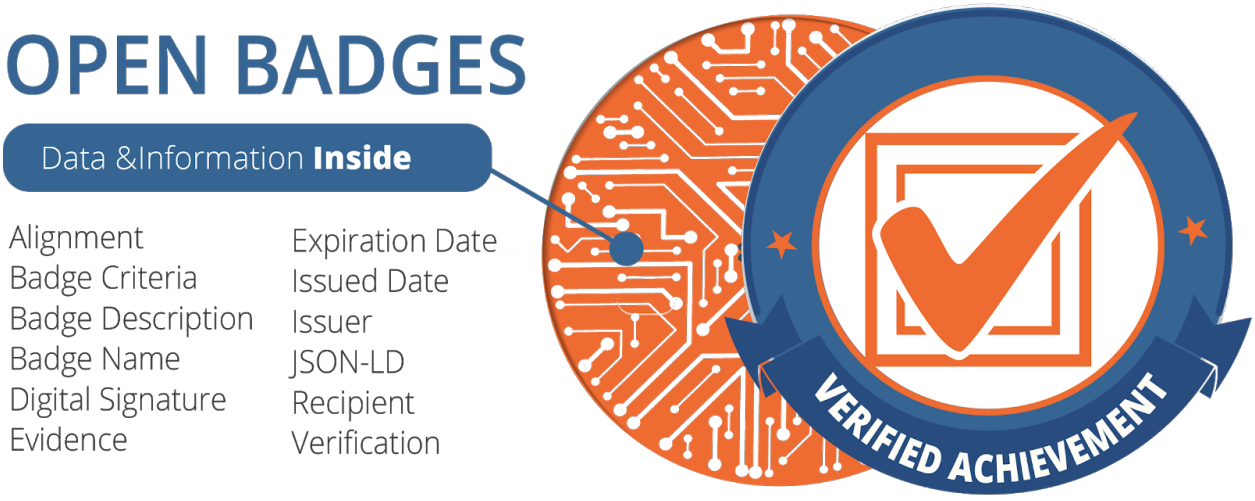

Figure 1. Open Badges image from https://openbadges.org/ created by IMS Global Learning Consortium. Image licensed under Creative Commons Attribution 4.0 International License

Importantly, open badges disrupt the traditional practice of the issuing organization owning the credential. Consider that graduates of a university often have to pay that same institution to get a verified copy of their own transcript. In the new landscape of open badges, the credential lives with the learner, not the issuing organization. When badges are created using an open badges platform as verified by IMS Global, the organization facilitating badge interoperability, the

learner can collect digital credentials in one place, a "badge backpack," regardless of the source [3].

This represents an important shift in thinking about educational credentialing and parallels other qualitative shifts enabled by new technologies such as media enabled by YouTube generated by individuals rather than media production companies. A further characteristic that distinguishes badges is that they are grounded within competency-based education. In a traditional course, all students are exposed to the same content, complete the same assessments, and do so within the same timeframe. What varies in this environment are the grades students receive which theoretically reflect their differing levels of course performance. By extension, one is meant to assume that a learner with an "A" knows the material at a higher level than a learner who earned a "C" in the same class. In contrast, competency-based education is based on the belief that actual competency in the specified area is more important than students completing the same content within the same amount of time. While not all digital badges are based on a competency model of education (e.g. some are awarded for participation) many are. This is another way in which the underlying technology affords a more informative credential. For instance, if the competency being recognized is data communication, the badge itself can link to a student's actual presentation that earned the badge. The following image provides an overview of the badge system focusing on a single creative writing badge earned from an issuer, emphasizing the importance of evidence, and the role of the badge backpack. This creative writing badge can live alongside a collection of badges earned from different universities, companies, and MOOCs in the badge backpack. The learner is then able to choose when, how, and which badges to share publicly.

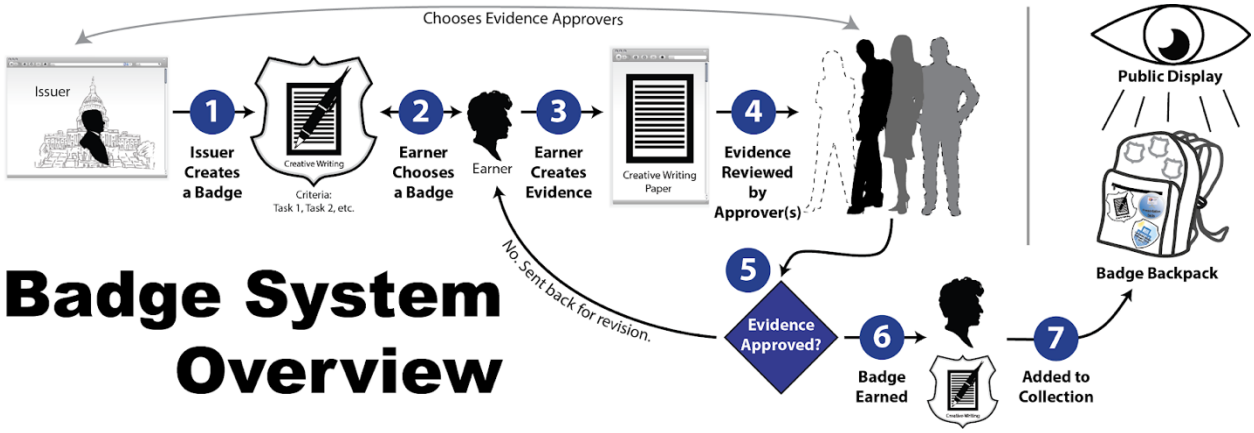

Figure 2. Badge system overview image reused with permission from Brett Bixler.

Who are the key players in this landscape?

Three key types of organizations offering badges are universities, MOOC providers like EdX, and corporations. Some universities award badges for attaining discrete skills within courses [4]. This approach augments traditional credentials such as course credit and provides learners a value add in that they now have transportable digital credentials that live with them rather than with the awarding institution. In addition to offering MOOCs, providers like EdX also now offer microbachelors courses targeting multiple audiences, such as those in graduate school who lack bachelors level competencies and those who want a more affordable way to earn core credits [5]. A third example of a key way in which digital badges are being deployed is large

organizations like Walmart and IBM [6] leveraging a badge platform in order to manage internal training for employees and recognize individual skills and competencies. According to the chief learning officer for Walmart, the goal of their badging initiative is three-fold: recognize discrete employee competencies, create more transparency of skill sets across positions, and provide learners recognition of skills if they do go outside Walmart for future employment [7].

The digital badge and microcredentialing landscape is vast and the reasons for participation varies. The specific instance of digital badge implementation to be discussed for the remainder of this paper falls into the first category of traditional higher education institutions offering digital badges as a value add for existing learners.

How can digital badges help Mechanical Engineering?

Whether they are referred to as "soft skills," "professional skills," "21st century skills," or something else, it is well established that there is a gap between recent graduate's competencies and what industry needs from its new hires. While ME programs continue to emphasize the cultivation of undergraduates who have mastered the technical fundamentals within the discipline as well as experiential learning, the contemporary workforce continues to need employees with skills that are not necessarily emphasized through formal technical training. Knowledge of fundamental topics in mechanical engineering is needed along with important skills that lead to newly employed engineers who can communicate well across positions and levels of technical expertise; manage and lead projects; understand basic business principles needed in small and large companies; and ideate when there are not already established explicit design specifications.

As a curriculum, most Mechanical Engineering programs by necessity are discipline focused, without much flexibility. Curricular changes typically involve a long process and significant justification. There are also a number of required foundational courses such as math, physics, and mechanics that are followed by the obligatory ME-focused courses such as thermodynamics, fluids, dynamics, labs, and design courses. The sheer breadth of required courses significantly constrains the time available to explore other critical skills. These curricula are additionally shaped by ABET, industry needs, and historical inertia, among other things. Lastly, there is the ever-present question of "what can we get rid of" when conversations take place about potentially adding new courses, the frequent answer to which is, predictably, "nothing." Employing digital badges within this context enables departments to address the documented skills gap and the need for development of new competencies and, in doing so, also give learners a way to personalize their ME curriculum.

II. Case Example: Digital Badges pedagogical design, implementation, and evaluation

Having established the broader landscape for digital badges as well as the need for such an innovation within Mechanical Engineering programs, we now discuss our experiences with digital badges starting with our initial exploration of their viability.

Early exploration

The initial motivation for our exploration of badging was our perception that students are missing out on key skills that would serve them well in their careers. Early benchmarking also showed the success being enjoyed by other programs such as work at Purdue University [8] and

the work of other schools like Robert Morris University [9]. Our particular departmental culture led us to survey the 12 members of our industrial advisory board. This group was evenly split on the idea of offering badges. Reasons cited against the badging effort included: 1) many companies already offer extensive in-house training on relevant but non-technical skills, 2) it is not clear if/how badges will be recognized by prospective employers, 3) it was not clear who might teach topics outside of traditional mechanical engineering topics, and 4) there was doubt on the benefit of a concentrated 4- or 8-hour workshop.

Other members of the advisory board were more encouraging. In fact, we immediately had volunteers to teach business- and leadership-oriented workshops. Other board members noted that it is difficult for an individual student to stand out in a large program and participation in an activity such as the proposed workshops does provide evidence of students going beyond the minimum requirements. Industry representatives from smaller companies were more likely to be in favor of the effort and noted that they had no such continuous learning platforms in place.

Even though our industry advisors gave us mixed feedback on the proposal, we still felt strongly about the potential of offering digital badges to our students on topics outside the normal curriculum. An additional motivating factor was the depth of our connections with true thought leaders with relevant expertise. We were confident that we would be able to attract very strong and engaging presenters. Luckily this turned out to be the case.

We recognized that our badge topics must address 21st century skills such as those identified by the ASME 2030 vision including the need to "[s]trengthen teamwork, communication, problem solving, interpersonal, and leadership skills" [10]. We additionally were aware of topic areas like project management that were misunderstood by students to the extent that graduates were accepting project management positions believing them to be managerial in nature. We surveyed our industry advisory board for areas needing improvement in recent graduates, as well as ME alumni for their suggestions for topics they wish they had learned in school. Lastly, as we started offering badges, we also surveyed the participating learners for other topics of potential interest to them.

Within the department, the implementation of the badges has gone through three distinct phases. In the following we will discuss each distinct phase of our digital badging initiative: (1) Phase I (Fall 2018 and Spring 2019); (2) Phase II (Fall 2019 and Spring 2020); and (3) Phase III (Spring 2021).

(1) Phase I (Fall 2018 and Spring 2019)

The first phase was largely a pilot to evaluate student interest and the feasibility of awarding badges. In terms of the pedagogical design of the badges themselves, it was crucial that the badge facilitators had practical expertise in the topic area. Nearly all of the areas identified were outside the realm of expertise of the ME faculty and we recognized the importance of "student exposure to practicing engineers and their experiences" [10]. Wherever possible, we wanted to have an ME alum facilitating the badge given the crucial role of modeling in education and students' natural connection with alumni from their own ME program. Table 1 provides an overview of each of the badges awarded during Phase 1. Important to note is that during this phase, the college itself had not yet invested in a badge platform and with one exception,

Geometric Dimensioning and Tolerancing, all of these badges were awarded through a homegrown university badging system.

TABLE 1:
Badges offered during Phase I (Fall 2018 and Spring 2019)

PHASE I - PILOT (Fall 2018 and Spring 2019)				
	Topic	**Facilitator credentials**	**Badge structure**	**Earned**
FA18	Geometric Dimensioning & Tolerancing	Internationally-recognized subject matter expert; leader in codes and standards community	1-day, 8-hour workshop; two activities w/ multiple choice assessment	36
SP19	Project Management	Pratt and Whitney executive	1-day, 4-hour workshop w/ multiple choice assessment	39
SP19	Value Engineering	VP with Lockheed Martin; ME departmental alum	2-day, 4 hours each day workshop, hands on activity w/ multiple choice assessment	14
SP19	Business Principles	Former executive at General Electric; NAE member; university faculty	1-day, 4 hours workshop w/ multiple choice assessment	18

Student feedback from the early workshops was very positive. The students were essentially unanimous in their praise of the topics, the instructors, and the organization of the workshop sessions. The biggest early challenge was in attracting sufficient numbers of students to participate in a completely optional learning program.

At this point it was recognized that digital badges were a feasible value add for ME students and an initiative that the department wanted to continue. The results were sufficiently encouraging that a full-time teaching faculty with a PhD in learning, design, and technology was hired to oversee the expansion and improvement of the digital badging microcredential program into a permanent part of the undergraduate program.

(2) Phase II (Fall 2019 and Spring 2020)

During Phase II of the department's badge implementation, the College of Engineering had identified digital badging across the college as a strategic focus and in the fall of 2018 invested in the Credly Acclaim badging platform. This formalized the badging efforts, standardized the visuals used for badges from any department in Engineering, and established a larger practice community. For example, during this phase, the department of Architectural Engineering also began awarding digital badges which allowed for more inter-departmental collaboration on badging successes and challenges.

This phase was also marked by a more structured collaboration between the badge facilitator and the director of online pedagogy in terms of the design and marketing of the badge. In order to align with the competency-based ideal of open badges, it was important that earning a digital badge included (1) expert sharing of knowledge and experience in their respective areas; (2)

hands-on constructivist activities whereby learners practiced the badge topics; (3) an assessment in which learners demonstrated that they had, in fact, achieved the competency warranting that they be awarded the corresponding badge. All of the badges earned during this phase were awarded in the Credly Acclaim platform. The final two badges scheduled for Spring of 2020 were canceled due to COVID. See Table 2 for details regarding the Phase II badges.

TABLE 2:
Badges offered during Phase II (Fall 2019 and Spring 2020)

PHASE II (Fall 2019 and Spring 2020)				
	Topic	**Facilitator credentials**	**Badge structure**	**Earned**
FA19	Value Engineering	VP with Lockheed Martin; ME departmental alum	2-day, 4 hours each day workshop w/ hands on activity & multiple choice assessment	22
FA19	Project Management	Pratt and Whitney executive	1-day, 4-hour workshop w/ multiple choice assessment	67
FA19	Making an Engineering Film	Media production consultant ME departmental alum (w/ BA in Film)	1-hour lecture in course; 3-hour workshop w/ hands on activity; students produce film	32
FA19	Digital Engineering	TE Engineer University alum, related dept	4-hour workshop; hands on activity and assessment	18
SP20	Introduction to AI in Engineering	TE executive; ME departmental alum	4-hour workshop; hands on activity; post-work	10*
SP20	Value Engineering	VP with Lockheed Martin; ME departmental alum	4-hour workshop; hands on activity; assessment during workshop	23
SP20	Personal and Career Networking	Entrepreneur; ME departmental alum	Canceled due to COVID19	
SP20	Business Principles for Engineers	Former executive at General Electric; NAE member; university faculty	Canceled due to COVID19	

*For Introduction to AI in Engineering, 32 students attended the badge workshop but only 10 completed the post-work and were awarded the badge

During this phase, a survey was distributed following each workshop and there was a separate debrief with the workshop facilitators. In order to further understand ME students' views on digital badges, a student group focus group was held. Lastly, data from within the Credly Acclaim system was considered. This system, student, and facilitator data collectively suggested a few key findings. First, consistent with what we found during Phase I, while overall student experiences of badge workshops and facilitators was very positive, it was at times challenging to get students to sign up for the badges. According to students this was due to an already tight schedule and an uncertainty of the value of a digital badge. We also found students were opting

out because they lacked sufficient understanding for how certain topics, like digital engineering, would impact them no matter where they ended up working.

The learning analytics data from Acclaim featured in Figure 4 is informative. When a digital badge is awarded, the student receives an email and in order to claim the badge needs to create an Acclaim account. As of the end of Phase II, 210 total badges had been awarded in the Credly Acclaim system. Only 116 students, however, actually claimed their badges. This discrepancy between badges awarded and claimed is consistent with other departments in the college of Engineering. On a positive note, of those 116 who claimed their digital badge, 76% shared the badge on LinkedIn. This supports the notion of the badge as a student owned object which the student can share when and where they choose.

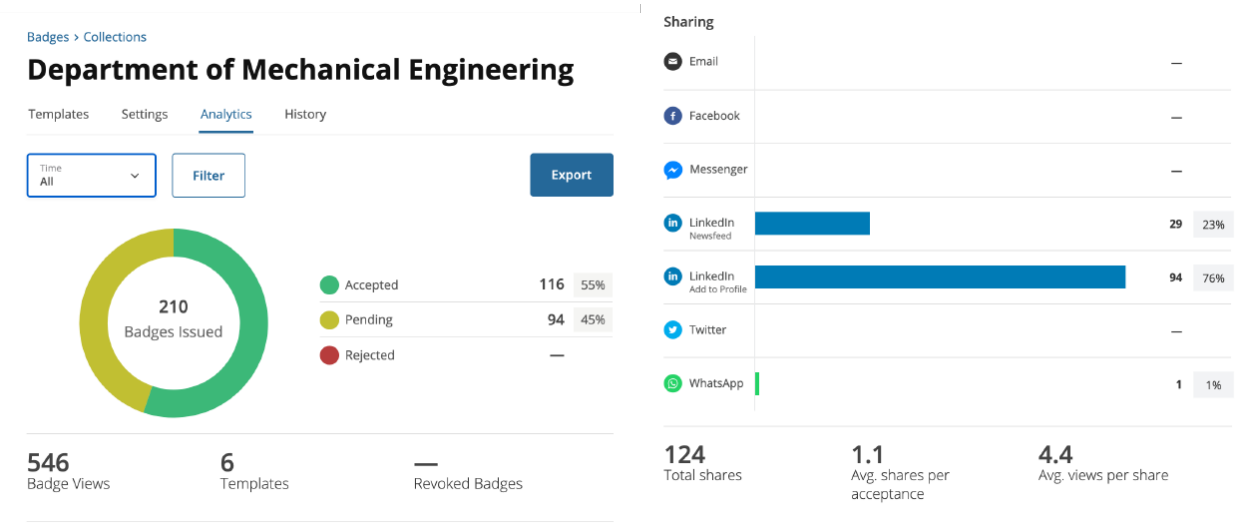

Figure 3. Screenshot from College of Engineering instance of the Credly Acclaim platform badges analytics.

During this phase we also struggled a bit with a "chicken and egg" scenario regarding the value of the digital badges, see Figure 5.

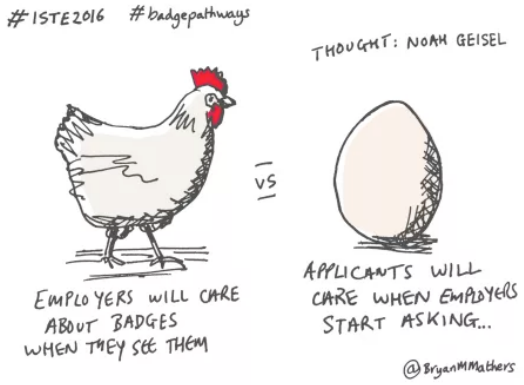

Figure 4. Chicken and Egg… image by @bryanMMathers is licenced under CC-BY-ND

Based on data and experiences of Phase II, it was determined that during Phase III the badge offerings would be integrated into credit offerings and that students needed more education regarding the nature and potential advantages of digital badges.

(3) Phase III (Spring 2021)

COVID-related uncertainty surrounding the teaching format of the fall 2020 semester led to the postponement of digital badge offerings until Spring 2021. Table 3 shows the five spring badge offerings. Rather than market these to students as stand-alone opportunities, the participation in the workshops was driven through two, ½-credit ME course offerings that launched in the fall 2020 semester. These brand new courses complement students' rigorous technical preparation with topics relevant to personal and professional development such as job searching, personal finance, career planning, and basic business skills. In each of the two classes, students choose their own microcredential digital badge from the five offered allowing some customization of the courses to suit their own interests. All ME students are required to take both classes ensuring that the badge sessions are well attended.

TABLE 3:
Badges offered during Phase III (Spring 2021)

PHASE III (Spring 2021)				
	Topic	**Facilitator credentials**	**Badge structure**	**Earned**
SP21	Business Principles for Engineers	Former executive at General Electric; NAE member; university faculty	Independent pre-work; 2-hour interactive Zoom workshop; independent post-work w/ assessment	25
SP21	Data Modeling for AI	TE Engineers	Independent pre-work; 2-hour interactive Zoom workshop; independent post-work w/ assessment	25
SP21	Data Visualization for Impact	Manager, Air Products ME departmental alum	Independent pre-work; 2-hour interactive Zoom workshop; independent post-work w/ assessment	27
SP21	Design Thinking for Engineers	Senior Instructor Luma Institute; Product Design faculty; ME departmental alum	Independent pre-work; 2-hour interactive Zoom workshop; independent post-work w/ assessment	21
SP21	Personal and Career Networking	Entrepreneur; ME departmental alum	Independent pre-work; 2-hour interactive Zoom workshop; independent post-work w/ assessment	25

Assessment data from the spring 2021 workshops will be used to drive further improvements to the administration of the badging program as well as the topics chosen for the sessions. Early results suggest that students are keenly interested in business-oriented topics, which receives almost no treatment in the required curriculum. They are also eager to gain experience with cutting edge technology such as artificial intelligence and formal design thinking.

Based on our experiences with Phase III, perhaps the single biggest improvement we made that may be of interest to others considering such a program is to integrate the workshop participation into a required course from the curriculum. This will allow the organizers to focus on maximizing the quality of the digital badges without undue time spent on marketing and "corralling" participants.

Lastly, while there is a great deal of variability of badges in terms of rigor and expectations, we have worked to ensure that any badge offered in this series that includes our university shield and departmental name will have consistent standards. All badge facilitators work with our Director of Online Pedagogy and the badges all include each of the following key elements: (1) Content and instructional information presented by the subject matter expert; (2) Hands on, interactive activities; (3) An assessment that ensures that the badge earner actually can do the competencies described in the badge meta-data.

Conclusion

Our ongoing journey into offering high-quality, pedagogically-sound digital badges has led to many improvements and lessons learned in the last 3.5 years. During this time we have continuously surveyed our alumni, our advisory board, and our students to ensure that the program offers relevant material in an active learning format. We have sought instructors who are often successful alumni from our own ME program and have both an interest and expertise in crucial areas for the contemporary workplace. We will continue to improve on our offerings and structure based and believe that the digital badges we offer are a value add to our ME students and it is likely that they will continue to encounter some form of microcredentials throughout their careers.

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