MCX

CMAA
Construction Management
Association of America

Member Communication Experience

NAC **Member Viewpoint**

Rethinking the Construction Education System

by Bob Prieto

This paper focuses on *construction* education as opposed to *engineering* education since I believe construction education presents some special challenges and opportunities. It begins by looking at the role of education in society and recognizing certain characteristics and objectives, including:

- The role in broadening the awareness of society and its current and emerging challenges.
- Improving the health and well-being (economic and otherwise) of society through a range of activities, including research, offering a platform for debate of a variety of views, and furthering education and training at multiple levels.
- Values development and reinforcement.
- Development of identities (national and professional).
- Curation of knowledge.
- Preparing individuals to positively contribute, through knowledge and skills training and development, in meeting the needs of society and the organizing elements (governmental, non-governmental, and private) that comprise it.

Attributes of the Construction Education System

With the foregoing as context, my effort here is to define the key attributes of a construction education system that meets society's needs as considered from the broader perspective on education just outlined. I describe these attributes as being:

- Holistic
- Integrated
- Lifelong
- Experiential
- Outcomes-focused
- Continuously improving

Let me touch on each of these attributes briefly.

Holistic

Holistic as I have used it here has two contexts. The first relates to the education process and objectives. The second relates to the scope of knowledge that is transferred.

With respect to the first, the education process and objectives, holistic education seeks to engage all aspects of the learner, including mind, body, and spirit, their passions if you will. It is based on the premise that each person finds identity, meaning, and purpose in life through connections to their local community, to the natural world, and to humanitarian values and broader global causes (for example sustainability, greenhouse gases, poverty, and health). Its aim is to call forth from people an intrinsic reverence for life and a passionate love of learning, give attention to experiential learning, and place significance on relationships and primary human values within the learning environment.

With respect to the second, the scope of knowledge that is transferred, the scope of construction education must have a strong contextual setting by addressing its role in a broad array of systems that encompass many of society's activities. These systems include:

- *Economic*—understanding the context of what drives markets and concomitant construction demands (type, quantity, location, timing, and others); factors driving the availability and costs of various economic inputs (labor, equipment, materials); costs and constraints imposed by a range of societal norms (laws, regulations, constraints on logistical and trade flows, cultural).
- *Social*—understanding not just societal norms, but the way in which stakeholder concerns are handled as well as what the then dominant concerns are. Rapidly developing communication channels, the nature of communication, and importantly the nature and process for successful stakeholder engagement.
- *Political*—the structure, roles, responsibilities, and often overreach of governments. Their role in project prioritization, inherent political risks, and how one engages in a political setting are especially important on large complex projects, but local and better bounded projects are not immune. Laws and regulation influencing construction as well as the underlying principles should be understood.
- *Intellectual*—emerging and emergent concepts that currently impact projects or will increasingly impact projects in the future must be catalogued, but more importantly, the underlying drivers must be understood. What are the outcomes they are trying to achieve? Examples of emerging concepts include the UN Sustainable Development Goals; resilience; integrated design and construction; and public health and social distancing.
- *Technology*—its trajectories, potentials, risks, and opportunities. For construction, this will require increased awareness of current and emerging manufacturing technologies (modularization; additive manufacturing; sku

management); application of automation technologies in a construction environment (real-time safety; drones; construction robotics; automated vehicles); adoption of a range of artificial intelligence (AI) techniques, including those associated with facial and voice recognition as well as machine learning.

Integrated

Construction education must increasingly be integrated in at least three dimensions. These include:

1. Across the entire capital asset life cycle, beginning with outcome clarification and articulation; program and project definition and objective and output definition and selection; project prioritization; project planning; basis of design definition (including the construction basis of design); design and associated constructability reviews; model based design and construction planning (5D Building Information Management (BIM); visualization); supply chain and construction logistics; construction; operation; maintenance; capital renewal; decommissioning; and restoration.

2. As one of four broad knowledge streams that must work closely together to successfully deliver a capital asset. These include:
    - Management—enterprise (owner, constructor, other industry participants); portfolio, program, and project.
    - Engineering—focused on effective integration with the process and opportunities to positively influence through timely interventions.
    - Construction—encompassing both construction management (as distinct from project management); general and specialty construction, including mobilization and application of labor, equipment, and materials.
    - Technology—associated with the asset to be developed or improved; management improving technologies enabled by AI, cybersecurity, block chain, or other emergent technologies; engineering technologies of various forms; construction management and automation technologies.
3. Within a framework set of issues encompassing both systems described above and also with specificity on issues related to: construction law; construction labor issues; and OSHA and other safety guiding principles and governing requirements. Construction must be seen as one system in a "system of systems." Systems thinking is a growing need. One only need look at the current coronavirus (COVID-19) pandemic to recognize the interconnectivity already present within our current system of systems.

Lifelong

Lifelong education can be thought of as occurring along four parallel vectors. The challenge each individual faces is to get not only enough of each vector, but a relevant balance consistent with their aspirations and society's needs. While I will define each of the vectors below in traditional terms, I want to underscore that I do see the need for traditional roles and responsibilities to change in order to meet the future education needs of construction.

The four vectors for lifelong education can be thought of as encompassing:

1. **Academia**—but in a changed and evolving role.
2. **Industry**—including its knowledge accumulation, curation, and dissemination roles as well as its role in lifelong education through licensure and continuing education requirements.
3. **Employers**—both governmental and private that retain or utilize construction services of any kind. Each may utilize bespoke processes and practices, but these should be founded on recognized construction management and construction principles. The potential for multi-employer alliances of various kinds in the future needs to be recognized.
4. **OJT, on the job training**—lifelong education must recognize and capture the value of experiential learning. This may best be done through formally capturing, communicating, and sharing lessons learned and best practices. This may be undervalued formally when we consider today's construction education environment.

Experiential

Elements of this have already been discussed. Two additional elements, however, warrant mention.

The first additional experiential element is the role of meaningful co-op or apprentice training programs. These have to be more than "filing" and "retrieving items" assignments. This is a challenge for many prospective employers who lack the knowledge and training on how to create and implement a meaningful co-op or apprentice program.

The second additional element involves mentoring. Mentoring relationships cannot be forced. They must emerge. Potential mentors must be educated on the value of investing their time in mentoring as well as how to be a good mentor. Those being mentored must understand how to find a mentor, what expectations they should reasonably have, how to be receptive, and the importance of having more than one mentor.

Outcomes-Focused

Today, construction education is heavily weighted towards an output focus. Some of this is driven by the nature of contracts, and worse by the narrowing of the mindset that contracts drive. Successful projects deliver good outcomes—for the owner, the constructor, and stakeholders. Success is measured not just

by the resultant capital asset, its cost, or schedule. It is also measured by the process to get to the end result, the value it creates as broadly viewed, and the level of unmet needs.

The holistic and systems approaches previously described will help create this outcomes awareness, and the construction opportunities inherent in outcomes-based contracts should be a subject of focus.

Continuously Improving

Continuously improving is a core concept in a revamped construction education system. It applies not only to construction enterprises and processes, but to the education system itself. Too many courses across all elements of the construction education system remain unchanged despite:

- Forty-plus years of failed productivity growth.
- The adoption of new ideas, approaches, and technologies in analog elements of industry:
    - Management
    - Contracts
    - Manufacturing
    - Supply chain
- Repeated failure of the classical theory of projects at scale.
- Rapidly evolving technologies with game-changing potentials (3D additive manufacturing; AI; materials breakthroughs).

Design of a Construction Education System

The design of a construction education system must explicitly address:

- Outcomes of a construction education system
- Scope of such a system
- Roles and responsibilities in a reconfigured system
- Delivery of educational outcomes
- Processes, systems, tools, and techniques to be employed

The discussion that follows represents “an incomplete contract.”

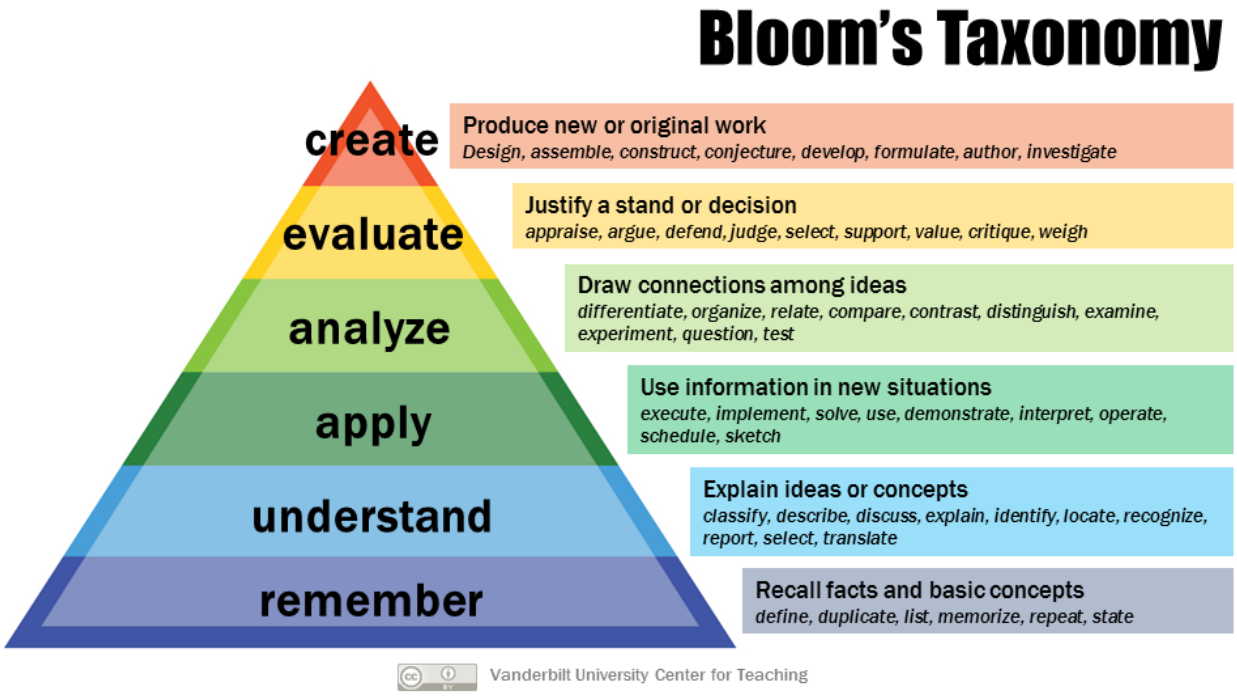
Outcomes of a Construction Education System

The outcomes of a construction education system can be thought of in terms of Bloom’s Taxonomy (see figure below). Bloom’s Taxonomy is a classification of different educational objectives and skills that educators set for their students.

As construction industry participants move through their careers, they should increasingly be able to produce new or original work (create). At different points along their career paths, the nature of what they create should be moving in a value-added direction.

Similarly as they move through their careers, the construction participants' source of training and knowledge will shift among the various participants in the broader educational system. It should be common for industry professionals to be at the apex of the taxonomy with respect to one knowledge area while at the same time moving up the taxonomy in a new skill or emergent area.

This concept of continuous learning/continuous improvement must be a core feature of the construction education system.

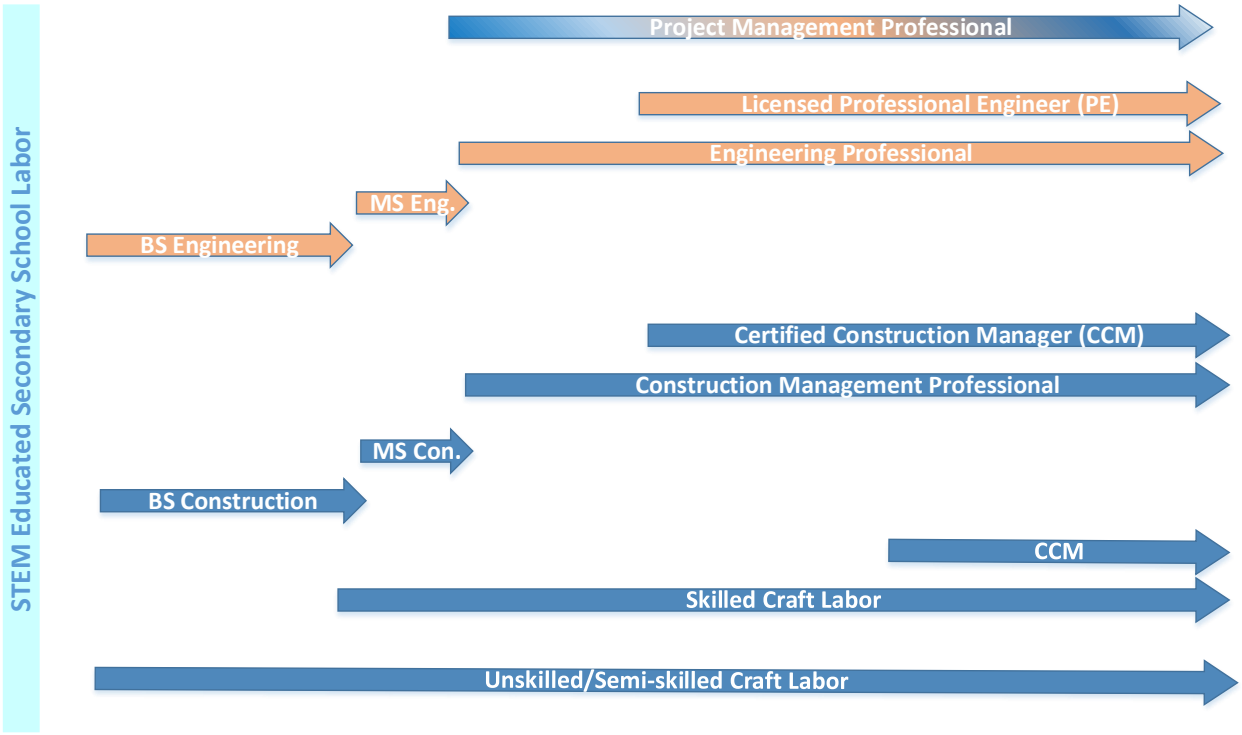


Scope of Such a System

The career paths of construction professionals are reflected in the following figure, with the engineering career path included for completeness.

The construction education system must explicitly address each of the following education/career paths:

- Unskilled to semi-skilled craft labor
- Unskilled/semi-skilled to skilled craft labor
- Skilled craft labor to Certified Construction Manager (CCM)
- Bachelor's/master's degrees in construction to Construction Management Professional
- Construction Management Professional to Certified Construction Manager (CCM)
- CCM to Project Manager



Roles and Responsibilities in a Reconfigured System

A reconfigured construction education system must be served by a system of educators/knowledge providers. The following table provides a view of what such a landscape might look like. The nature of the educators and how their interactions within a renewed construction education system change are discussed in delivery of educational outcomes.

Note the extended usage of Professional Development Hours (PDH) training.


Career Stage
Unskilled
Semi-skilled
Skilled
BS Construct
MS Construct
Construct Professional
Certified Construction Professional (CCM)
Project Manager
Construction Executive
Education System Element
Basic Construction Skills
Advanced construction skills
Apprentice
Skilled Tradesman
BS Construction Curriculum
MS Construction Curriculum
Construction PDH
Construction Body of Knowledge
CCM
PM Education & Training/ PDH
Gen'l Management Training
Executive Training
On the Job (OJT)
Craft Training (OJT) Trade School
Apprenticship Program
Tradesman Program Trade School
University
University
PDH Providers
CMAA
PM Education and Training Providers
Management Education
Executive Certification and Degree Programs

Education providers in a reconfigured construction education system are initially identified in the legend on the above matrix. Each provider's role is described below:

- **OJT**—On the job training is often informal, learn-by-doing training that is highly experiential in nature. In today's technology environment, this is readily complemented by a series of YouTube® how-to videos, many of varying quality. A coordinated and consistent approach to such how-to videos would aid the profession and would be a reasonable adjunct to trade school curriculums. They represent an entry level form of distance learning as well as provide a ready refresher before undertaking a task. The industry would benefit by having equipment and tool suppliers provide such videos in support of their products and make them available in a national construction knowledge commons.
- **Craft training/trade schools**—Reinvigorated craft training and trade schools must be economically attractive in order to fulfill industry and candidate needs. In a reconfigured construction education system, it is envisioned that introductory materials in each course would be delivered by remote learning techniques. This would include available training stations associated with the trade school or other affiliated entities. All-important hands-on training would be delivered using a combination of industry trades personnel, who would be compensated for their efforts, and coordinated apprenticeship or similar programs. It is envisioned that more robust craft training/trade schools would have affiliations with local university construction management programs and major construction users/providers to create a self-reinforcing ecosystem.
- **Apprenticeship programs**—delivered in conjunction with trade schools, labor organizations, and providers of construction, apprenticeship programs are an important element of the trade school ecosystem described above.
- **Trades programs**—linked to the apprenticeship program and trade school and broader ecosystem described above, the graduates of trades programs would have an opportunity/requirement to deliver one course in their specialty area after one year as a certified trades professional, bringing a real world feel back into the program.
- **Bachelor's degree programs** in construction would have a core offering through the first three years of study with an opportunity to begin specialization in the fourth year of the program. Three broad tracks of specialization are envisioned:
    - Construction management
    - Construction engineering
    - Construction technology

  Electives would draw heavily on industry practitioners to bring current real world experience into the core curriculum. Delivery of these courses would rely largely on distance learning techniques and would be certified for PDH (for continuing education/lifelong learning). Introduction to quality PDH programs would help build a continuous engagement in post-matriculation.

Emphasis should be placed on more robust and higher quality co-op efforts. Beginning with the second year, at least one short program each semester should be geared to seeing real life construction in the field.

- **Master's degree programs** in construction should be constructed to be one-year in duration; have an ability to at least partially overlap with the senior year of the bachelor's degree program; and focus on one of the three broad tracks of specialization referenced above. PhD track candidates would be required to take appropriate coursework/electives dealing with research methods.
  Self-learning using remotely available coursework in the form of PDH programs will be an essential element here, further opening up these programs to career-engaged individuals. There should be at least one project-based experience with affiliated trade schools to begin the development of real world interaction and understanding with craft labor.
  Master's level curricula should ensure appropriate levels of understanding of the Construction Body of Knowledge developed by the Construction Management Association of America (CMAA). Introduction to this body of knowledge should begin in the last year of the undergraduate program.
- **PDH providers** play a transformative role in a renewed construction education system. They offer the opportunity to deliver timely, fresh, and focused content on demand in a multi-media environment. Design of PDH courses becomes increasingly important, recognizing that target audiences may include:
  - Undergraduates
  - Graduates
  - Construction professionals expanding their personal horizons, preparing for changing roles, acquiring new skills for new opportunities, or meeting certification or licensure requirements.
  - Skilled labor seeking to transition to the construction management track.

  PDH providers also offer universities the opportunity to become lifelong learning partners.

  Specific PDH providers may include:
  - Traditional universities
  - Online universities and for-profit education corporations
  - Industry associations and organizations such as the Construction Management Association of America (CMAA), the Associated General Contractors of America (AGC) and the Project Management Institute (PMI)
  - Corporate "universities" that make their curricula more broadly available, perhaps in conjunction with the education ecosystem concept previously referenced

- Industry technology and equipment suppliers elevating their brand and product awareness
- "Pure" technology providers looking to expand their offerings into the construction space (IBM, Microsoft, Google, Amazon)

In addition, other knowledge providers should be considered as part of this ecosystem even in the absence of direct PDH offerings.

- **The National Academy of Construction** Executive Insights articles and Ask Me Anything webinar program are examples of valuable knowledge content.
- **CMAA** is recognized for having an accredited construction education role. The CMAA Body of Knowledge serves as a foundational element in design of construction education programs, and its Certified Construction Manager (CCM) recognition has the potential to serve as construction's equivalent of engineering licensure.
- **Project management (PM) education and training providers** are well established and include industry organizations such as PMI. A "transition to project management" for construction managers needs development.
- **Management education and executive development programs** for the construction industry would benefit from a reinvigorated and reconfigured construction education system.

Delivery of Educational Outcomes

The future requires educational outcomes to be delivered differently. The key differences that the future requires include:

- **Reinterpreting "universitas magistrorum et scholarium,**" which roughly means "community of teachers and scholars" in a 21st Century and a post-COVID-19 context. Teachers and scholars may be increasingly contracted for a period of time with tenure extended only in the most outstanding situations, with the universities almost playing the role of patron to intellectual genius. Utilization of real world practitioners will grow and the community will be expanded consistent with the ecosystem suggested previously.
- **A different engagement model** that relies on both distance and contact learning. Distance learning will draw PDH type courses and lectures forward and provide for a higher degree of guided self-study. What can be taught remotely will be with contact learning occurring after individuals have demonstrated proficiency with the distance learning materials through exams or engaged interrogatory. Contact learning will include:
  - Lecturer one-on-one and small group contact sessions
  - Peer group, team, and project-based learning
  - Interaction with other ecosystem participants
  - Field-based learning
  - Co-op program elements

- **A different economic model** built on lifetime engagement with individuals, a value-added ecosystem, and more tightly integrated industry partners. Content will be more broadly used, but at lower unit costs.
- **Reconsidering, redefining, and renewing the construction education system** including clarity of outcomes and increased agility. Education today lags industry needs. Increasingly it must be structured to anticipate those needs and put in place the value-adding intellectual content that users (students, industry, government, and corporations) require. The nature and role of research needs to be considered.
- **Construction education ecosystems** with interactions more akin to the earliest scholastic guilds. Each participant in the ecosystem not only learns from others, but challenges others to think deeper about approaches and belief sets.

Processes, Systems, Tools, and Techniques To Be Employed

Processes, systems, tools, and techniques to be employed have been largely covered. The future construction education system requires tighter integration, a lifelong focus, and real world knowledge, experience, and engagement. Increasingly, delivery will rely on remote learning, project-based learning, and ecosystem engagement—crafts, corporations, industry players, and sites. Remote learning will be supported by interaction in gaming-like construction settings, 5D BIM models, and AI-enabled construction simulations.

The COVID-19 pandemic has not created the imperative for rethinking the construction education system. Rather it has merely accelerated it.

About the Author

Bob Prieto was elected to the National Academy of Construction in 2011. He is a senior executive who is effective in shaping and executing business strategy and a recognized leader within the infrastructure, engineering, and construction industries.