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Editor's Note

Welcome to the latest edition of our magazine, where we explore the theme of "Shaping Future Civil Engineering Professionals." We are excited to present a curated collection of articles and engaging discussions with experts that illuminate the cutting-edge advancements in the field.

As the landscape of civil engineering continues to evolve, embracing its dynamic nature, we underscore the vital role of education in bridging the gap between academic knowledge and professional practice. The American Society of Civil Engineers (ASCE) envisions a future where civil engineers embody roles as master builders, environmental stewards, innovators, integrators, risk managers, and leaders shaping public policy by 2025. In this issue, our mission is to contribute to this vision by exploring various topics in technologies, skill sets, and knowledge essential for the next generation of civil engineering professionals.

As you navigate through the pages, we delve into the application of data analytics in geotechnical engineering, offering insights into understanding subsurface soil and connecting theoretical knowledge with practical applications. This edition also highlights the significance of management and communication skills, emphasizing the imperative to consider sustainability and address climate change in engineering practices.

Furthermore, we anticipate the future of education in civil engineering, nurturing the upcoming generation within both academic and professional realms. This issue provides a platform to comprehend the evolving educational landscape, offering insights into the challenges and opportunities in preparing future professionals.

Our sincere gratitude extends to the contributors who have generously shared their perspectives and experiences, enriching this edition with valuable knowledge for the benefit of future generations of civil engineers. Thanks also to our editorial team for their efforts in crafting this issue.

This magazine is a knowledge product of AIT Solutions, serving as a professional communication platform for experts and researchers, and providing readers a window to the latest technologies, events, and developments in the field.

Thank you for joining us on this insightful journey.

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Civil Engineering's Evolving Landscape: Skills, Trends, and Pathways

As we now stand in an age dominated by digital advancements and global challenges, it's imperative to think deeply about the future trajectory of civil engineering education.

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Over 40 years ago, when I began my civil engineering journey, we were transitioning into an era where calculators replaced manual methods, streamlining complex calculations. But even then, many designs were primarily hand-crafted. As someone who has spent years both in professional practice and as an educator in civil engineering in general and structural engineering in particular, I've seen first-hand the monumental shifts in our industry. As we now stand in an age dominated by digital advancements and global challenges, it's imperative to think deeply about the future trajectory of civil engineering education. How do we ensure our next generation is equipped for the challenges ahead?

The current state of civil engineering education has come a long way from where we started. Today's curriculum heavily integrates computational tools, with students becoming proficient in advanced software applications even before entering the professional practice. Theoretical knowledge, once derived from dense textbooks, is now supplemented by online resources, webinars, and interactive platforms that offer dynamic ways to grasp complex concepts. Furthermore, universities globally have emphasized the need for practical experiences. Many now incorporate internships, cooperative education programs, and hands-on laboratory sessions as pivotal components of their degree programs. While this integration of technology and real-world application is commendable, it also brings forth challenges. Balancing strong foundational concepts and thorough theoretical knowledge with practical skills and ensuring students are ready for the multifaceted demands of the job market is a constant concern.

Today's curriculum heavily integrates computational tools, with students becoming proficient in advanced software applications even before entering the professional practice

Challenges in Today's Civil Engineering Education

The expansive nature of modern civil engineering goes beyond merely erecting structures. It embraces a holistic approach, focused on designing and building adaptive, sustainable, and resilient infrastructures to meet the growing complexities of urbanization and climate change. This paradigm shift demands engineers with broader perspectives, capabilities of anticipating future challenges and weaving technical expertise with an understanding of societal and environmental impacts. Consequently, education must evolve, moving beyond traditional methods. Educators must nurture adaptability in

students, encouraging them to delve into both the intricate technical details and the broader context of their work.

The landscape of civil engineering education is undergoing a profound transformation, propelled by technological advancements that redefine our approach to infrastructure and a pressing need for sustainability in the face of environmental challenges. As we prepare future civil engineers, we must equip them not only with technical prowess but also with a deep commitment to environmental stewardship and AI integration.

Civil engineers may also learn to be "prompt-engineers" to effectively interact and make use of the power offered by AI chatbots.

While engineers in general, and civil engineers are no exceptions, have been taught and trained well in the technical aspects of their subjects and disciplines, the curriculum and focus have often lacked in building soft skill so essential in the society and in work places these days.

Technological Integration and Educational Evolution

Today's engineering tasks have been revolutionized by technology. Building Information Modelling (BIM) stands as a testament to this evolution, weaving architects, engineers, and builders into a cohesive unit, eliminating disjointed project phases. Drones have revolutionized field surveys, offering unprecedented access and high-resolution data capture. Yet, the most promising arena might lie within emerging classroom technologies like Virtual and Augmented Reality (VR/AR), ushering students into experiential learning landscapes.

Simultaneously, the power of Artificial Intelligence and Big Data is gaining momentum, offering predictive modeling and resource optimization possibilities. As such, civil engineering curricula must adapt swiftly, integrating courses on AI, machine learning, and data analysis. Practical hands-on experiences with AI tools should become the norm, mirroring the integration of CAD software in the past. This emphasis on technological literacy prepares engineers for the complexities of modern projects.

Incorporating AI education into civil engineering programs becomes imperative. Courses on AI, machine learning, and data analysis must intertwine with hands-on experiences using AI tools for design, analysis, and project management. Furthermore, fostering data literacy and ethical considerations within AI applications aligns engineers with sustainable and responsible practices. Civil engineers may also learn to be "prompt-engineers" to effectively interact and make use of the power offered by AI chatbots.

The Paradigm Shift: Sustainability and Resilience

However, amidst these technological leaps, the imperatives of sustainability and resilience seem large. The historical focus of civil engineering on functionality and cost-effectiveness often sidelined environmental impacts. The late recognition of environmental issues and the prioritization of rapid development in the post-war era exemplified this trend.

Fast forward to the present day, civil engineering acknowledges its pivotal role in addressing environmental challenges, spurred by heightened climate change awareness and stringent regulations. The discipline is actively transitioning towards sustainable design and construction practices, emphasizing eco-friendly materials, energy efficiency, and climate-resilient infrastructure. This evolution permeates civil engineering education, teaching future engineers to design with environmental impact in mind.

A Unified Vision: Integrating Sustainability, AI, and Engineering Practice

As the profession marches towards a more sustainable future, civil engineers find themselves at the forefront of innovation. There's an opportunity to lead in sustainable design and construction methods, fostering collaborations between environmental scientists, policymakers, and urban planners. The civil engineering profession is evolving to embrace sustainability actively. Engineers are now involved in designing resilient infrastructure, incorporating eco-friendly materials, and energy-efficient designs, and integrating renewable energy sources into urban planning.

Embracing AI integration within this paradigm equips engineers with an AI-augmented landscape, emphasizing adaptability, continuous learning, and the development of essential soft skills.

The Path Ahead: Integrating Technological Advancements and Sustainability

Looking ahead, the synergy between technological advancements and sustainability becomes the cornerstone of civil engineering education. By swiftly adapting curricula to include emerging technologies, fostering interdisciplinary collaborations, and instilling a deep understanding of sustainable practices, we mold engineers to prepare to tackle the challenges of tomorrow.

Conclusion

While the historical focus of civil engineering may have downplayed environmental impacts, there's an undeniable shift toward rectifying this trajectory. Today's engineers are increasingly recognized as pivotal in combatting climate change and promoting sustainability. By integrating technological advancements with ethical and environmentally conscious practices, the profession stands poised to shape a resilient and sustainable future.

Subsurface Data Analytics for Civil Engineering Challenges

The engineering properties of the subsurface soil must be understood in order for any civil engineering work to be built safely and effectively.

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Because of the nature of their work, civil engineers must adapt their studies, designs, and buildings to the effects of climate change. Estimates of local-scale impacts and required system capacities, as well as addressing institutional inertia regarding the infrastructure, are both necessary for an effective response to the growing inadequacy of civil infrastructure. Ground movement beneath urban areas due to a phenomenon known as "underground climate change" poses a potential threat to the long-term functionality and structural integrity of buildings and other infrastructure.

The engineering properties of the subsurface soil must be understood in order for any civil engineering work to be built safely and effectively. Typically, these characteristics are gleaned from geotechnical laboratory testing of site-collected soil samples. Electrical geophysical methods, on the other hand, enable rapid measurement of soil electrical properties such as electrical resistivity and conductivity directly from the soil surface to any depth without disturbing the soil, in contrast to more traditional methods of soil analysis.

Due to its speed, low cost, and lack of destructiveness, the geoelectrical survey, and the electrical resistivity and induced polarization surveys in particular, is very appealing for assessing subsurface properties. Soil's electrical resistivity is its ability to impede the flow of an electrical current. Soil spontaneous electrical phenomena and the behavior of electrical fields are significantly influenced by the presence of solids and liquids. Current flow through a subsurface medium made of layers of materials with different resistivities provides a useful context for defining resistivity. Induced polarization (IP) is an auxiliary technique that, like electrical conductivity, probes the rock matrix's capacity to store electrical charges. Sulfides and iron-oxides, as well as conductive fluids and clay minerals, are especially problematic for IP. The same instruments used to test for electrical conductivity can also be used to test for induced polarization. Chargeability imaging is a supplementary technique to conductivity polarization that can visualize an additional petrophysical property. An integrated geoelectrical investigation for a proposed civil engineering work of a construction site layout was carried out to determine the competency of the subsoil. For example, the use of electrical resistivity data to obtain geotechnical information from a region has shown great promise as an aid tool, with the potential to extrapolate data from SPT

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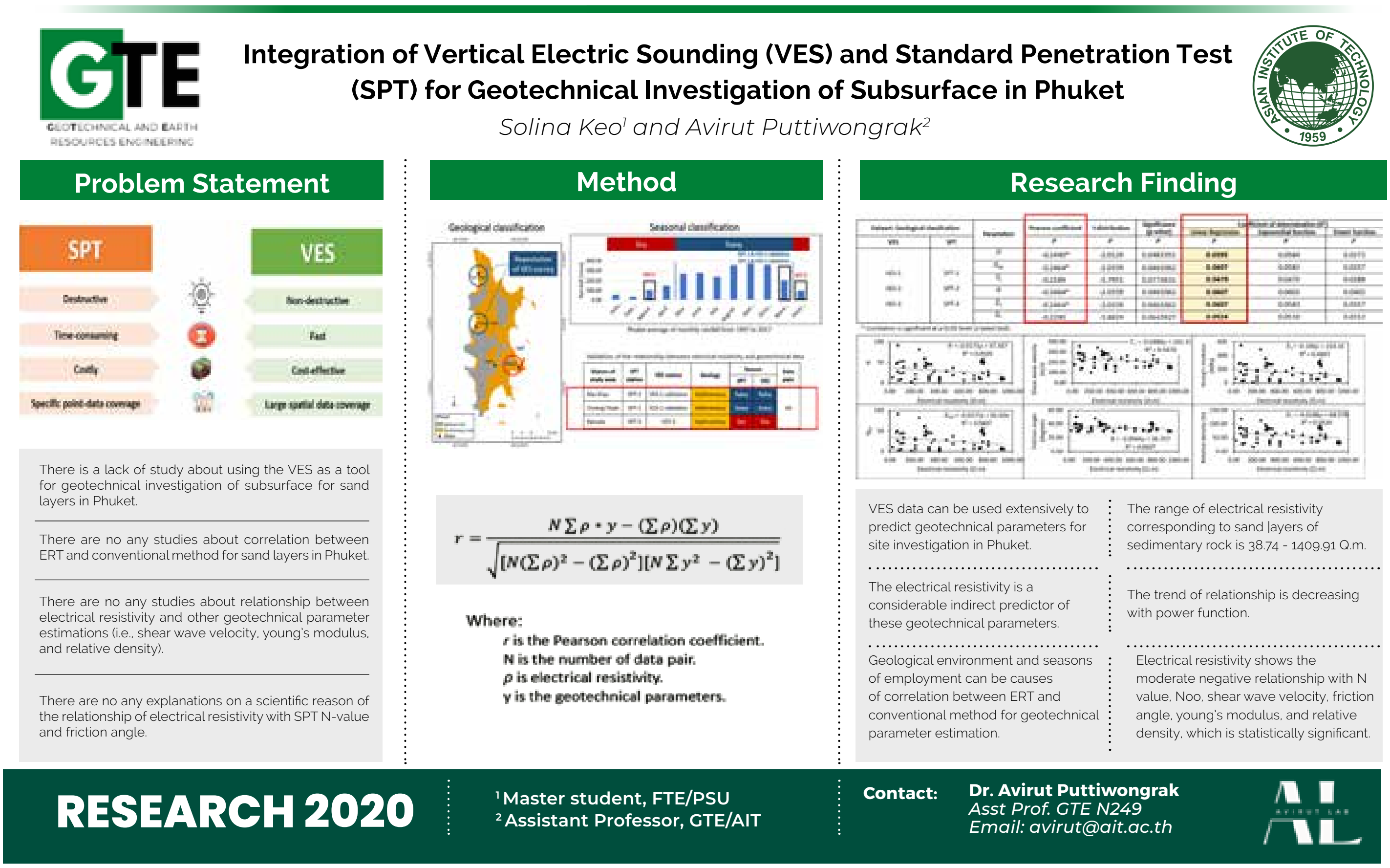

surveys and thus address the shortcoming of a lack of comprehensive structural characterization in civil engineering projects. Geological and climatological data classifications were used to identify the factors influencing the association between electrical resistivity and the SPT N-value. The best fit, an exponential model, was revealed by classifying geological and climatic data, and the regression parameter (R2) of the relationship between electrical resistivity and SPT N-values was slightly increased from a simple plot. The geotechnical properties of soils can be quickly and easily determined by substituting the correlated electrical resistivity for the actual physical parameters via an empirical relation. Statistical analysis of a large database of SPT N-values and associated electrical resistivity values could be used to develop a more precise prediction model in the future.

Laboratory studies could shed light on the electrical characteristics of subsurface issues, and the experimental conditions can be carefully managed. There is still a critical lack of reliable testing data, which prevents mechanistic models from being validated in relation to the effect that property changes have on the subsurface conditions of construction sites. Indoor laboratory geoelectric experiments utilizing sandboxes are frequently used in addition to numerical models and in-situ field testing due to the benefits of well-controlled parameters, an increased amount of soil data, and a shorter amount of time required for the experimental simulation. Suppose the regularization coefficient has been predetermined using simulations completed prior to the measurements. In that case, this can be useful in the field for the purpose of making decisions in real-time, which can be

Subsurface Sandbox

Subsurface Sandbox for geoelectrical measurement is used to imitate the subsurface condition to study the geophysical parameters of the subsurface in responding with the dynamic and complex subsurface behavior.

advantageous. In the study on a sandbox to carry out parametric studies, it is suggested that the geophysical and geotechnical techniques for soil testing together can be used to depict meaningful contributions for the geotechnical engineers in the foundation, design, and construction of roads and buildings. In performing well-constrained sandbox experiments for the purpose of understanding the subsurface conditions associated with hydro-mechanical disturbances caused by a sudden change in fluid pressure in a water-saturated controlled sandbox, It is possible to conduct the development of linkages among laboratory sandbox experiments, numerical modeling, and field data acquisitions in order to determine the possibility of using these three methods to evaluate the development of a dynamic problem in the subsurface. An effective tool for a parametric study that perturbs subsurface variables in the conceptual model, the sandbox experiment of geoelectric measurements is used to explore design alternatives that can effectively support subsurface conditions. When it comes to geotechnical engineering works, the data from geophysical surveys can be of assistance in better understanding the subsurface conditions. In order to investigate the intricate and dynamic issues that are associated with the subsurface conditions, multi-scale data from the laboratory sandbox, a numerical model, and field acquisition can be utilized. There is no way around learning about the engineering properties of the subsurface soil before constructing any kind of built structure if you want your project to be successful. A new trend for civil engineering societies would be data analytics in geotechnical engineering. Big data from several sources could be utilized for state-of-the-art and state-of-the-practice knowledge to ensure that meaningful results are obtained for the design of infrastructure. The entire building process will be confronted with a significant obstacle brought on by digital transformation, which will include AI, AR and VR, the Internet of Things (IoT), and other related technologies. In spite of the fact that information pertaining to the subsurface continues to be an essential component of civil engineering works, geotechnical engineers are becoming increasingly collaborative and have access to a vast amount of data. Digitization has brought about a shift in the operations and decision-making processes of geotechnical engineers as a result of the increased availability of a wider range of technological options. In the future, the geotechnical engineering industry will rely significantly more on digital data, analytics, and virtual representations of the subsurface geophysics in order to provide the most accurate model possible for use in the appropriate environments for construction sustainability.

A new trend for civil engineering societies would be data analytics in geotechnical engineering.

Shaping Future Civil Engineering Professionals

Civil engineering is the core and essence of human society. It embodies safe and secure housing and infrastructure, resulting in wellness in our communities.

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The last pandemic altered beliefs and perceptions and generally exposed society to grave vulnerabilities.

The future generation, especially civil engineering professionals, ought to recognise the shortcomings that devastated populations, especially in urban environments, and adapt themselves and their thinking accordingly.

There are many challenges that the youth of tomorrow will have to face, including the use (or misuse) of artificial intelligence and its endless possibilities.

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Civil engineers must inherently deal with multiple facets of society. In the design stage, they must interact with the clients, who may be architects or end users. During the tender process, they must deal with prospective vendors who can be numerous entities depending on the tender style. After that, during the construction phase, the civil engineer must work with several contractors and often interact with the individual foreperson and labour.

Depending on the size and nature of the project, the civil engineer may be the Principal Agent on behalf of the client, coordinating the activities of the other areas of technical expertise in a leadership role. On other building-related projects, the architect will likely be the Principal Agent, and the civil engineer will work within the team. It is essential to understand these roles and to respect hierarchy. Client interaction, be it the principal client or the architect, and management is pivotal to the success of a project. In the case of civil engineering, as mentioned above, where several entities are involved in every project, it is even more important to communicate effectively, both in verbal and written communication. Furthermore, the challenge is to manage expectations and perform effective project management. At the university level, there is a need for understanding and exposure to the basic principles of procurement, tendering, construction, invoicing, and risk management.

Moreover, every profession has its own "language". It is important not to use this "language" and its acronyms when dealing with those who are not familiar with the same. Successful engineers understand their client's culture and requirements and can demonstrate, in the client's "language", how to achieve the desired result. Training in marketing, namely, how to sell professional engineering services, is essential—for example, explaining to a client why one approach to a problem may be better. Often, civil engineers do not feel very comfortable doing this.

Training in marketing, namely, how to sell professional engineering services, is essential—for example, explaining to a client why one approach to a problem may be better.

With all its modules, business management is an excellent medium to teach future civil engineers how to navigate the process, and it needs to be taught in the university itself. When an engineer graduates, the individual has no idea about business activities (and this is true for all engineering fields). Sadly, nothing prepares a student for the (harsh) reality of starting work. Teaching all these

Sustainability and climate change agenda is foremost in everyone's mind today, the effects of which are felt in everyday life by all segments of society. Civil construction plays a contributory role in emissions of CO_2.

aspects at the right time is essential and beneficial to the success of every project and, therefore, to humankind.

Subsequently, continuous training must be given for each module with real-time interaction. This entails bringing the industry together with the pedagogy.

A case must also be made to stress understanding the basics, the first principles. Sound knowledge of this doctrine will enable future civil engineers to grasp whether the computer program's results are correct quickly—an essential criterion.

Then there is the dilemma of working in public or private sectors. Each has its role in society, and future civil engineering professionals must again be aware of it. Cross-pollination is desirable but not easy to achieve.

Sustainability and climate change agenda is foremost in everyone's mind today, the effects of which are felt in everyday life by all segments of society. Civil construction plays a contributory role in emissions of CO_2. In 2021, materials used in the construction of buildings accounted for around nine per cent of overall energy-related CO_2 emissions, and the construction sector accounted for over 34 per cent of energy demand and approximately 37 per cent of energy and process-related CO_2 emissions. Civil engineering professionals must know about sustainable construction and promote supply chains that support energy-efficient designs and low-carbon construction.

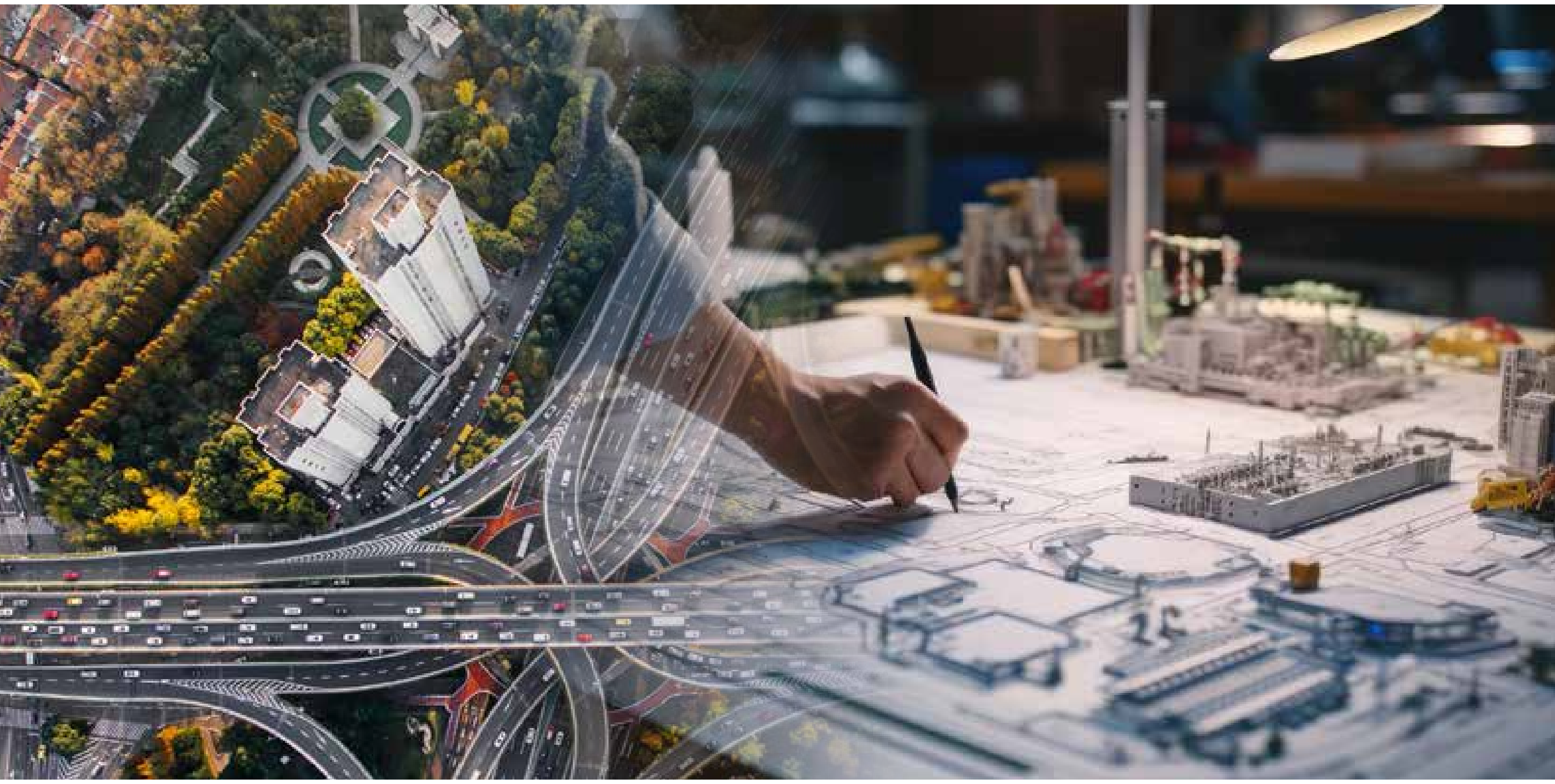
Water supply, sewage and waste management is another crucial issue within civil engineers' purview. The design of this infrastructure must also be sustainable.

Professional civil engineers must take a leadership role in examining the feasibility of a project and state unequivocally whether the project is viable or not. This, in particular, relates to large infrastructure projects with a very long gestation period from concept to completion, spanning several years.

In conclusion, civil engineering deals with nature. Over the centuries, it has had a significant impact on Mother Earth. Think of the cities, roads, and dams that have been constructed. With a crystal ball, some of our predecessors could have done things differently. However, the baton will be handed over to future civil engineers with far more sophisticated tools, with the same lack of a crystal ball. Hence, every engineer needs to take a leadership role and bravely and innovatively execute projects while always considering the impact of their work on the environment. It is the role and responsibility of civil engineering professionals not only to preserve the planet but, more importantly, to reverse the trend of deteriorating environmental conditions due to construction activities, adopt emerging technologies in construction, and continually improve upon the same. It is all a matter of promoting the mantra of "Wellness".

Viva la civil engineering!

Systems Thinking in Civil Engineering



Civil engineers bear the responsibility for the complete life cycle of their creations-from planning and design to facility management over its useful life.

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Civil Engineering stands as a global and all-encompassing profession devoted to meeting the diverse needs of societies worldwide. This multifaceted discipline encompasses the development of various civil infrastructure systems, including structural, hydraulic, geotechnical, environmental, transportation, and power generation systems. The ultimate goal is to enhance the overall quality of life for communities.

Traditionally, civil engineers were responsible for planning, designing, constructing, operating, maintaining, and decommissioning infrastructure to improve the quality of life. However, as urban populations burgeon and infrastructure systems grow, the intricate interconnections between infrastructure,

environmental, political, and social systems have become increasingly complex. The education of future civil engineers must extend beyond traditional design areas, incorporating knowledge from emerging fields such as economics, finance, statistics, environment, and social sciences. This holistic approach ensures resilience and sustainability at every phase of the civil engineering system development cycle.

Achieving success throughout the entire life cycle of a project necessitates a comprehensive understanding of all relevant elements. Civil engineers bear the responsibility for the complete life cycle of their creations—from planning and design to facility management over its useful life. Recognizing that real-world challenges demand more than a traditional scientific approach, civil engineers now prioritize a systems-thinking approach. This approach considers the relationships between the built environment, nature, and the community, emphasizing systems approaches in civil engineering facilities' development.

Currently, practicing civil engineers often informally acquire knowledge and skills in systems engineering after their formal education. Integrating more systems thinking into civil engineering education can bridge this gap, enabling engineers to apply knowledge from various disciplines and enhance their analytical skills for both routine and emerging tasks.

Addressing complex challenges requires breaking down entities into smaller, manageable components. This decomposition approach, a fundamental principle of systems analysis, facilitates the development of large civil engineering infrastructure. These systems can be defined based on physical infrastructure and operating rules aimed at providing services to society, progressing through phases such as Needs Assessment, System Planning, System Design, System Construction, System Operations, System Monitoring, System Preservation, and System Termination.

At each phase, civil engineers develop plans and conduct systems optimization by analyzing alternatives and selecting the best one. Feedback and lessons learned from each phase are essential for developing adaptive systems. System dynamics, a simulation-based tool, incorporates holistic concepts and internal time-delayed feedback loops, providing a deeper understanding of dynamic complex systems over time.

Economic efficiency has traditionally dominated decision-making in civil engineering systems development. However, there is a growing emphasis on incorporating life cycle costing and sustainable, long-term solutions, transcending purely monetary decision criteria. Systems thinking further supports embedding sustainability and resilience principles, evaluating unintended consequences, and understanding the broader set of systems dynamics influencing the focus area.

"Doing the right project" must be done in the conceptual stage of the project lifecycle. Understanding the economic, environmental, and social impacts of alternative schemes is important for civil engineers. "Doing the project right" requires sound engineering decisions based on systems thinking at all phases of development of civil engineering systems. To be effective, engineers need the ability to assess the economic, environmental, and social aspects of alternatives and to communicate with, collaborate with other concerned disciplines and stakeholders.

Looking ahead, as civil engineers comprehend the global context and societal challenges, developing high-level communication skills will be vital. Civil engineers are poised to take leadership roles in systems integration, partnering with diverse stakeholders to implement engineering solutions that address the evolving needs of society.

Building Tomorrow: A Conversation with Professor Worsak Kanok-Nukulchai on Shaping Future Civil Engineers

Professor Worsak Kanok-Nukulchai
Fellow of the Academy of Science, Royal Society of Thailand,
Executive Director of Chulalongkorn
School of Integrated Innovation, and
Former President of Asian Institute of Technology (2013-2018)

Q **How has the landscape of civil engineering education evolved over the years, and what key trends do you foresee shaping the future of education in this field?**

A Civil engineering education has undergone significant transformation over the years, adapting to technological advancements and evolving industry needs. The current trend has shifted from producing specialist engineers with deep, focused expertise to developing generalists. These generalists possess versatile skills and the capacity to delve deeply into new areas as required.

Software has become increasingly crucial. In the past, we relied more on hands-on experience and engineering intuition, which often required high safety factors due to the less precise nature of the calculations. But now, with powerful software, we're able to achieve more precise solutions even with more complex engineering problems, making digital competence an essential skill for modern civil engineers.

However, there's a risk here – the risk of engineers becoming mere operators driven by software, rather than innovators and creators. To counter this, engineers need to be trained to think creatively, and go beyond conventional methods.

Looking ahead, I see the future of civil engineering education as a balance between deep technical knowledge and broad, adaptable skills, alongside digital competence, and a strong focus on innovation.

Q **To prepare the next generation of civil engineers for increasing climate challenges and sustainability issues, what additional knowledge and skills should be emphasized in their training?**

A To gear up the next generation of civil engineers for the growing challenges of climate change and sustainability, their training needs to be more inclusive and forward-thinking. First and foremost, it's not just about understanding climate science; it goes beyond that. We need to broaden their knowledge base to include global megatrends, like climate change, urbanization, and resource preservation. This will give them a more comprehensive perspective on the diverse factors affecting climate change and sustainability.

Also, we can't overlook the importance of interdisciplinary collaboration and soft skills. These are critical in navigating the complex nature of sustainability challenges. Ethical decision-making, social responsibility, and effective communication – these skills are just as vital as technical knowledge.

In summary, I believe civil engineering courses across all disciplines should include a module that specifically addresses the challenges, societal and environmental impacts, and sustainability considerations of their areas. This approach will ensure our future engineers are not just technically skilled but also prepared to make a positive and effective contribution in our rapidly changing world.

Q **With the rapid advancement of technology, how can educators strike a balance between traditional engineering principles and incorporating modern tools and techniques into the curriculum?**

A In civil engineering, we're constantly adapting to technological advances, which poses a unique challenge for educators. It's crucial to balance traditional principles with these new tools and techniques. The core engineering principles form the bedrock of our understanding – they're what help engineers grasp how systems behave.

Yet, we can't ignore the role of modern technology, like computer modeling and software, and even the Generative AI. These tools are fantastic for efficiently solving real-world problems, but they're not just magic boxes. Engineers need to know what's happening inside these black boxes, how they connect to the basic principles we teach, and what are their limitations. If they don't, there's a risk of misusing the technology or misinterpreting its outputs.

So, when we teach these modern tools in class, make sure to discuss the fundamental principles and assumptions behind the tools, and talk about their limitations. This way, we're preparing engineers who are not just tech-savvy, but also deeply grounded in the fundamentals.

Q **The integration of resilience and sustainability into civil engineering projects is becoming crucial. How can educational institutions equip students to be at the forefront of resilient and sustainable infrastructure development?**

A In today's world, the focus on resilience and sustainability in civil engineering is more important than ever. To prepare students for this, our educational approach needs to be both integrated and interdisciplinary. It's not just about teaching separate components; it's about showing how everything connects to create sustainable and resilient projects. This way, students get to see the big picture – how each part affects the environment and contributes to the project.

In our new curricula, we must incorporate real-life case studies of successful sustainable projects, which offer invaluable practical insights. We should employ project-based learning, giving students hands-on experience in applying these principles. Additionally, connecting students with industry experts is crucial, so they can learn the latest practices and trends from the real world.

Q **How can civil engineering programs nurture future engineers to be master builders, innovators, and integrators, especially in collaboration with professionals from other disciplines?**

A In today's world, where everything is interconnected, it's essential for civil engineering programs to do more than just teach technical knowledges. We need to develop master builders, innovators, and integrators. The rise of digital technologies and AI brings fantastic opportunities, but it also poses a risk of engineers becoming mere operators. To prevent this, we're really focusing on several key areas.

Firstly, we must encourage civil engineering students to think beyond traditional design codes. By utilizing software and AI as innovative tools, engineers should aim to explore creative designs and solutions, rather than merely acting as operators adhering to established codes.

We also emphasize holistic problem-solving. It's not just about the technical side of things; we consider the social, environmental, and economic impacts too.

Teamwork and communication skills are crucial as well. In the real world, they'll need to collaborate with diverse teams, so we start that in the classroom.

Real-world projects should be a big part of the new curriculum. These projects involve working with architects, environmentalists, urban planners, and other professionals from various fields, giving students hands-on experience in integrating different perspectives and skills. And, of course, we focus on ethical and responsible engineering. It's about understanding the long-term effects of their work on society and the environment.

By combining all these elements, we aim to prepare well-rounded civil engineers who are not just technically skilled but also excel in innovation, integration, and collaboration. This is what the modern landscape of civil engineering demands, and the educators must commit to meeting that challenge.

Novel Pedagogical Approaches in Engineering: The Role of Open Educational Resources (OER) Movement

What are Open Educational Resources?

In July 2002, UNESCO convened a group of academics at the "Forum on the Impact of Open Courseware for Higher Education in Developing Countries" in Paris. It was held to assess the open courseware movements of that time including the OpenCourseWare initiative of the Masachusetts Institute of Technology (MIT) (Havemann, 2016; D'Antoni, 2009). At this forum, the term "Open Educational Resources (OER)" was coined and was defined as:

The open provision of educational resources, enabled by information and communication technologies, for consultation, use and adaptation by a community of users for noncommercial purposes (UNESCO, 2002).

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Beside MIT's OpenCourseWare, several other initiatives in 1990 and early 2000s (e.g., Connexions (now OpenStax) from Rice University, open educational materials at the University of Texas, Federal University of Ceara, and Carnegie Mellon University, etc.) provided a strong historical context to the emergence of OER movement (Mishra 2017). As this movement started growing, other efforts were made to define the term and the concept. For example, William and Flora Hewlett Foundation is a well-known contributor to this movement and defines OER as:

teaching, learning and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others. Open educational resources include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials or techniques used to support access to knowledge. (William and Flora Hewlett Foundation, 2008)

The 2012 Paris OER Declaration was formally adopted at the 2012 World Open Educational Resources (OER) Congress held at the UNESCO Headquarters in Paris. This declaration defines OER as:

teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions. Open licensing is built within the existing framework of intellectual property rights as defined by relevant international conventions and respects the authorship of the work.

This recommendation is the first international normative instrument to embrace the field of openly licensed educational materials and technologies in education.

In order to explain OER in simple words, the 4Rs (reuse, revise, remix and redistribute) framework is quite useful (Mishra, 2017; Wiley, 2014). It often provides a clear description of how OER allows revision and contextualization of the work. Wiley (2014) added a 5th R (retain) considering that although the right to retain is strongly implied in open licenses, it has never been addressed directly in the discourse around open content.

As a major development in November 2019, the General Conference of UNESCO adopted "The Recommendation on Open Educational Resources (OER)" in its 40th session. This recommendation is the first international normative instrument to embrace the field of openly licensed educational materials and technologies in education. It defined OER as:

learning, teaching and research materials in any format and medium that reside in the public domain or are under copyright that have been released under an open license, that permit no-cost access, re-use, re-purpose, adaptation and redistribution by others.

UNESCO's OER logo developed by Jonathas Mello and licensed as CC-BY under a Creative Commons Attribution license.

Based on these definitions, it becomes clear that in order to consider any teaching, learning and research material as OER, it should be (a) made available in public domain, and (b) be allowed to re-use, re-distribute and share with little or no restrictions. This is where the role of an "open license" comes in.

What is an Open License?

Whenever a content creator wants to share his/her creative work without requests for permission, it can be done either by (a) dedicating that work to the "public domain", or (b) licensing it openly. The 2012 Paris OER Declaration articulates the use of an "open license" which grants permission to access, re-use and redistribute a work with few or no restrictions. It enables creators to allow more freedom in what others can do with their works while letting the creators to retain the ownership of their work. Creative Commons (CC) is an American non-profit organization and international network devoted to educational access and has released several copyright licenses, known as Creative Commons (CC) licenses, free of charge to the public. These are one of several public copyright licensing systems that enable the free distribution of an otherwise copyrighted material. They give everyone (from individual creators to large institutions) a standardized way to grant the public permission to use their creative work under copyright law. From the user's perspective, the presence of a CC license on a copyrighted work answers the question, What can I do with this work? There are six different CC license types. They are listed in Figure 2 (from most to least permissive).

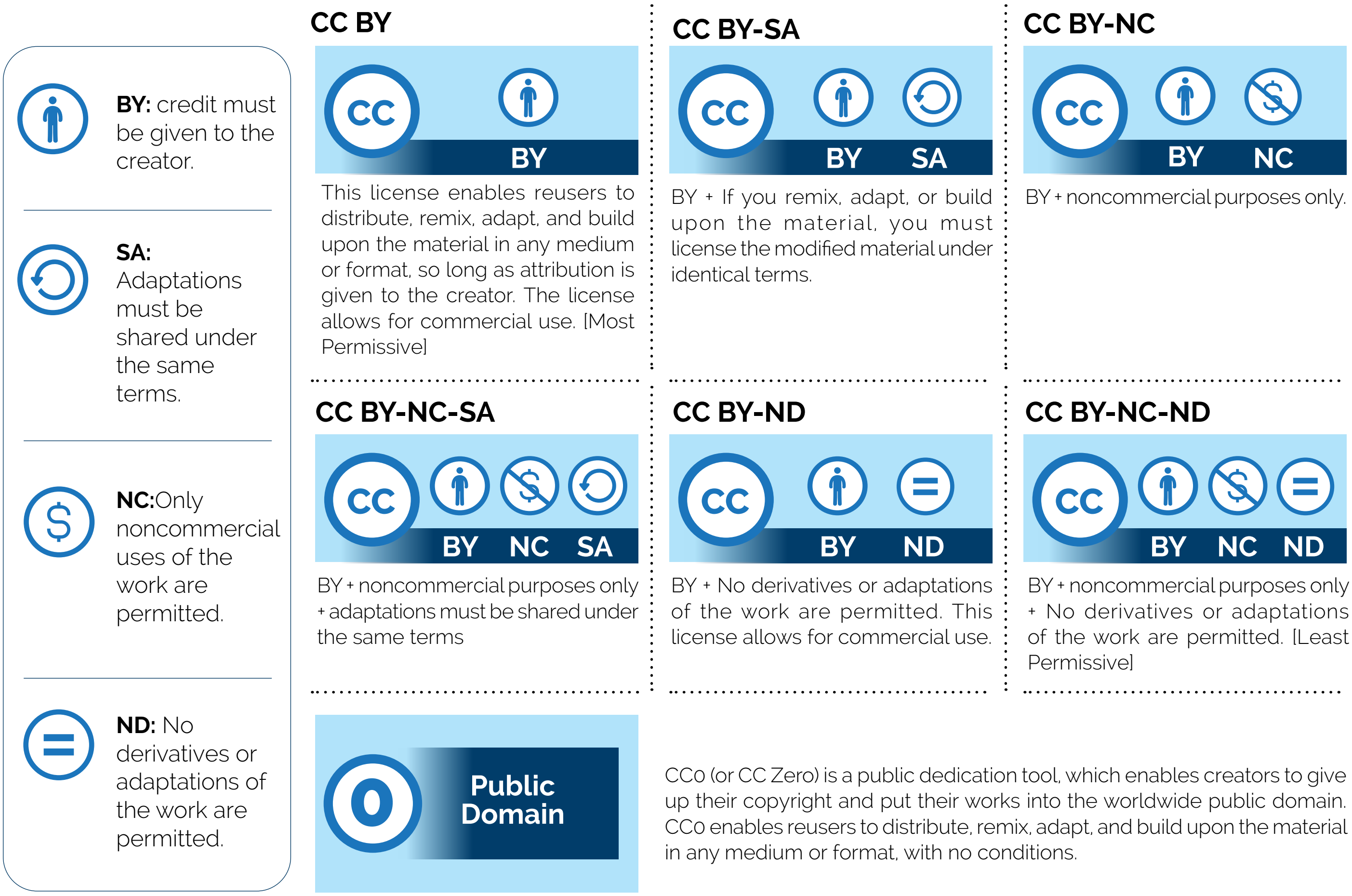

Figure 1: *The six license options from Creative Commons licensing system to grant the public permission to use your creative work under copyright law.*

Strictly speaking, only four out of these six licenses can be considered open. The CC BY-ND and CC BY-NC-ND don't permit any derivatives or adaptations of the work and, therefore sometimes, often become a point of discussion in OER movement. However, owing to their permittance for reuse, works protected by these licenses (e.g., open textbooks) are often considered under a broader definition of OER.

OER as a Tool to Improve Participatory Learning

The OER movement proposes an extensive free access to information in the form of online digital resources for teaching, learning and research. With several completed and ongoing OER projects in various STEM fields, the opportunities for educators to implement novel pedagogical approaches and to enhance students' participatory learning have increased rapidly. In recent years, these new trends have paved the way to introduce novel interactive approaches in almost all aspects of transformative and inclusive learning experience.

In recent years, the world has passed through a big transformation in the ways educational content is created, shared and used. This recent shift has several aspects and implications which have permanently altered the way we learn and teach new concepts and technologies. In the traditional model of a classroom, the instructor uses his/her presentation skills along with audio-visual aids to transfer complex concepts to his students. However, recent teaching practices have now drifted away from this conventional model. Nowadays, with the advent of online educational tools and with growing exposure to easily accessible internet resources, this one-way approach of delivering knowledge is no more effective. Today's classrooms need to be more interactive, alive, and collaborative to fulfill the educational needs of the students. Instead of traditional ways of problem-solving, engineering instructors nowadays are trying to equip their students with the development and use of efficient programming codes, software, and advanced computational tools. This shift is redefining the process of skill development in several fields of professional education including engineering and information technology. Several studies have shown that the instructional approaches based entirely on self-paced computer assistance are extremely effective. The development of online tutoring systems provides a new way to harness and exploit the educational potentialities of computers keeping in mind the social dimensions of the learning process. The goal of an intelligent tutoring system can be expressed as its ability to customize or rather individualize the learning process.

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In such a changing scenario, the use of OER can significantly accelerate the participatory learning process by helping educators harness the fruits of growing technological advancements. Several organizations, universities and individuals have stored their OER in the public web domain for free use or sharing by others, and can range from full courses to individual topics. By strategically incorporating them in existing educational setups, a collective effort can be made to ensure a more equitable and inclusive learning environment (Figure 3).

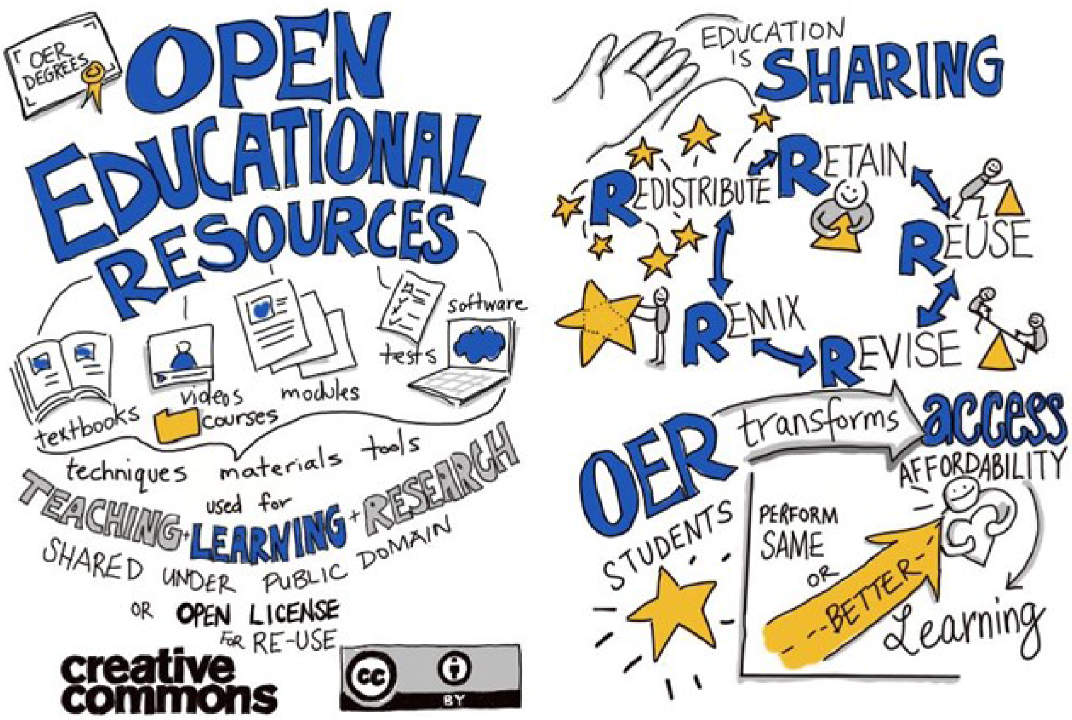

Figure 2: *OER is sharing" by Forsythe (2017)*

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Engineering the Future: Q&A with Richard Moh on Digital Landscape and Sustainability in Civil Engineering

Richard Moh

Chairman, Moh and Associates, Inc.
member of MAA Group

Q: Could you share your insights regarding the significance of industry-academia collaboration in shaping future civil engineering professionals?

A: Industry and academia collaboration has always been crucial in shaping the landscape of various professions. This is equally, if not more, true for civil engineering professionals. The fact that civil engineers build necessary infrastructure for the well-being of societies already indicates the scale of the projects they have to manage. The scale of such projects is highly integrated with both our built and natural environment. The complexity in the issues involved has consistently necessitated close collaborations among government, industry and academia.

Through the execution of projects, the industry would not only know the pertinent issues that may require research and development, but also know the necessary skills and knowledge that engineers need for the future. Academia provides more space and fewer interruptions for focusing on the research and developments of these problems. Academia also can leverage the creativity of young minds to generate newer and more innovative ideas that the industry may not be able to conceive. Areas of developments include R&D of construction process, construction materials, contractual relations, new design approaches, contract issues and the use of digitalization technology. Quality engineers play a crucial role in ensuring safety and maintaining quality throughout design and construction phases. Engineers need to be equipped with the skill set to collaborate with people from diverse backgrounds, including those without engineering expertise. In industry practice, civil engineers must communicate clearly with government officers of all levels, work closely with various civil engineering specialists, collaborate with financial and legal professionals, and engage in effective communication with the public and laborers.

It is important for industry to provide ongoing feedback to academia regarding the skills, attitudes and values required in the workforce. This ensures a steady stream of talented individuals entering the profession. Mutual collaboration between industry and academia is essential for enhancing the professional environment of the civil engineering. In the context of today's challenges, including digital technology disruptions, climate change, and geopolitical shifts, a closer and tighter collaboration between industry and academia is more crucial than ever.

Q Considering the fast-paced evolution of technologies, what transformative impact do you believe emerging technologies can have on the field of civil engineering?

A The technologies today are evolving much more rapidly than the field of civil engineering can keep pace with. Technologies such as 3D scanning, drones, digital modeling, and cloud computing can bring both positive and negative impacts to the field of civil engineering. Referring to my lecture, "Engineering Digitalization in Our Built Environment," at AIT in October 2023, some of the positive transformative impacts include enhancing efficiency across each stage of project cycle, boosting productivity, fostering clear communications among all stakeholders, achieving cost savings, and contributing to sustainability. These technologies enable engineers to gain a more comprehensive global perspective throughout planning, design, construction and operation/maintenance stages. As a result, the design process of a project can undergo changes, fostering greater collaboration among engineers from different disciplines, and allowing for the consideration of requirements at later stages ahead of time. All of these, if done carefully, can enhance the quality and safety of the project. However, all of this depends on the ability to change the mindset and traditional habits of engineers. The process of adopting new technologies must be carefully planned and monitored to prevent overdependence, thus avoiding a decrease in reliance on the critical and fundamental engineering judgment.

Q With an increasing focus on climate change and sustainability, how does MAA envision its role in championing eco-friendly practices within the civil engineering field?

A Climate change is a dire situation which all humanity must face together. We must all try our best to minimize the activities that instigates climate changes. In MAA, the ideas of eco-friendly practice began as early as the founding of the company. The guiding principles of professionalism, integrity, quality and people are highlighted as the core values at MAA emphasized by our two founders, Dr. Za-Lee Moh and Dr. Za-Chieh Moh. MAA has been dedicated to sustainable development since early 1990s, aligning with the global awareness to combat climate change. The focus and approach of civil engineering at MAA underwent a transformation, shifting from traditional mere service-oriented model to a collaborative engagement with people, the built environment, and the natural world.

We not only encourage our engineers to be aware of the necessity of green actions but also actively promote industry awareness

and advocate for changes in regulations. As an example of green action, the Fazih River Management Project located in Taichung Taiwan adopted a nature-oriented design and construction method. In this initiative, natural materials, including boulders, logs, and vegetation, were extensively used as eco-friendly alternatives to conventional reinforced concrete. This choice was made to protect the flora and fauna resources within the river's ecosystem. Another noteworthy example is the Taipei Mass Rapid Transit System, where a station was relocated to protect the habitat of the Taipei Tree Frog, an endangered species, specifically. This project was carried out with intensive eco-system monitoring and close interaction with ecological conservation group. In addition, MAA conducted an extensive study on the application of eco-technology in road engineering. Planning and design principles adaptable to the practical conditions of the eco-system under consideration were proposed as guidelines for practical road design.

In land development, MAA has widely adopted the principle of balancing excavated and backfilled soils to eliminate environmental impacts resulting from the transportation of soils. For water reuse, MAA has been served as both the design and project management consultants for major water reclamation plants across Taiwan. The completed plants currently provide 18,000 cubic meters per day (m^3/day) of reclaimed water. Additionally, with plants in various stages of design, construction, or readiness for operation, the total anticipated daily capacity of reclaimed water is expected to reach 105,000 m^3/day.

To build a resilient urban environment, MAA has successfully completed the planning of system networks of common utility ducts for Taipei, New Taipei, and Kaohsiung cities, with a combined population exceeding 9 million. In addition, MAA has been pioneering in digital development and application of smart technology in the field of civil engineering. Practical cases include the Smart Electric Toll Collection System for Highways, Building Information Modeling (BIM) for railway, buildings and pipelines, development of mobile device for construction supervision, three-dimensional smart query and management for underground utilities, personal protective equipment (PPE) for construction safety, and the others.

In 2023, MAA introduced its own Environmental, Social, and Governance (ESG) criteria and practices. This initiative, beyond reducing operational risk, aims to create new business opportunities and meet the expectations of social responsibility. The implementation of ESG is envisioned as the next milestone, demonstrating the company's dedication to sustainable development.

Q **What strategies does MAA employ to stay at the forefront of technological advancements, ensuring that its professionals remain well-equipped to tackle the challenges of the ever-evolving digital landscape in civil engineering?**

A MAA has been focusing on innovation, a core value established since the founding of the company, and actively implementing support measures. The approaches adopted for achieving technological advancements and ensuring readiness for challenges can be summarized as follows:

- Stay informed about the trends of digital technology development across various fields.
- Understand the needs for civil engineering, enhance our visibility in current market, and target new markets.
- Promote engagement and collaboration between the company and academic community.
- Keep identifying talent, updating work protocol whenever necessary, and preparing for change.
- Follow a top-down approach for launch of the actions after the initiation of the concept.

Our pioneer in engineering practices can be demonstrated by a latest project involving safety evaluation for Taiwan High Speed Rail. To identify geology and hydrogeology hazards, the satellite technology InSAR with GNSS was introduced for measuring ground deformation and providing accurately positioned information for the geological slope survey required to cover a large area.

MAA places strong emphasis on collaboration with academia. Recent examples include the research projects on application of UAV for land development, automated computation for construction progress, application of AI for deep excavation, and others. In addition, to further enhance the collaboration, MAA regularly offers a full semester seminar and a capstone course at National Yang Ming Chiao Tung University and National Central University, respectively. The lectures or capstone course are delivered by senior engineers or project managers with various disciplinary. While the seminar aims to provide students with perspectives and insights into engineering practice, the capstone course offers them the opportunity to apply their knowledge and skills to real-world problems, simulating challenges and complexities they may encounter in professional settings.

MAA actively encourages its engineers to document and present insights and learnings derived from their practices. Since the 1970s, more than 600 technical articles have been published in various conference proceedings, journals, and technical magazines. Demonstrating a consistent willingness to share its development and progress, MAA actively engages with both the engineering community and academia.

Q **Looking beyond the immediate future, how do you see the synergy between artificial intelligence, BIM, and data analytics shaping the way civil engineering professionals approach their work in the coming decade?**

A From our perspective, the synergy of BIM, data analytics, and artificial intelligence is poised to trigger a paradigm shift in the field of civil engineering. We anticipate that in the immediate future, more efficient, sustainable, and intelligent approaches will emerge, transforming our work in the following aspects.

Planning and design

BIM

Comprehensive digital representation through BIM, optimization utilizing artificial intelligence, and the identification of patterns and trends with data analytics will collectively contribute to achieving more efficient and sustainable development.

Maintenance

These technologies will facilitate the development and implementation of a proactive approach to assess the performance of assets over time, predict maintenance needs, mitigate costs, reduce downtime, and extend the lifespan of assets.

Construction

The synergy of technologies, including robotics, drones, automated control, image recognition techniques, and real-time monitoring, is anticipated to further enhance efficiency and safety in our operations.

Collaboration and Communication

The integration of BIM with AI and data analytics will be utilized to facilitate seamless communication and collaboration among clients, designers, contractors, and third parties.

Project management

The integration of these technologies will enable the monitoring and control of schedule and budget. Issues such as potential delays, resource allocation, interface conflicts, and design changes will be predicted and analyzed under this synergy. This foresight allows for the implementation of necessary measures in advance, optimizing the overall performance of the project.

Decision making

The synergy of these technologies will be applied to analyze data generated by BIM modeling, construction activities, and infrastructural systems, providing crucial information for informed decision-making.

The synergy of AI, data analytics, and BIM enables civil engineers to continuously refine their approaches over time, fostering ongoing improvement and innovation in civil engineering practices. However, it is crucial to bear in mind the importance of avoiding excessive dependence on AI and data analytics and the role of engineering judgment should remain as crucial as ever.

Shaping the Future: The Impact of Professional Master in Structural Design of Tall Buildings on Civil Engineering

In the ever-evolving field of civil engineering, the construction landscape is reaching new heights – quite literally. With the increasing demand for skyscrapers and tall structures, the role of structural engineers has become more crucial than ever. To meet this demand and equip civil engineers with specialized skills, Professional Master in Structural Design of Tall Buildings (PMTB) is shaping the future of civil engineering.

Professional Master in Structural Design of Tall Buildings

PMTB is a response to this growing demand for specialized expertise. These programs go beyond the foundational principles taught in traditional civil engineering education, delving into the complexities of tall building design, including structural systems, seismic considerations, and wind dynamics. The The curriculum is designed to provide students with a holistic understanding of the challenges and innovations inherent in tall building construction.

The Rise of Tall Buildings

In recent decades, the global skyline has been transformed by towering structures that defy traditional engineering norms. Tall buildings are not merely symbols of architectural prowess; they represent the intersection of art, science, and functionality. As cities expand vertically, there is a pressing need for engineers who possess a deep understanding of the unique challenges associated with designing and constructing tall buildings.

Specialized Knowledge

One of the keyways in which these programs shape the future of civil engineers is by offering specialized knowledge. Students are exposed to advanced topics such as performance-based seismic design, and wind engineering. This specialized knowledge equips graduates with a competitive edge, making them sought-after professionals in the field of structural engineering.

Interdisciplinary Approach

The design and construction of tall buildings require a multidisciplinary approach. PMTB encourages collaboration between engineers, architects, and other professionals. This interdisciplinary approach mirrors the real-world challenges faced by civil engineers working on complex projects, fostering teamwork and effective communication skills.

Real-World Application

Theoretical knowledge is valuable, but its real worth is realized when applied to practical scenarios. PMTB includes hands-on projects that allow students to apply their learning to real-world situations. This practical experience is invaluable in preparing civil engineers for the challenges they will face in their careers.

Conclusion

The Professional Master in Structural Design of Tall Buildings is playing a pivotal role in shaping the future of civil engineering. By providing specialized knowledge, fostering an interdisciplinary approach, promoting real-world application, this program prepares engineers to tackle the complexities of designing and constructing the skyscrapers that define our modern cities. As the demand for tall buildings continues to rise, the graduates of these programs are well-positioned to lead the way in creating the structures that will shape our urban landscapes for generations to come.

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