ENGINEERING CHANGE LAB USA

Context:

Technology: Artificial intelligence, machine learning, data analysis, the Internet of Things, and other technologies often developed by non-engineers increasingly being utilized in engineering solutions.

Education. Emergence of new engineering disciplines, new engineering technology programs, and blended, multi-disciplinary degrees driven by industry and student demand. "Interdisciplinary education is 'blowing up the silo' that engineers should be educated in only one discipline. Engineering students are increasingly diverse and seeking different ways of thinking and different approaches to solving problems." (Tim Jacobs, Texas A&M)

Legislation: Increasing focus by legislators on reducing barriers to entry and easing the portability of licenses.

Public Perception: Lack of understanding by the public of what engineers do, of the fact that not all engineers need to be licensed, and of the differences between software developers and licensed engineers.

Engineering Practice: Complex, inter-disciplinary, collaborative projects; imperative for more sustainable, resilient designs; increasing stakeholder and public involvement; technologies spanning jurisdictional boundaries, integration of emerging technologies into projects, and engagement in design of and design within systems of systems.

Breadth of Engineering Community: Growing numbers of engineering technologists and non-engineering technologists within the overall population of the engineering community.

Industrial Exemption: The industrial exemption which has been used to shield engineers working in industry from licensure requirements was originally designed to serve the needs of 2nd Industrial Revolution industries (complicated technologies whose risk and liability could be effectively assessed and assigned to industrial corporations or governmental agencies). The emerging technologies of the 4th Industrial Revolution are nested in complex systems involving numerous parties that span multiple regulatory and corporate boundaries, significant and often difficult to assess risks, and highly ambiguous situations where responsibility is hard to assign to a single party.

Mapping a *Transformational* Shift

Internal Combustion Engine

Electricity

Assembly Line

Advanced Chemistry

From...
Today's **Licensure Model** largely conceived and structured to address the technologies of the 2nd Industrial Revolution

1

Micro-Ethics & **Macro-Ethics**
A focus on ethics extending beyond the "micro-ethical" concerns addressed by the traditional licensure model to encompass the responsibility of engineers for the macro-ethical issues presented by emerging technologies and the entire systems impacted by engineering projects

2

Analytical & **Critical Thinking**
Technological challenges of the 4th Industrial Revolution demand not only the traditional analytical and problem-solving abilities, but also mastery of critical thinking and systems thinking skills as well as an enhanced capacity for self-awareness and reflective practice.

3

Single License to
Modular Regulatory Schemes
Adoption of a tiered and/or phased regulatory system that parallels the growth and development of individual practitioners and teams. This could include an early license focused on engineering basics and ethics, followed by tailored licenses and certifications for disciplines / areas of practice.

4

Static / High Inertia to
Agile & Adaptable
Given unprecedented advances in technology, new principles, protocols, rules, and policies are needed to accelerate the positive and inclusive impacts of these technologies, while minimizing or eliminating their negative consequences. Current regulatory institutions, including engineering licensure, are struggling to keep up. There is an urgent need for a more agile approach to licensure that can adapt in real-time to a rapidly changing socio/technological environment and address potential exponential impacts that often accompany emerging technologies.

5

Education / Exam / Experience & **Portfolio / Peer Review**
Shift from the current model which relies on an exam with education and experience requirements to a regulatory system that also includes credentials, such as a portfolio demonstrating essential engineering skills, peer reviews (multi-disciplinary peer reviews) certifying professional competence, values, and mindsets, and/or dissertation evaluation approaches.

6

Disciplinary Body of Knowledge & **Lifelong Learning**
Supplement the current model, which tests for competence with respect to a discipline's technical body of knowledge at a certain point in time, with strong requirements for lifelong learning and mastery of an ever-evolving professional domain (emphasis on emerging technologies and complex socio-technological systems).

7

Single Discipline & **Interdisciplinary**
Combine existing licensure for a single discipline (civil, mechanical, electrical, etc.) with licensure and certifications for interdisciplinary practice (mobility engineering, biomedical engineering, smart city engineering, robotics, de-carbonization engineering, etc.)

8

Individual Practitioner & **Team-Based Practice**
While continuing licensure of individuals develop team-based (project or platform based) licenses that can encompass teams of engineers, engineering technologists, computer programmers, and non-engineers engaged in the creation and development of emerging technologies.

9

State-Based to **Blended Self-Regulation, State, National, & Global**
Move from a licensure model dominated by state regulation to a blended licensure system that combines self-regulation (Canadian model) with state and national (and global) requirements and regulations.

Artificial Intelligence

Cyber-physical Systems

Virtual Reality

3D Modeling

Big Data

Internet of Things

To...
A future **Regulatory System** designed to fit the needs of the present practice of engineering as well as the needs and dynamics of the 4th Industrial Revolution and the Engineering Grand Challenges of the 21st Century.

Expectations for Regulatory Systems:

- The public relies on the competence and ethics of engineers to keep them safe.
- Professional engineers must regard their duty to public health, safety and welfare as paramount.
- Regulators protect the public by setting standards and holding practitioners accountable to those standards.
- Professionals are entitled to be governed by practices that are transparent, objective, impartial, fair, and timely.

Tenets:

1. Foster the role of engineers and the engineering community as stewards of technology and nature on behalf of society.
2. Move beyond only the protection of the public interest to the incorporation of a beneficial mindset.
3. Attract a higher percentage of the engineering community toward formal recognition of professional status.
   - Increased public benefit
   - Enhanced trust
   - Symbol of professional identity. purpose and commitment
4. Improve social equity, diversity, and inclusion. Remove unfair barriers to licensure for disadvantaged members of the engineering community.
5. Increase portability across state, national, and global lines.
6. Drive innovation and continuous learning within the domain of the engineering community.
7. "Broaden the view of the outcomes of engineering which shines the light on changes in processes needed and expands the skills that engineers need." (Mark Abbott, ECL-Canada)