Innovation in Structural Engineering: A career for the 21st Century

Dr Jennifer Keenahan
World Population

• 10 billion people in 2060

• Living to 95+

• Working to 75+
World Balance

• Asia’s century

• A third of the global population live in India or China
• Structural Engineers are LEADING the transformation of these countries
Urbanisation

• 50% of population live in ill-prepared MEGA-cities
• 75% in 2060

• Essentials
  • Food and nutrition
  • Clean water and air
  • Transport
  • Education
  • Healthcare

• ONLY Structural Engineers have unique knowledge about the planet to solve this problem
Climate Change

• Rising sea levels

• Unbalanced use of water resources

• By definition, by their training, Structural Engineers are the ONLY ones who understand the structural world enough to mitigate these problems
Sustainable Development Goals

1. No Poverty
2. Zero Hunger
3. Good Health and Well-being
4. Quality Education
5. Gender Equality
6. Clean Water and Sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation, and Infrastructure
10. Reduced Inequalities
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace and Justice
17. Partnerships for the Goals
Industrial Revolutions

1

1st industrial revolution

Mechanical production based on water and steam power

First mechanical loom

2nd industrial revolution

Mass production enabled by division of labor and electricity

First conveyor belt

3rd industrial revolution

Use of IT and electronics

First programmable controller

4th industrial revolution

Cyber-Physical Systems
Internet of Things
Artificial Intelligence
Big Data

First ifactory4.0
1. SoundLab

Can you imagine the sound of a new railway?

Current train 300kph: Without noise mitigation

HS2 Railway, UK
1. SoundLab

Combines acoustic simulations with visualisations

Innovation in community and stakeholder engagement
2. Drones

Boland’s Mills
2. Drones

- 3D Mapping
- Coastal inspections
- Crane & scaffolding inspections
- Stockpile monitoring
- Personnel movement
3. Building Information Modelling
Metro North construction may be brought forward

Cabinet is considering accelerating the project as part of review of capital programme

Fiach Kelly

Paschal Donohoe is to tell Ministers that there is an additional €2.6bn available for capital investment up to 2021.
Photograph: Brenda Fitzsimons
Virtual and Augmented Reality

Boland's Mill Virtual Reality Model
4. Virtual and Augmented Reality

VR - computer generated environment giving the user the impression they’re inside the building

AR – superimpose computer generated images onto user’s view of the world

A ‘target’ (QR code) used to sync location of digital 3D data with real world
4. Virtual and Augmented Reality

• Powerful visualisation tool
  • Stakeholders
  • Virtual team meetings

• ‘Track-changes’

• Construction sequence

• Safety plan & communication of hazards
5. Computational Fluid Dynamics
For the Built Environment

\[ \rho \left( \frac{\partial \mathbf{v}}{\partial t} + \mathbf{v} \cdot \nabla \mathbf{v} \right) = -\mathbf{p} \cdot \nabla T + \mathbf{f} \]
5. Computational Fluid Dynamics
For the Built Environment

- Fluid flow - complex, non-intuitive, interaction many features
- Modelling of Fire and Smoke, Wind, Thermal Behaviour and Tonal Noise
Innovation in Fire Design

- Prescriptive Fire safety standards
- Specialist full scale tests - expensive
- Complex modern building design
  - Larger open plan spaces
  - Higher utility of space
Deal worth €3.1m agreed to remedy Longboat Quay defects

Agreement to be put to apartment owners but funds cover projected fire-safety work

© Mon, Dec 19, 2016, 01:00

Olivia Kelly

It is understood owners of 299 apartments in Longboat Quay will not have to contribute to fire safety costs.

Photograph: Dara Mac Dónaill
Innovation in Wind Design

Main road into Leeds 'should be closed in high winds' after pedestrian was killed by flying lorry

A coroner made the recommendation following the death of Edward Slaney, who was hit by a lorry that flew through the air 'like a hot air balloon'

Bridgewater Place Tower, Leeds
Innovation in Wind Design

Point Village Wind Study
Innovation in Wind Design

Green light for plan to build Dublin’s tallest office block
Permission granted for 73 metre €60m Nama-funded Exo structure at Point Village

Olivie Kelly

Point Village Wind Study
Innovation in Wind Design

Point Village Student Accommodation

Client Paid

Client Saved

Total 500K

200K screens on roof garden

300K from avoiding canopy

CFD fee 15K
Innovation in Thermal Comfort

New Pre-Boarding Zone, Dublin Airport
Innovation in Thermal Comfort

New Pre-Boarding Zone, Dublin Airport
Innovation in Façade Design

Beetham Tower, Manchester
A valued engineer?
A Structural Engineer?

• Electronic software giants - lost perspective on real human need

• Are you a leader or are you a follower?

• Part solution for a better, more sustainable world for 10bn in 2060?