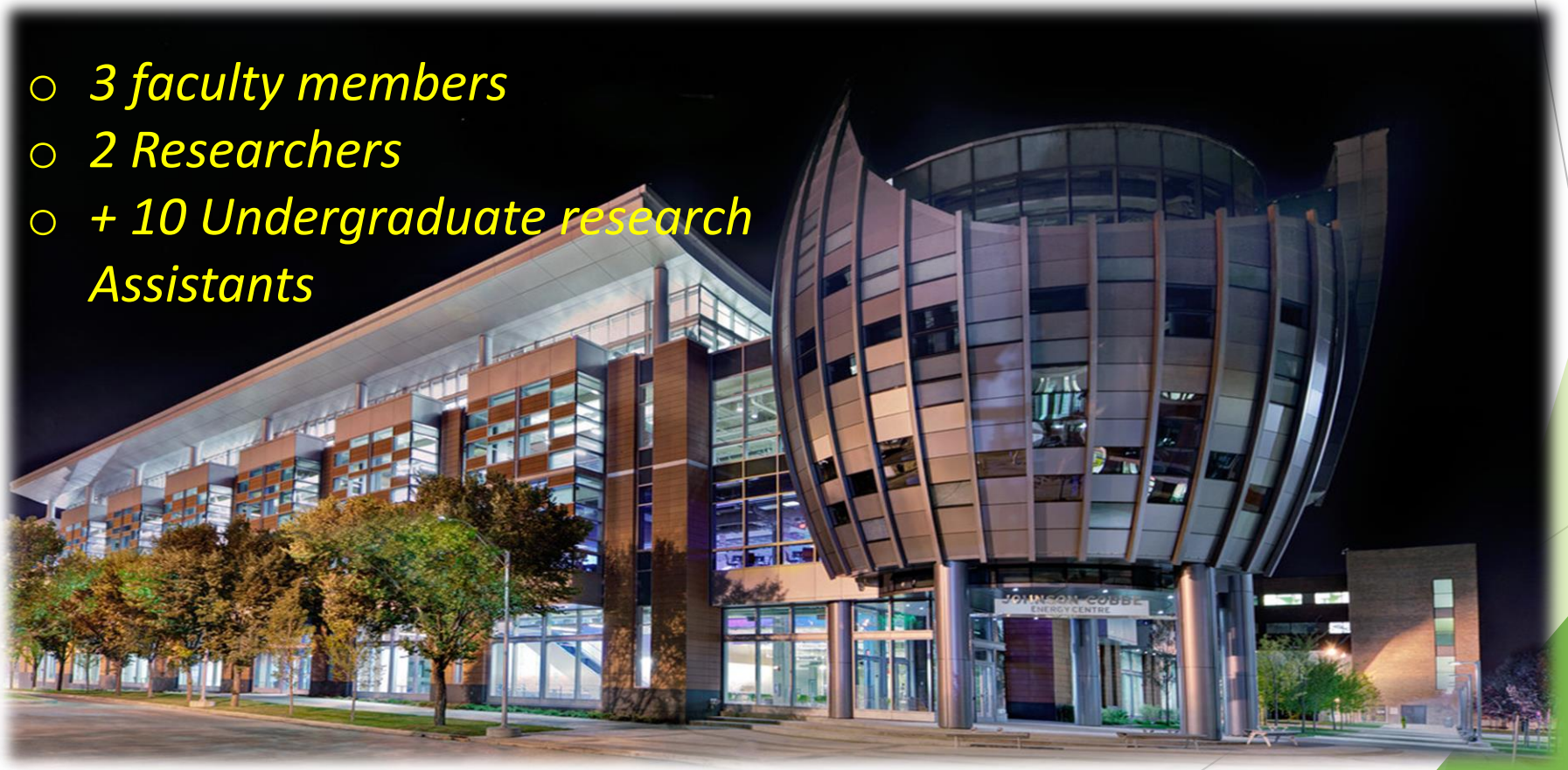
# Value of Innovation in Construction

Dr. Azzeddine Oudjehane

# Southern Alberta Institute of Technology
# - CIRUS -
# Centre of Innovation & Research in Unmanned Systems




- *3 faculty members*
- *2 Researchers*
- *+ 10 Undergraduate research Assistants*

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# Dr. AZZEDDINE OUDJEHANE

Gradate degrees in Materials Science Engineering and Business Administration

30 years experience in R&D, business innovation and, market development performance evaluation, education and training

+100 publications and presentations at international conferences,

Members of journal review committees

Committee chair of sessions at conferences.

Vice Chair – Chapter Leadership Board of the Alberta Chapter of CaGBC - Canada Green Building Council.

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# TODAY'S LEARNING OBJECTIVES

- Identify the trends for innovation in construction
- Analyze innovation in construction
- Define the life cycle approach for value of innovation+
- Recognize the sustainable value of an innovative instruction method
- Identify the value of innovative quality control using unmanned systems in construction

# Trends in Construction

- Technology advancement and integration in construction projects (BIM, Ai,…)
- Modular and prefab construction methods
- Increased safety consideration
- Integration of sustainable practices (WELL, Resiliency;…)
- Increased costs of materials

Source McKinsey report 2018

# The Construction sector

- ✓ In 2014, the global construction industry was worth $8.7 Trillion. + $12 Trillion by 2020
- ✓ 35% of investments in emerging markets (South east Asia, MENA, India,...) in 2013, will reach 52% in 2025
- ✓ Construction investments in Canada: ~$399 B in 2013; ~$ 405 B in 2014 (+1.25%)
- ✓ In 2004, construction investments in Canada was ~$180 B +125% investment increase in 10 years

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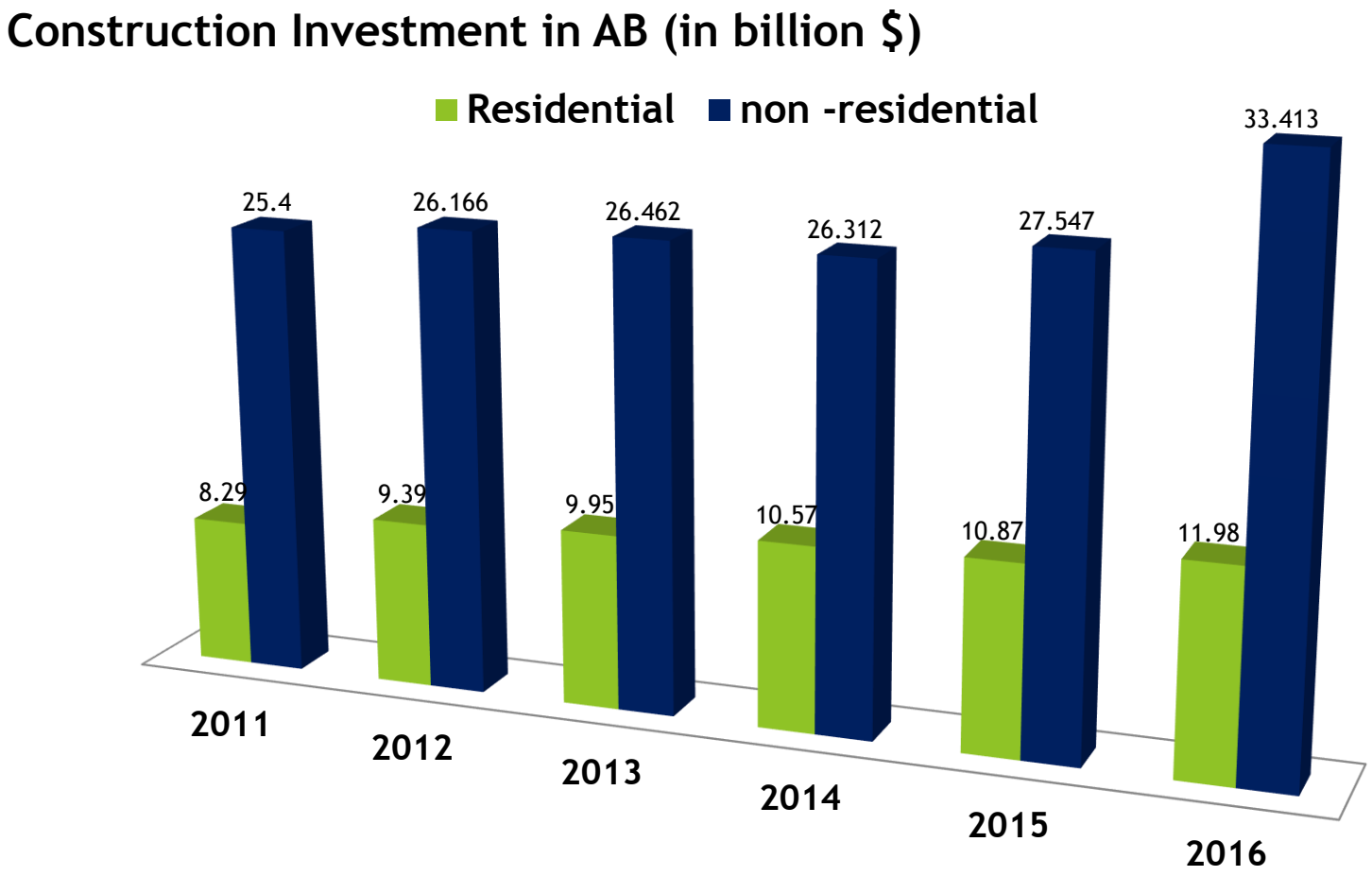
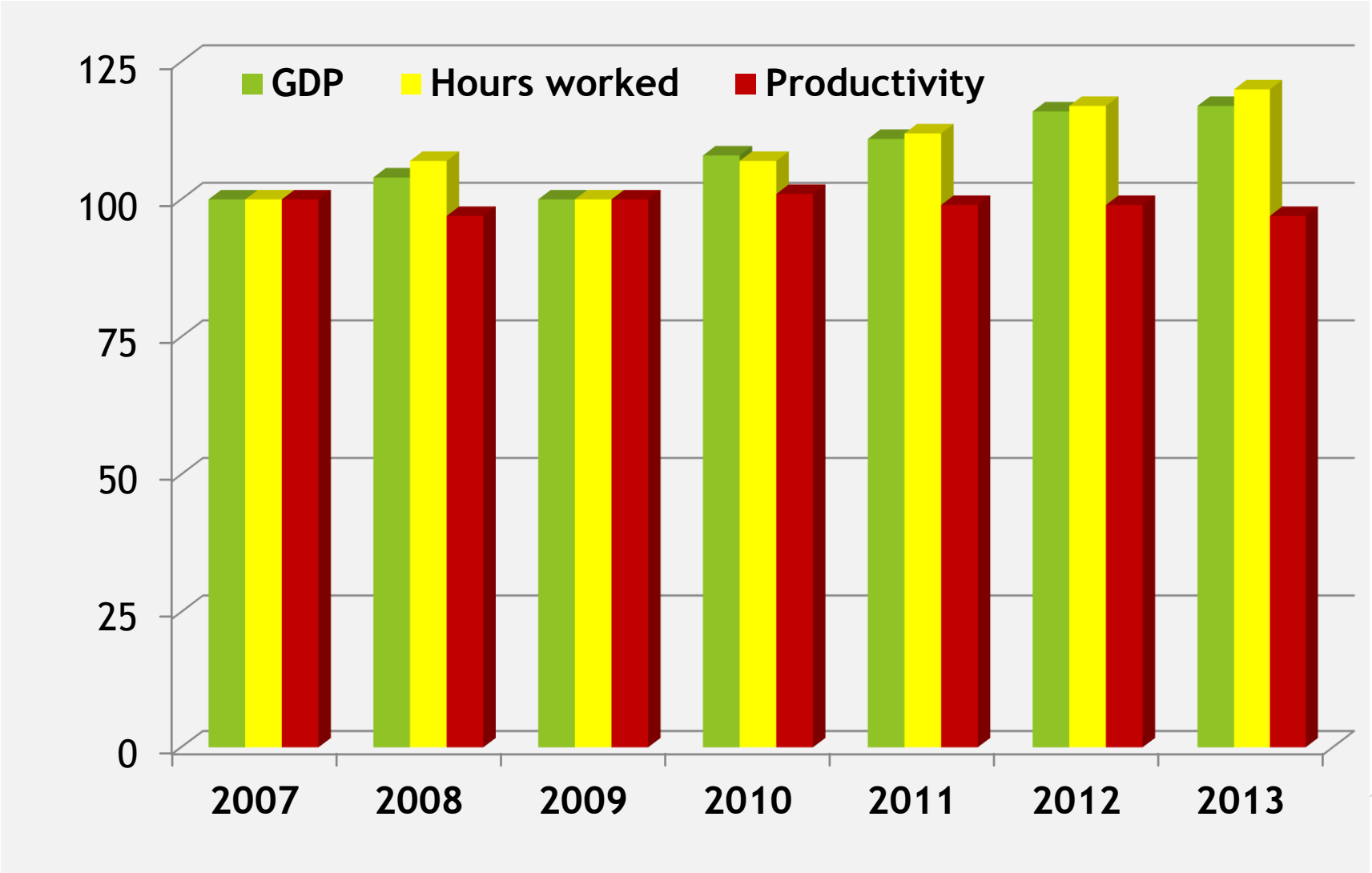
# The Construction sector



# Opportunities and Challenges of the construction sector

- **Economic uncertainty**
- **Steady growth and strong demand for projects**
- Labour market and workforce issues
- Green and sustainable construction
- Lean construction
- Innovation and new technologies such as BIM
- Efficiency and productivity: “Construction 2.0”

# Productivity in the construction industry




Source: StatsCan

# Innovation in Construction (1)

## Top 10 Trends

1. Detailed 3D BIM modeling
2. Cost 5D and schedule 4D modeling with Macro-BIM
3. Pre-fabrication
4. Energy-saving building systems
5. Smart buildings



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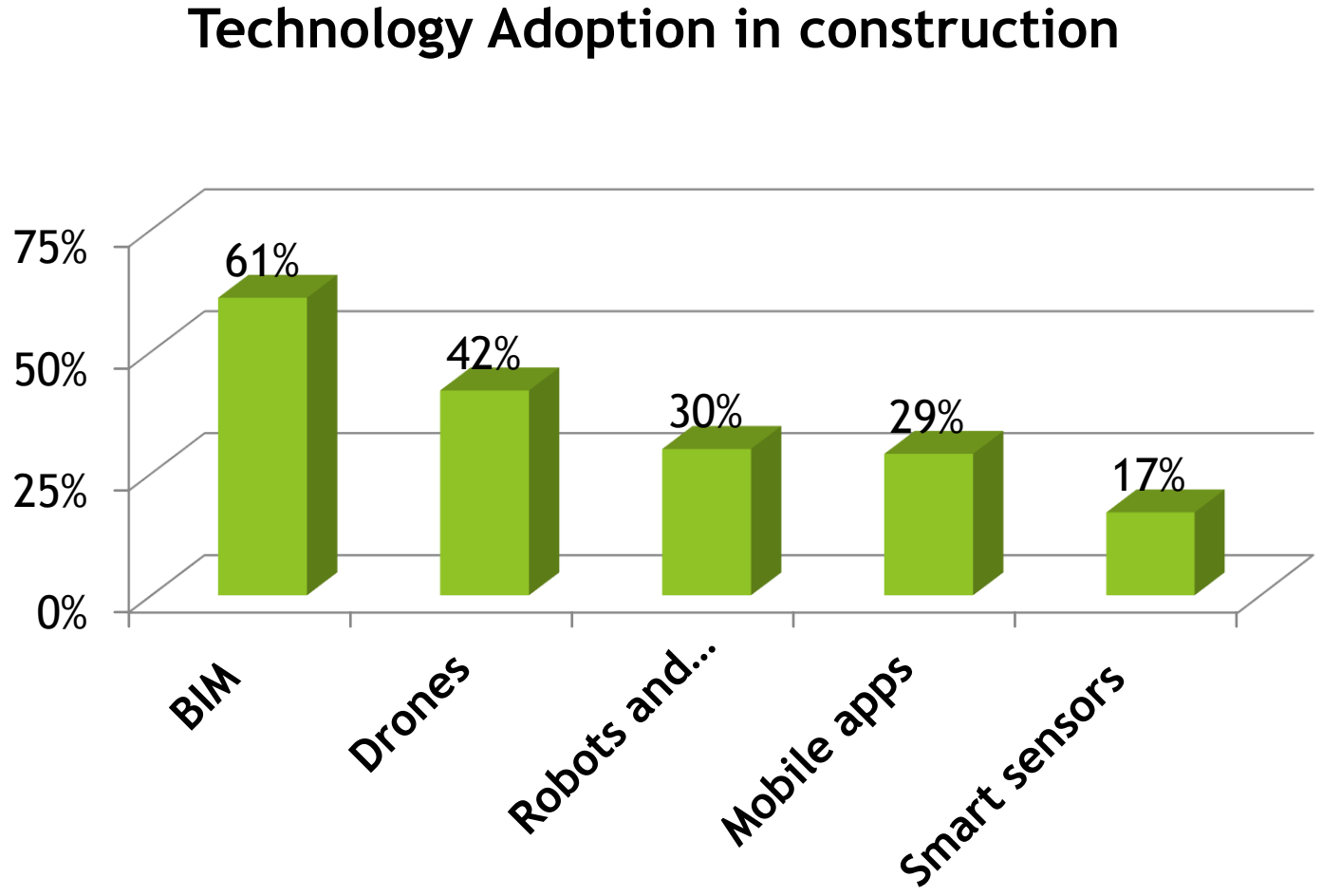
# Innovation in Construction (2)

## Top 10 Trends

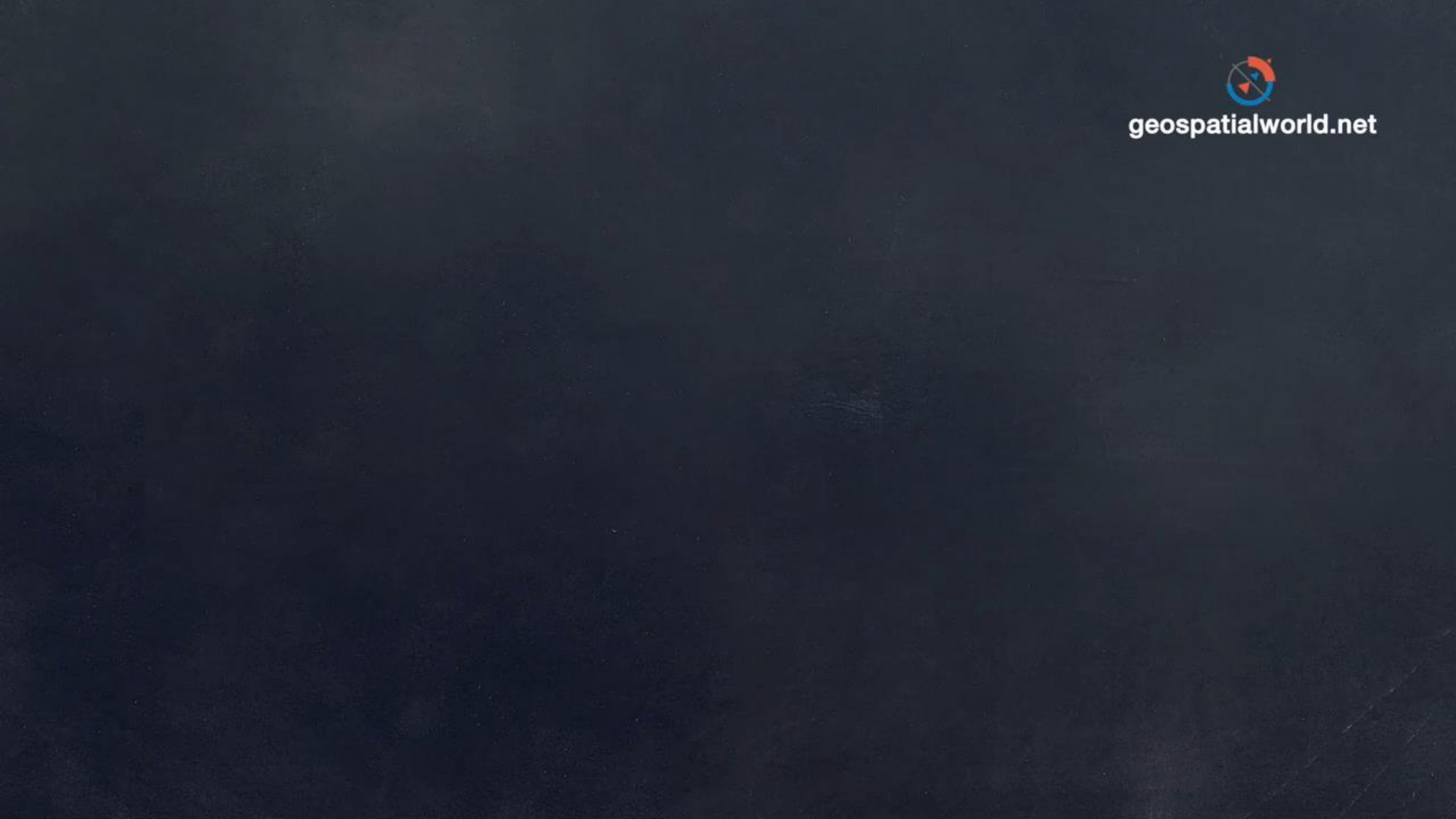
6. Integrated mobile technology and information on jobsites
7. Robotic automation
8. Unmanned Aerial Vehicles (UAVs)
9. 3D Printing in construction
10. Enhanced jobsite safety

# Change in Construction

## Slow but certain

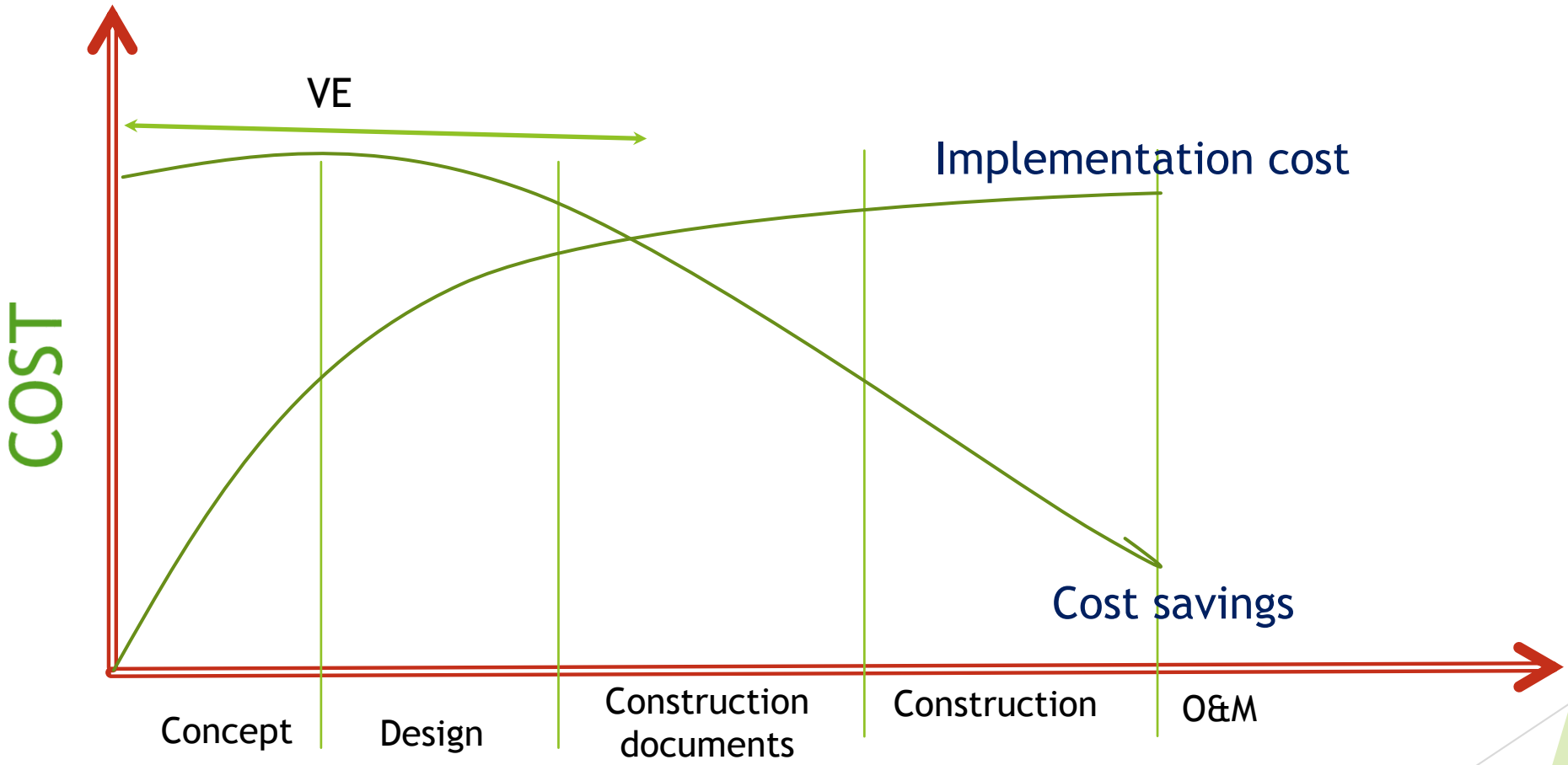



Source: KPMG  Global construction strategy

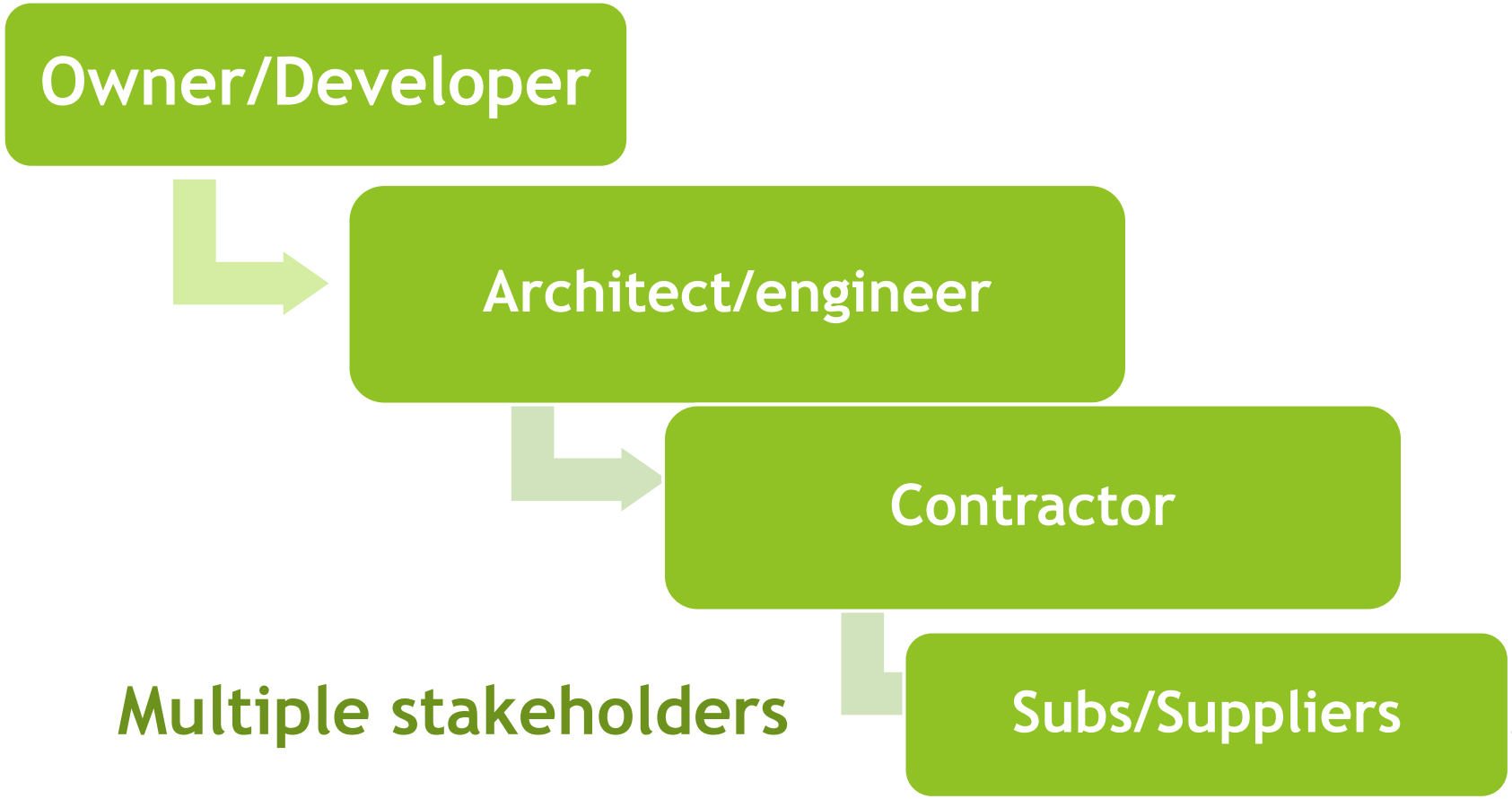

geospatialworld.net

# Where is the Value Analysis in all this?

# VE in construction projects

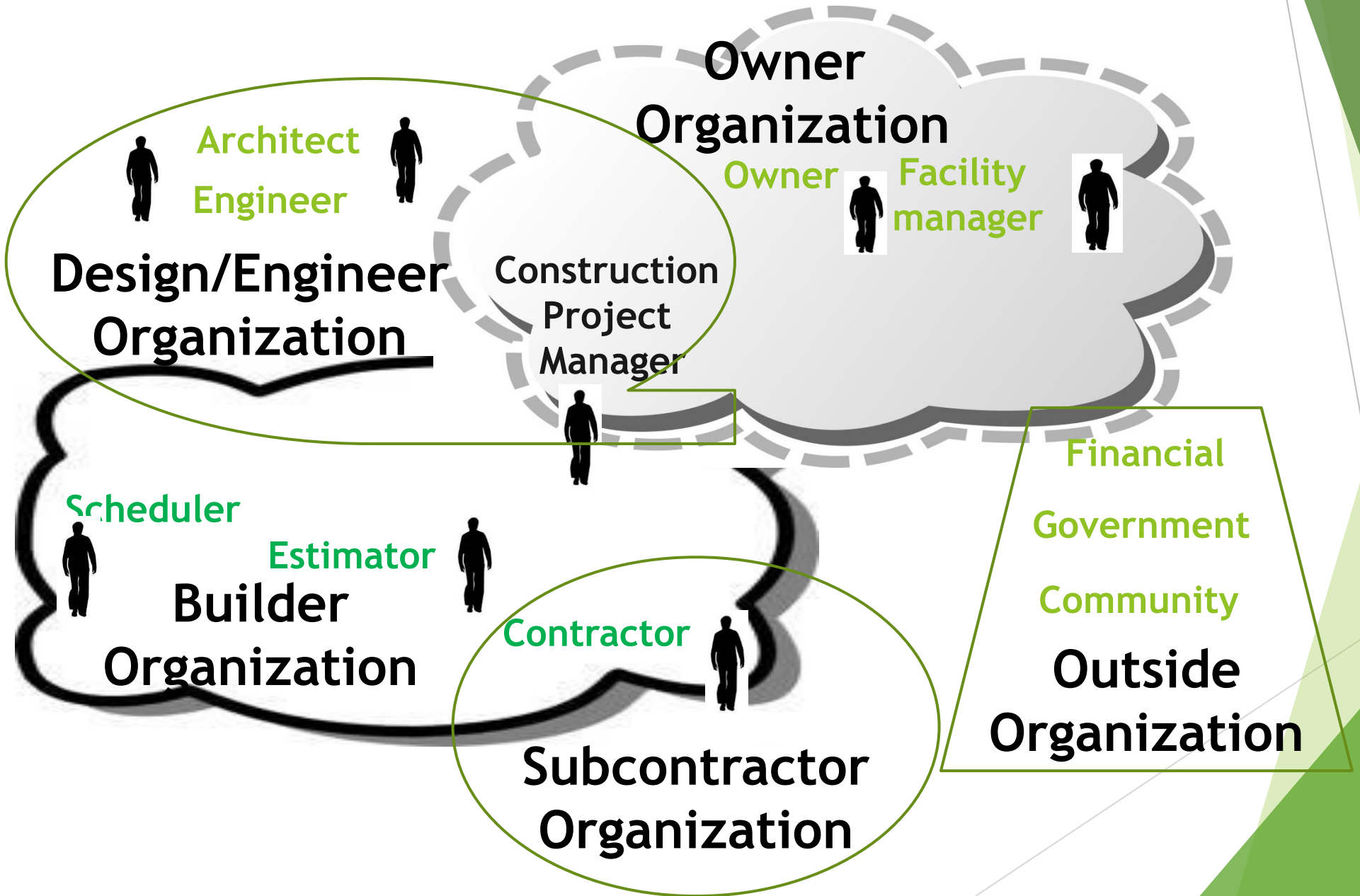


# The business model in construction projects




Multiple stakeholders

# The stakeholders in a construction project



# ISSUES OF THE CONSTRUCTION SECTOR IN 2018

- Unpaid work: over 11 M $ in litigation
- Aging workforce and labor shortage 54% of Managers are boomers
- Variety of Technology among the general contractors
- Contract terms unfavorable to sub-contractors
- Safety
- Project delays: 25% of projects completed within 10% of deadlines- Integrated Project Delivery (IPD)

Source: Esub Construction

# The value of Innovation in Construction

Can be measured by Increments and increase in:

- Productivity
- Profitability
- Market diversification

# Cross Laminated Timber for Tall Wood Mass Buildings in Alberta

**Mitchell Hagan**

**&**

**Azzeddine Oudjehane**

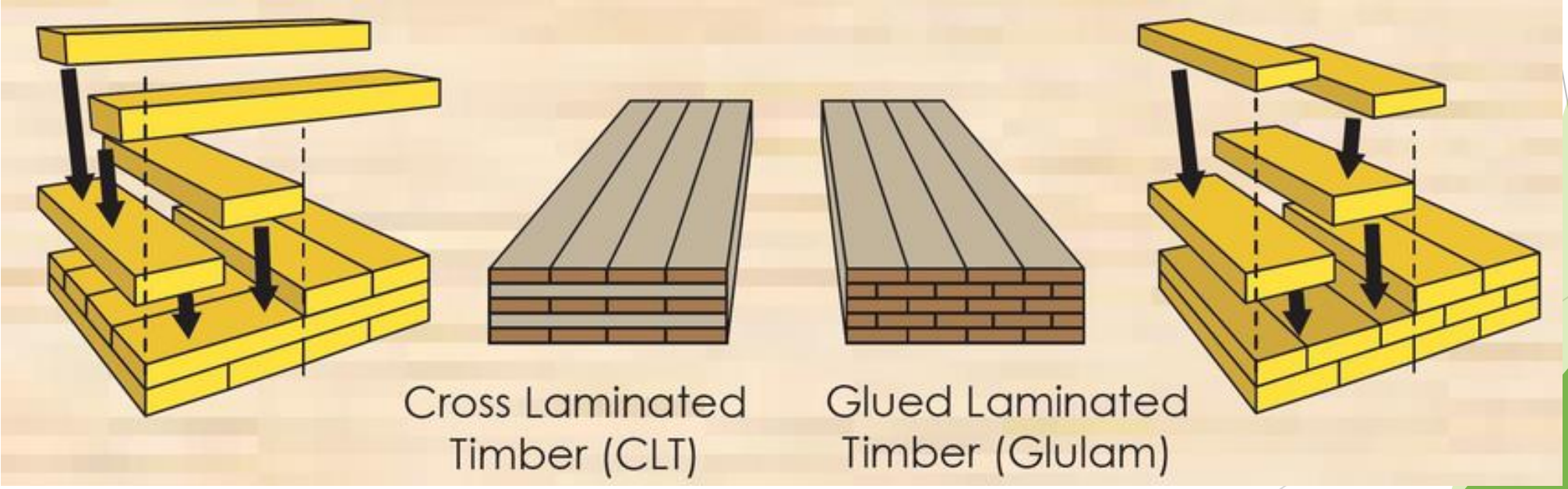
# THE VA - CASE

- 1 construction project: a 10 storey residential building
  - 2 construction methods
    1. Prefab – Integrated design and project delivery
    2. Conventional
  - 2 building materials
    1. CLT - Innovative approach
    2. Reinforced concrete


+10
+1

# Cross Laminated Timber

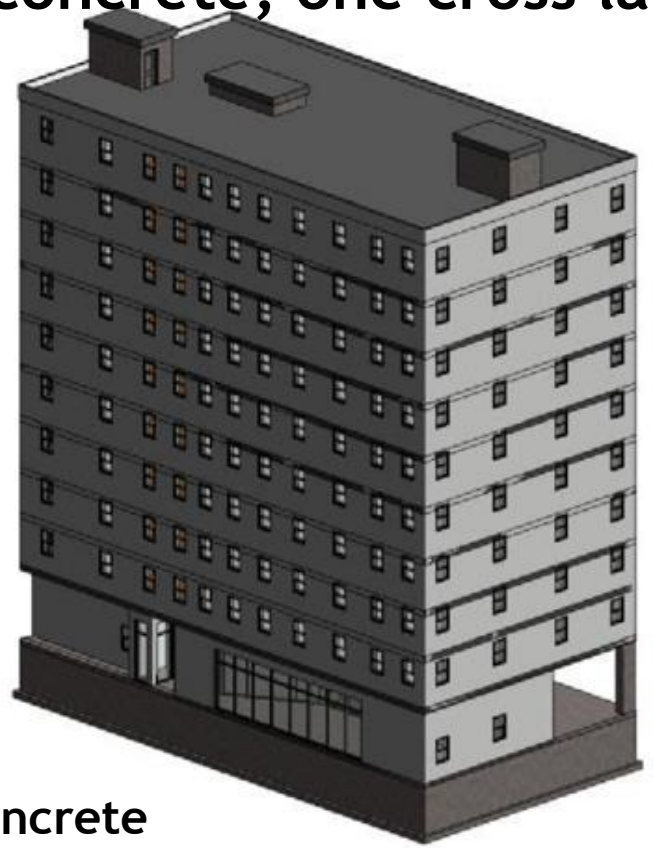
- Lumber laminated perpendicular to each other
- All walls and floors act as structural members
- Fully prefabricated



# Revit Models

- Two 10-storey buildings
- Identical floor area
- One concrete, one cross laminated timber

- Models used for energy analysis, material estimation, and generic building information



Concrete

Cross Laminated Timber

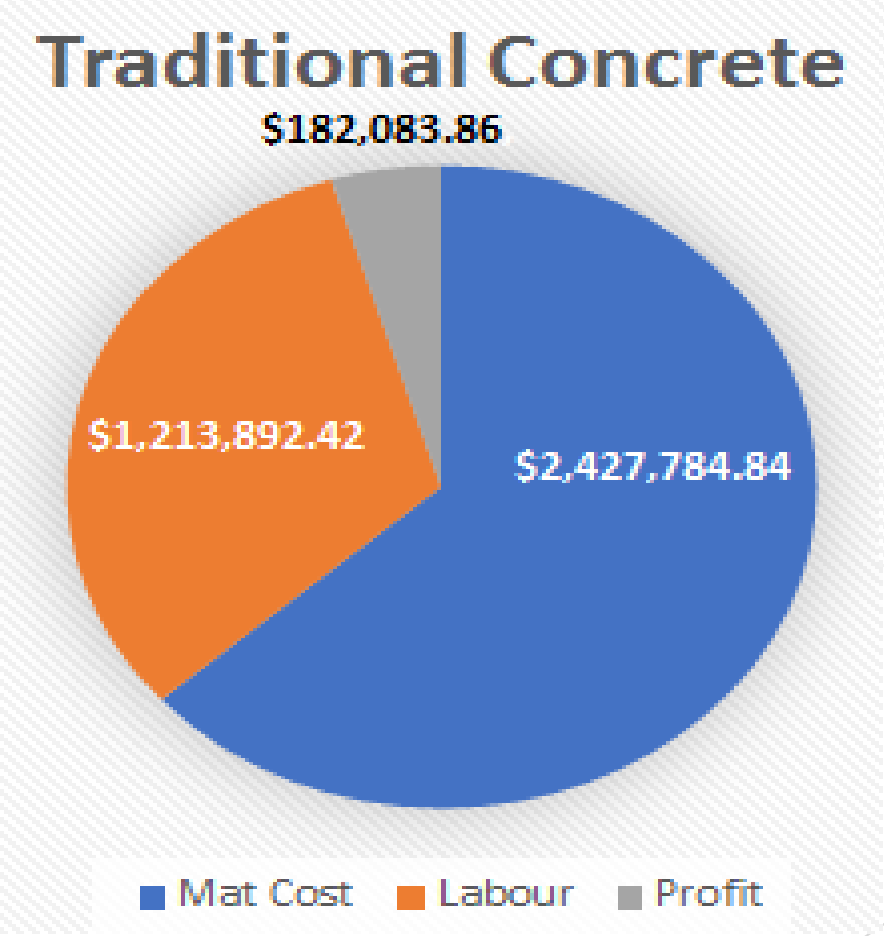
# Energy Analysis

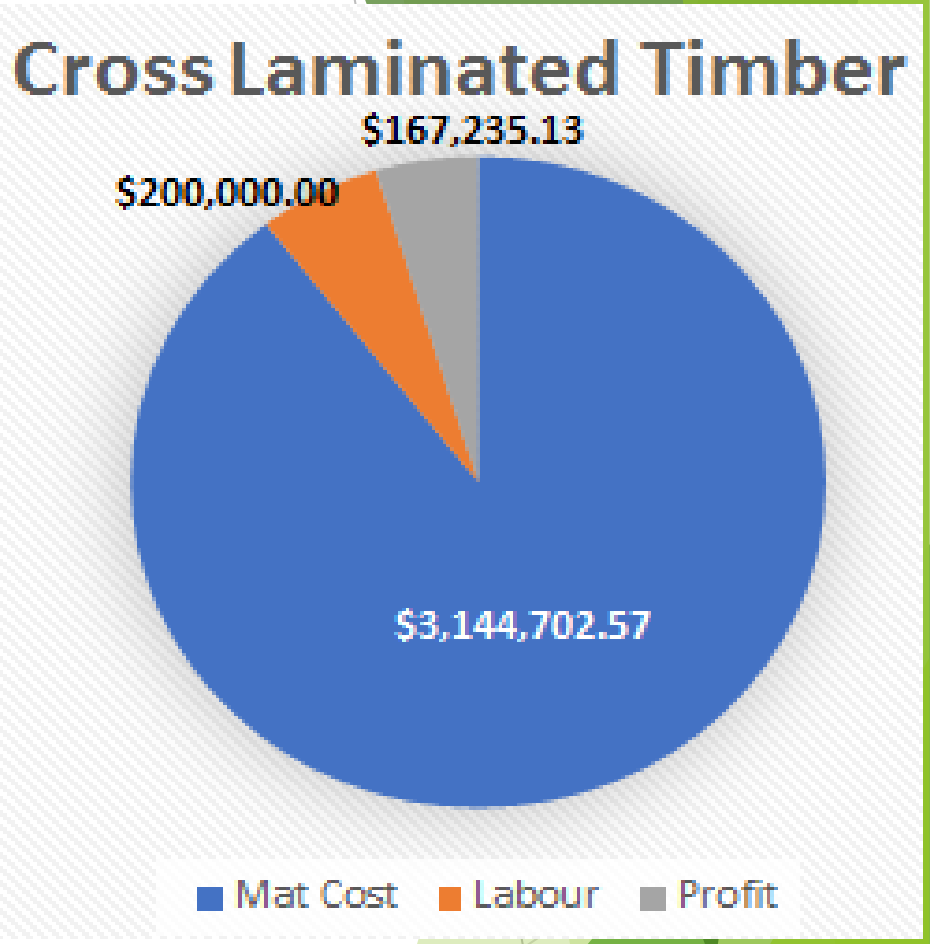
- Using Revit models
- Energy Analysis using Insights
- Material properties based on industry design standards
- Both buildings had same cladding systems

| Concrete | Cross Laminated Timber |
| --- | --- |
| Heating cost per year of $382,736 | Heating cost per year of $235,107 |
| Requires 2,100,000 BTU per hour to heat<br>**+60% more** | Requires 1,300,000 BTU per hour to heat |

# Material Analysis

- Material quantities based on Revit models
- Material costs based on industry standards
- CLT cost based on applicable ply



# Additional Comparisons

| Traditional Concrete | Cross Laminated Timber |
|---|---|
| Built with non-renewable resources | Built with renewable resources (20 year grow time) |
| Building method reduces ability to alternate floor plans | Honey combing allows for alternating floor plans |
| Concrete must cure for 30 days | Prefabrication minimizes on-site build time |
| Heavy structure requiring deep earth works | Structure weight ¼ of concrete, foundation reduced by 2/3 |
| Invented for simple, low cost developments | Invented to help heal the environment |

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# Monitoring building envelope efficiency

**Joseph Matthieu, Shaun Hoffman**

**&**

**Azzeddine Oudjehane**

# THE VA - CASE

- Quality control and Commissioning of projects
  - Traditional commissioning and QC using a handheld Infra Red
  - Use of UAV equipped with IR sensor

# Current UAV Technology

DJI M210RTK with dual payload

Image Courtesy of DJI

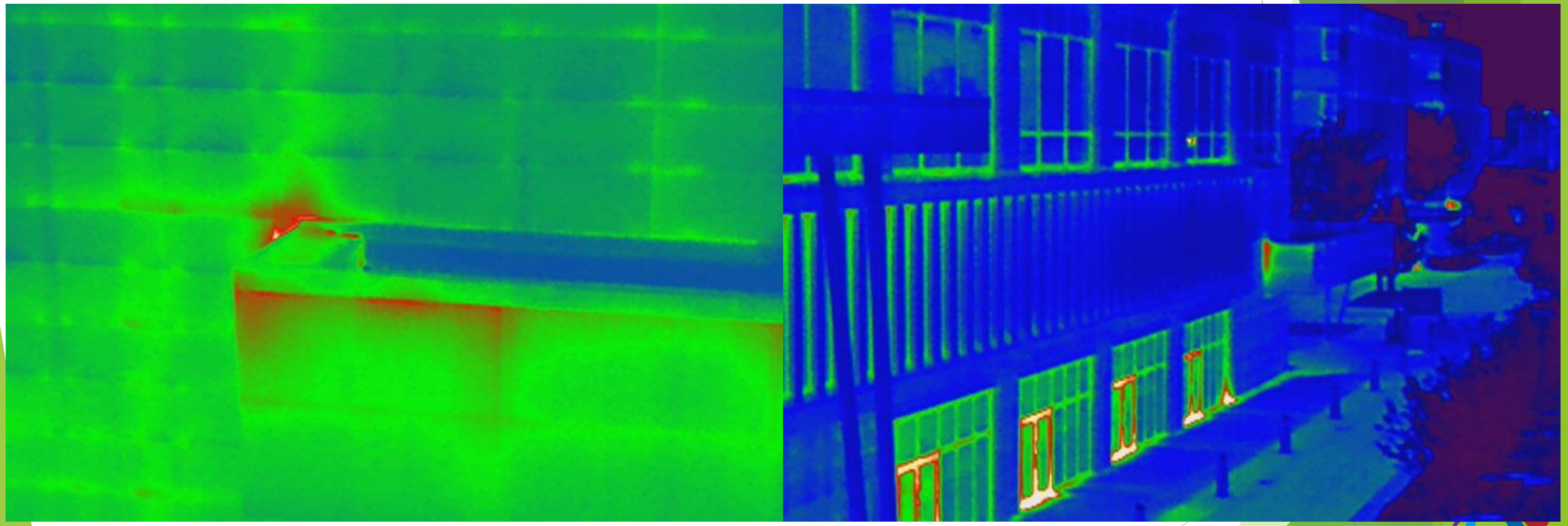
DJI Zenmuse XT Sensor

Image Courtesy of DJI

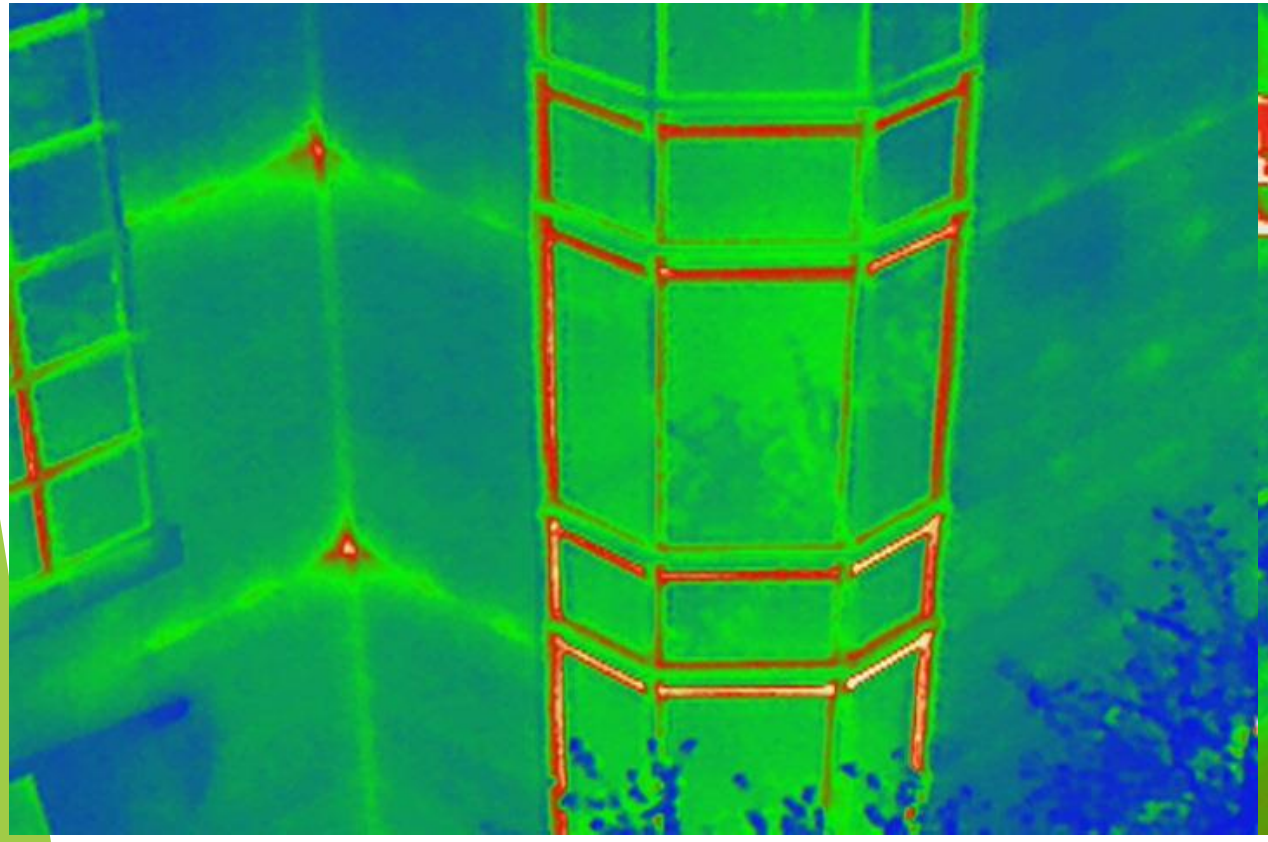
# IR Handheld

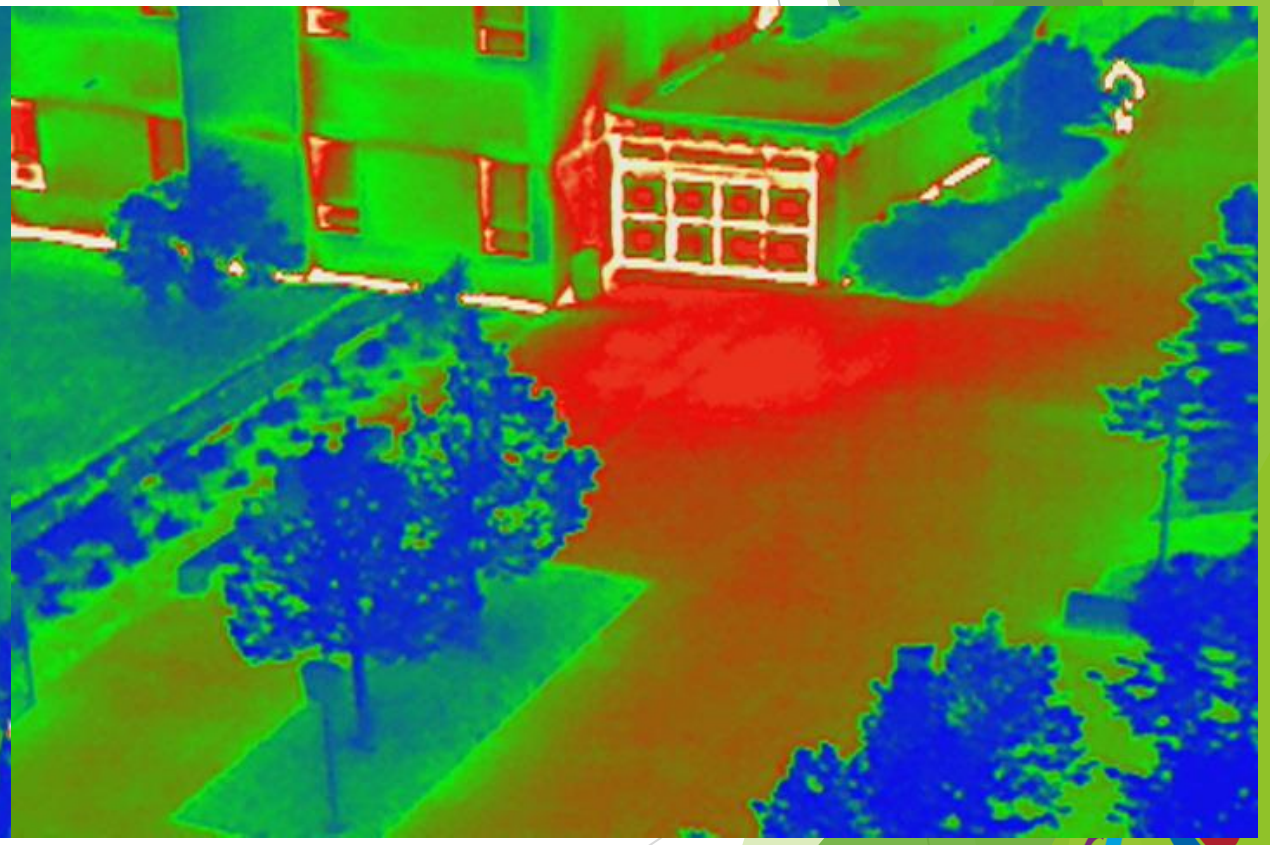
Courtesy of FLIR

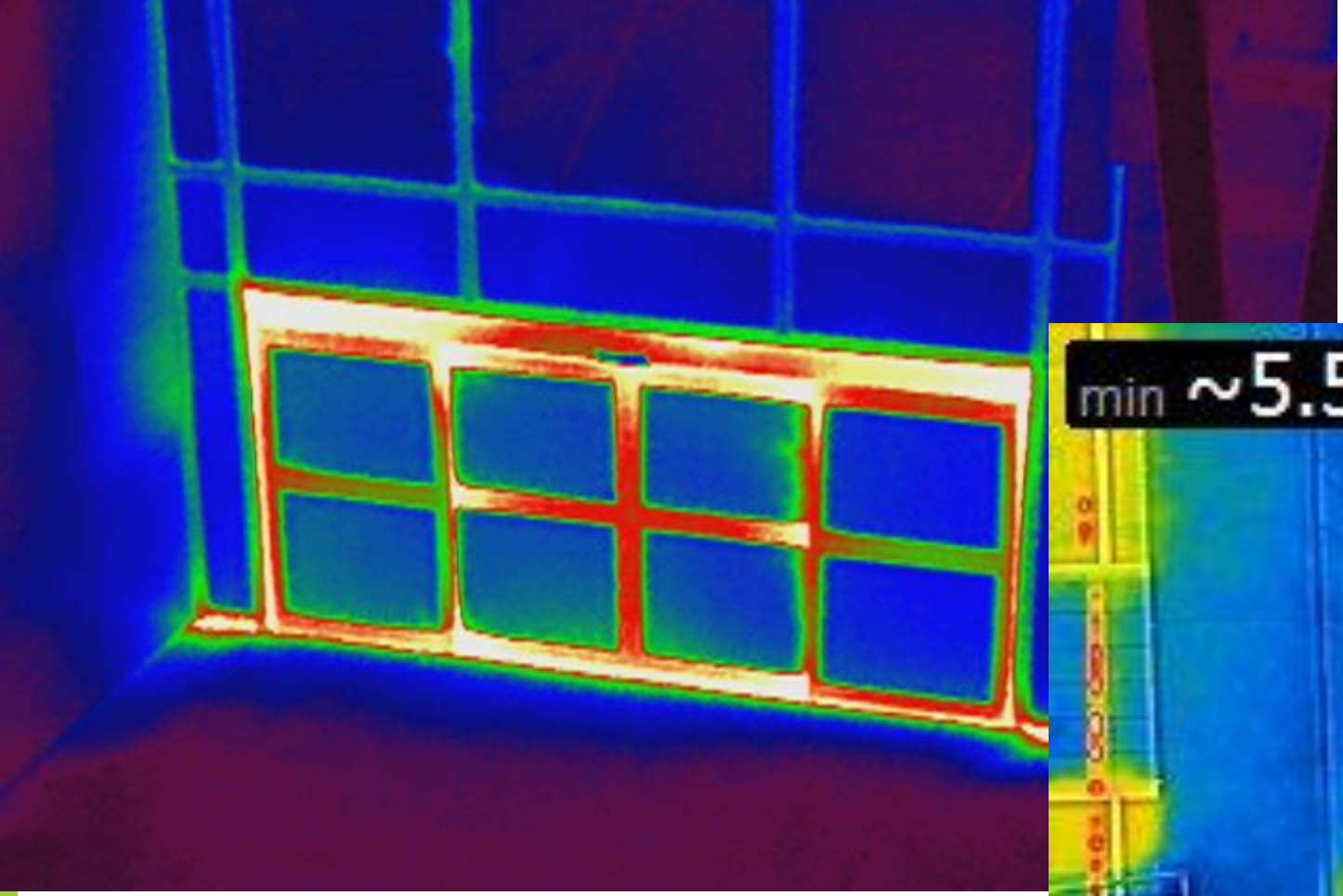
# Examples of UAV Radiometric Images cont.



# Examples of UAV Radiometric Images








Drone image vs Hand held image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