Presenter: Carlo Carbone  
Title: *Mise en contexte des défis et enjeux de la réglementation de la Régie du bâtiment du Québec concernant l'entretien des façades*  

I. Introduction et structure de la présentation  
   a. Objectifs  
      i. Comprendre le contexte réglementaire  
      ii. Identifier les types d'édifices concernés  
      iii. Déterminer les méthodes pertinentes d'intervention  
      iv. Identifier les enjeux par rapport au patrimoine bâti et sa conservation  

II. Contexte de la réglementation et du domaine bâti  
   a. Sécurité des biens et des personnes  
   b. Préservation du patrimoine bâti  
   c. Qualité de la construction d'origine  
   d. Évolution de la façade comme système  
   e. Façades régies  

III. Responsabilités du propriétaire  
   a. Registre  
   b. Rapport de vérification  
   c. Programme d'entretien  
   d. Capitalisation long terme  

IV. Responsabilité des professionnels  
   a. Méthodes de vérification  
      i. Les éléments visibles et les éléments dissimulés  
      ii. Contenu du rapport  
      iii. Documentation  
      iv. Éthique de recherche  
   b. Fréquence des rapports  
   c. Conditions dangereuses  

V. Conclusion  
   a. Défis pour le professionnel averti  
   b. Défis de la disjonction des champs (inspection vs conservation)
1) **Project Overview and Brief Review of Presentation Objectives (2 minutes - JK)**
   a) Project overview outlining the various challenges faced while managing the substantial and intensive exterior masonry restoration work to one of Canada’s most prominent heritage structures
   b) Intent of masonry conservation effort and general masonry work scope

2) **Prequalification and Procurement Risks (5 minutes - JK)**
   a) Prequalification criteria for the selection of the masonry restoration and masonry conservator contractors
   b) Development of work plans to ensure maintenance of quality and safety
   c) Properly trained stonemasons/cutters/carvers within the industry

3) **Communication with Exterior Masonry Team (5 minutes - MB)**
   a) Assembly and management of conservation and masonry contractor teams
   b) Structure and organization
   c) Roles, responsibilities and lines of communication
   d) Use of supporting technologies

4) **Quality Assurance and Quality Control Management (5 minutes - MB)**
   a) QA/QC Plan
   b) Contractor compliance and acceptance
   c) Sign off process

5) **Closing**
Presenters: Matthew Farmer
Title: And the Pinnacles Shook: Repairing Washington National Cathedral’s Earthquake Damage

- History of the Cathedral - The Facts
  - Construction Schedule
  - Historic Facts
  - Prior Damage/Repairs
- Sustained Damage at the Cathedral
  - Examples
- Stabilization and Assessment Findings, Repair Recommendations
  - Extent and Breadth of Damage
  - Patterns in the Damage
- Repair Considerations
  - Safety
  - Access
  - Funding Stream
  - Purchase of Scaffolding
  - Phasing and Prioritizing of Repairs
  - Integration of Deferred Maintenance Items
- Structural Analysis
- Repair Implementation
  - Apse Flyers
  - Apse Buttresses
  - South Turret
  - Grand Pinnacles
- Trial Repairs - Setting the Standard
1. **Introduction**

“Laser scanning, 3-Dimensional modelling and digitally-assisted replication are useful for documentation and digital archiving purposes but are they useful in any way when fabricating a replacement carved stone for a conservation project?” A discussion.

The theme for this year’s APT conference is “métissage”. This presentation examines the “métissage” of old and new technologies currently in use around the world in the replication of historic architectural carved stonework.

The presentation will be offered by David Edgar, Conservator and carver with RJW Gem Campbell Stonemasons in Ottawa, Stephen Fai, the Director of CIMS (Carleton Immersive Studios) at Carleton University, Ottawa and James Hayes, PhD student at Carleton.

2. **Learning Objectives**

- The extent to which historic architectural fabric can be replicated through digital means.
- The philosophical implications of the digitalisation of craft skills and architectural conservation repair methods.
- The involvement of craftspeople in the digital process.
- The similarities, differences, advantages and disadvantages between the digital process and the traditional craft process.
- The impact of the digital method on the intangible craft heritage of a historic structure.
- An assessment of the viability of the respective approaches in terms of cost, safety concerns, skill shortages and project schedules.

3. We will examine the theme “Exploring the relationship between traditional craft, building science & emerging technologies” in the context of the West Block Rehabilitation Project where both emerging technologies and traditional crafts are currently in use. Our topic of discussion will be presented in a series of arguments (For) and Counter Arguments (Against). The major points are listed below. Arguments *For* are presented in italics.
4. **For and Against The Digital Method**

- Digitally-assisted acquisition technologies, such as laser scanning and photogrammetry require little to no physical impact on the stone carving being copied. Photogrammetry requires no physical contact, while a hand-held laser scanner may require small adhesive targets to be affixed to the stone carving.

Traditional hand-recording methods are non-destructive and involve minimal contact. The process of hand-recording allows the carver to learn every contour, angle and texture of the carving to be replicated. This ensures the best possible end result and the knowledge gained during the recording process offers efficiencies and short-cuts during the carving process – helpful where there are cost and schedule concerns.

- Digitally-assisted acquisition technologies are well suited for scenarios where there is no construction infrastructure in place, such as scaffolding and where removal of the stone carving is not feasible. A digital copy can be made with the use of a man-lift for a few hours without removing the stone carving from its context. A stone carving several stories above the ground could be digitally acquired using a UAV (drone) and photogrammetry.

Why do architects and conservators demand millimetre-perfect copies when specifying the replication of historic decorative stonework? Repetitive carved elements such as the bosses, label stops, capitals, spandrel panels and even ball flowers at the West Block appear to be identical only when viewed from the ground. Close inspection invariably reveals each carved element to be individual and unique, a reflection of the carver who produced the work. Each generation of restoration carvers should have the opportunity to produce replacements that reflect their period in history and their methods of working.

- Digital fabrication technologies such as 3D printers, CNC routers, and robotic mills are becoming more versatile and pervasive. In the same way, that pneumatic tools, and industrial saws have altered the workflow of “traditional” stone carving without destroying it, robotic mills will also impact and alter stone carving. As tools change, so does the work.

Agreed. Carvers must keep an open mind about emerging technologies or risk becoming obsolete. The modern restoration stone carver apprentices in the exact same way as a medieval carver would have done, working with hand tools only (the only difference is the length of apprenticeship which is much shorter today). Similarly, a carver will also learn draughtsmanship in the traditional way before progressing onto AutoCAD. Once proficient, the carver usually incorporates power tools as and when necessary in order to be able to compete in the modern market.

- Digitally-assisted fabrication workflows reduce human labour for certain portions of the workflow, but the skill, knowledge of stone carving, and artistry are still required to make a successful stone carving.

Agreed. A computer design cut by CNC might not blend well with existing historic work without the involvement of a carver who knows the material and understands its possibilities and limitations. Currently speaking, a carving cannot be completely fabricated, ready for installation, by a machine only. At best, the digital process can replace a stone carver’s apprentice and can remove all but a little waste material. The carver is then required only for the final pass.
5. Conclusion

Digitally-assisted replication of carved stonework is currently possible.

- Is it cost-effective compared with traditional methods?
- Is it a valid approach? We conserve historic buildings in part by conserving traditional crafts and their methods.

We value and admire stone carvings on buildings in part because we know that these pieces were made by human hands. It could be argued that the digital replication of a carved element diminishes the object’s intangible heritage value. Do objects made by machines resonate in the same way as objects made by hand?
Session Title: **Characterizing the Weathering of Angkor Sandstone**  
**Kulen Mountain, Cambodia**

I. **Introduction to Kulen Mountain quarries** (1 minute)  
   a. Source material for Angkor temples in Cambodia  
   b. Quarry samples come from previous study by Carò and IM (2012)  
   c. Goal: Address minerals susceptible to weathering inherent in the source material  
   d. Goal: Address effect of Cambodia’s climate and timescale on weathering

II. **Methods** (1 minute)  
   a. Thin section petrography  
      i. Information on grain size, sorting, and accessory minerals  
   b. Electron Microprobe Analysis (EMPA)  
      i. Chemical composition of individual mineral grains  
      ii. Can get the range of mineral compositions in a sample  
   c. X-Ray Diffraction (XRD)  
      i. Analysis of clay fraction (<2μm particle size)  
      ii. Determine presence/absence of swelling clays

III. **Results** (3 minutes)  
   a. Thin section petrography  
      i. Feldspar-rich sandstone cemented by chlorite and calcite  
      ii. Presence of weathered rind  
      iii. Hematite rims on grains and lining pore spaces  
   b. EMPA  
      i. Several iron and calcium bearing phases  
      ii. Fe- and Ca-rich phases weather rapidly  
   c. XRD  
      i. Presence of smectite and chlorite  
      ii. Smectite is a swelling clay  
      iii. Chlorite contains swelling layers

IV. **Conclusions** (2 minutes)  
   a. Source material for the Angkor temples has high potential for weathering when exposed in the tropical Cambodia climate  
   b. Swelling clays in Angkor sandstone vulnerable during wetting-drying cycles