Defining Quality Assurance
10th Annual CTEP/APWA Western Canada Pavement Workshop
The City of Calgary, Barry Poon

Feb 5 2019
1. Defining Quality

2. The City’s perspective of Quality
   • Designs (Pavement & Mixes)
   • Materials
   • Construction Practices

3. Roles and Responsibilities

4. Challenges

5. Continuous Improvement
   • Collaboration with Industry
   • Construction Best Practices
   • Innovations

6. Tools, Templates, Checklists
ROADS SERVICES

- Capital: $87M
- Operating: $157M

- 980 staff
- 600 equipment: $25M

- Inspect 16,300 lane km
- Paint 9,000 crosswalks
- Maintain 450 bridges
- Add 75 new signal communications
- 100 new RRFB’s
- Complete LED retrofit
- Pave 270 lane km
- Produce 140,000 tonnes of asphalt
- 3,913 lane kms of P1 SNIC Routes

- Issue 21,000 permits
- Manage 90,000 SR’s

- 980 staff
- 600 equipment: $25M

Feb 5 2019  Quality Management  2019 CTEP/APWA Pavement Workshop
Most Calgarians agree that Calgary is both a “great place to make a life,” and a “great place to make a living.”

City Manager Jeff Fielding

“Quality is the best business plan.”

~John Lasseter
WHAT DOES QUALITY MEAN?

Definition
• the standard of something as measured against other things of a similar kind; the degree of excellence of something.

Quality Management System (ISO 9001)

• Products and services that meet customer requirements
• Consistently meet expectations; continuous improvement
• Most efficient and effective manner possible.

Other interpretations:
• Conformance to specifications
• Suitable for its intended purpose
• A degree of excellence
• A product or process that is safe and reliable
UNDERSTANDING QUALITY

Quality – A matter of perspective

- **Public**: a good smooth ride with minimal disruption
- **City (owner)**: long lasting pavement, at low cost with minimal maintenance
- **Contractor**: meeting project specifications at minimum time and cost (profit & reputation)
A group of scientists and engineers, led by Charles Benjamin Dudley formed ASTM in 1898 to address the frequent rail breaks affecting the fast-growing railroad industry. “Helping our World Work better”

QUALITY – NEED OR WANT?

Project Management

- Time, budget, & quality
- Quality vs. performance
- Safe, clean, and well maintained
- Durable and reliable
- Low maintenance/repair cost
How do you achieve value?

Value can be defined as the ratio between needs (benefits) and resources (expenditure).

\[
\text{VALUE } \alpha = \frac{\text{Needs Satisfied} \text{ (benefits realized)}}{\text{Resources Used} \text{ ($, people, time, materials, etc.)}}
\]

"Features Tell, Benefits Sell"
Sig Ridgley, York University/Schulich School of Business
LOWEST PRICE IS NOT ALWAYS BEST

THE BITTERNESS OF POOR QUALITY REMAINS LONG AFTER THE SWEETNESS OF LOW PRICE IS FORGOTTEN.

Source: linkedin
How do we measure quality?

- Quality is specification driven – does it meet requirements?
- Quality is measured at start of life – percent passing specification acceptance

Source: www.lifetime-reliability.com

Tools:
- Agency specs & standards; ASTM, ISO etc.
- Quality management systems & processes
QUALITY ASSURANCE & CONTROL (QA & QC)

QA focuses on defect prevention; QC focuses on defect identification

QA
- Process based to managing quality
- Specs, standards, defect prevention in deliverables
- Planning stage – proactive quality process
- Quality audit
- Responsibility of the owner
- **Doing the right things, the right way**

QC
- Product based approach - Verify quality of the product
- Operational activities & methods
- Construction stage – reactive ongoing process
- Find defects in products and service deliverables
- Inspection and testing
- Responsibility of the contractor
- **Things being done, are being done right**
Specifications, guidelines and standards are met.
Outcome/output is high.
Eliminate waste and over-design.
Increase efficiency of operations.
Customer satisfaction.
Less rework resulting in savings.
High level of confidence and a motivated team.

“People forget how fast you did a job but they remember how well you did it”
Howard Newton
INGREDIENTS OF GOOD QUALITY

- Specifications
- People (workmanship)
- Equipment
- Material
- Construction practices
Quality in Municipal Government

- Roads mission, vision and goals
- Roads customer service promise
- Everyone responsible for quality
- Annual “Citizen Satisfaction Survey”

ROADS 2018 GOALS

<table>
<thead>
<tr>
<th>RESPECT</th>
<th>SERVICE</th>
<th>SAFETY</th>
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</table>

Goal 2: Excellence in service delivery that focuses on both quality and cost-effectiveness.

We will demonstrate excellence in the quality and delivery of services we provide every day for citizens, internal customers and staff. Teams will establish service standards and measure performance on a regular basis. Customers will experience a well-maintained transportation system.

Ranked the best city to live in North America and fourth best in the world in 2018
• **Quality Management:** Process of planning, coordinating and monitoring the delivery of targeted quality levels on a program or project. (Includes design, inspection, QC, QA)

• **Quality Assurance:** A structured assessment to determine whether or not activities comply with The City’s project management policies, processes and procedures.

• **Quality Control:** Inspection/testing of the specific project deliverables/product to determine if quality standards (technical specifications) are in compliance.
Contractor shall submit:

- Quality Management Plan in accordance with ISO 9001
- Key personnel, quality control and inspection procedures
- ECO plan, Health and Safety Plan, Inspection Plan
- All material must be of the quality specified
MANAGING OUR ASSETS

Risk Diagram

- 2018 Risk
- Projected Risk 2022

Risks: Critical & Poor Condition Asset Classes

- Bridges
- Pavement (2022)
- Signals
- Sidewalks
- Plus15

Condition to Criticality Target Threshold

Opportunities: Non-critical & Good Condition

Increasing Deterioration Condition

Increasing Criticality
WHO IS RESPONSIBLE FOR QUALITY?
QUALITY MANAGEMENT PLAN, QUALITY CONTROL, QUALITY ASSURANCE

Quality Assurance

Owner sets specifications, standards
(QA of consultant by owner (25-30)%)
QA of Contractors work by Consultant (25-30%)
QA of Subcontractors work by Contractor (25-30%)

Quality Control

QC by City (100% of their own work)
QC by Consultant (100% of their own work)
QC by Contractors (100% of their own work)
QC by Subcontractors (100% of their own work)
**ROLES AND RESPONSIBILITIES – CITY AND CONTRACTOR ONLY**

**QUALITY MANAGEMENT PLAN, QUALITY CONTROL, QUALITY ASSURANCE**

**Quality Management System or Plan**

**Quality Assurance**

- Owner sets specifications, standards
- MCP - QA of Contractors asphalt and concrete work by Consultant (25-30%)
- QA of Contractors subgrade or base work by City GIS compaction inspectors
  - Permits
  - Internal (TI, Water, Greenline, WRS
  - Subdivisions –consultants do QA and reports sent to City

**Quality Control**

- QC by City (100% of their own work)
- QC by City (100% of their own work)
- QC by Consultants (100% of their own work)
- QC by Contractors (100% of their own work)
- QC by Subcontractors (100% of their own work)
QA SUMMARY OF 2018

Concrete and Asphalt - Material Compliance

• 85 asphalt mix designs reviewed and approved
• 700,000 tonnes asphalt tested and verified
• 60,000 m³ concrete tested
• > 300 compliance letters issued
• 16 Projects / locations were identified for adjustments (typical are AC, compaction, air void and gradation etc.)
Material Compliance Program (MCP)

- Hot mix asphalt & Portland cement concrete
- Site, monitoring, sampling, testing and reporting
- Operates 7 days a week
- Independent consultants

**2018 Asphalt Compliance**

<table>
<thead>
<tr>
<th>Contractors</th>
<th>% COMPLIANCE</th>
<th>% NON COMPLIANCE</th>
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<tbody>
<tr>
<td>A</td>
<td>99</td>
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<tr>
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<tr>
<td>M</td>
<td>93</td>
<td>7</td>
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</table>
QUALITY ASSURANCE OF PAVEMENT DESIGN

Pavement Designs - QA

- 200 pavement designs reviewed and approved in 2018 (new subdivisions and capital projects)
- Standard and non-standard designs
- MEPDG for pavement design
- Innovation vs. quality

Conforce grid installation in concrete
Quality Assurance – Compaction Testing

Subgrade and Granular Materials

- 5024 permits issued in 2018
- Subgrade Compaction
- Proof Roll Subgrade
- Granular Material Compaction
CHALLENGES IN NEW SUBDIVISIONS

- Short construction season
- Shoulder season and winter specs
- QA & QC roles and responsibilities
- Mix designs - higher than allowed RAP/RAS
- Construction practices
Similar challenges to New Subdivisions Plus:

- Traffic accommodation
- Pedestrian accommodation
- Working hours – noise bylaw
- Utilities coordination
POOR CONSTRUCTION PRACTICES

- Granular base saturated from rain
- Concrete past expiry time (120 mins)
- Paving in rain, snow, frozen ground
- Paving when the temperature is below +5 deg C. (refer to specification)
- Backfilling in thick lifts (> 300mm)
- Absence of quality management (QA & QC)
- Paving in smaller segments
POOR QUALITY PRACTICES – CONSEQUENCES

• Reduced pavement life (Metis/128 Ave)
• Passing on future lifecycle costs (Savana, Taradale, Evanston, Symons Valley)
  - Premature failure before FAC
  - Settlement, rutting, cracking, raveling
  - Lack of safety, accessibility, detours
  - Higher maintenance cost
CONTINUOUS IMPROVEMENTS
CONSTRUCTION BEST PRACTICES

- City specification & guidelines
- Lessons learned with contractors
- Identify quality issues
- Improve construction practices
- Be Innovative
- Quality management plan: QA & QC
- QC templates and check lists
Continuous Improvements Collaboration with Industry

- Consulting Engineers of Alberta (CEA)
- Alberta Road Builders and Heavy Construction Association (ARHCA)
- Building Industry Land Development (BILD)
- Alberta Sand and Gravel Association (ASGA)
- Alberta Motor Transport Association (AMTA)

Individual responsibility, collective accountability
# FIELD QUALITY CONTROL

## 1.0 SOIL AND GRANULAR MATERIAL FIELD COMPACTION AND MOISTURE CONTENT

### Quantitative Measurements

#### Material Design Properties
- Material type?
- Laboratory Compaction Test method (A, B, C)
- Max. Dry density Kg/m³
- Specified Min. Compaction %
- Specified Moisture Content %

### Field Compaction Test Results

- Nuclear gauge readings
- Wet Density kg/m³
- Moisture Content %
- Dry Density kg/m³
- Compaction %

### Quality Characteristics/diagnostics

1. Is the backfill material frozen?
2. Backfill material free from organics/other unwanted materials?
3. Is the backfill done in uniform layers? 300mm max?
4. Is the moisture content within the specified limit?
5. Is the lift thickness within specified limit?
6. Any defective, rutting, weaving & soft spots while proof rolling?
7. Defective areas corrected as per the specifications?

In case of rain or snow, tested sections to be retested and reproof rolled.
- Test frequency - test/lane/25m/lift

### Table: Field Quality Control

<table>
<thead>
<tr>
<th>TEST ROUTE</th>
<th>MATERIAL DESIGN PROPERTIES</th>
<th>COMPACTION</th>
<th>ELATION</th>
<th>DRY DENSITY</th>
<th>MOISTURE CONTENT</th>
<th>QUALITY CHARACTERISTICS/DIAGNOSTICS</th>
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<tbody>
<tr>
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<td></td>
<td>(h)</td>
<td>(mm)</td>
<td>(kg/m³)</td>
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### Notes:
- In case of rain or snow, tested sections to be retested and reproof rolled.
- Test frequency - test/lane/25m/lift.
FIELD QUALITY CONTROL
2.0 HOT MIX ASPHALT (HMA)
FIELD COMPACTION AND ASPHALT CONTENT (AC) TESTS

Quantitative Measurements
- Temp. of Hot Mix at various stages (at the plant, behind the paver and when the finish roller).
- Ambient Temp.
- Compaction test results
- A/C Content

Quality Characteristics/diagnostics
- Has tackcoat been applied evenly and sufficiently?
- Any signs of segregation?
- Are joints compacted tightly and sealed?
FIELD QUALITY CONTROL
3.0 CEMENT CONCRETE
PLACEMENT AND COMPRESSIVE STRENGTH TESTS

Quantitative Measurements

Design Properties
- A/Content 5-8%
- Max. Aggregate Size 20mm
- Max. W/C Ratio 1.45
- Min. Cement Content 310 kg/m3
- Min. Compressive strength 32 Mpa

Concrete placement field tests
- Slump mm
- Air content %
- Mix. Temp C
- Mould dimensions

Compressive strength test results
- Strength MPA
- Age (Days)

Quality Characteristics/diagnostics
- Is site suitable for concrete placement?
- Is the granular base compacted, approved?
- Are slump and air within design spec.?
- Is concrete placed continuously?
- Winter specs between Sept. 30-May 1?
- Hot and cold weather considerations

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Thank you to all the consultants, contractors, agencies, utilities, vendors, and industry partners for your support and great relationships with the City of Calgary.

Quality Matters

Safely Building A Great City Together
Working together on quality is a shared responsibility

Making sure bad things don’t happen to good people and projects
World Without Quality
Acknowledgements

Sukhwinder Dhanoa, P.Eng.
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and
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Geotechnical & Inspection Services

calgary.ca

Making a Difference
Working together to build a better Calgary