Legacy and heritage: who’s our Hippocrates?

James E. Diekmann
K. Stanton Lewis Professor
Construction Engineering and Management
University of Colorado - Boulder
Congratulations Susan and Shayne
Legacy and heritage: who’s our Hippocrates?
And our heritage
Brunelleschi’s Dome
Centerring for vaults and domes
Brunelleschi’s innovations

- Design
- Equipment
- Productivity Mgmt
Work site canteen – Empire State Building
Learning from the past

- What other innovations lie buried in the historical record?

- How often have the actions of past master builders, designers, and constructors anticipated our current construction practices?

- What should universities be telling architecture and engineering students about their intellectual and professional heritage?
  - Can the understanding of our construction heritage encourage appreciation of modern construction practices?
  - Can the understanding of our construction heritage promote new innovations?
“Who knows only his own generation remains always a child” (1917)

George Norlin
President – University of Colorado
It’s a big world with a long history

<table>
<thead>
<tr>
<th>REGIONS</th>
<th>TIME PERIODS</th>
<th>PROJECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>Ancient</td>
<td>Civil/Military</td>
</tr>
<tr>
<td>Asia</td>
<td>Medieval</td>
<td>Religious</td>
</tr>
<tr>
<td>Middle East</td>
<td>Renaissance</td>
<td>Buildings/monuments</td>
</tr>
<tr>
<td>Americas</td>
<td>Industrial</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Modern</td>
<td></td>
</tr>
</tbody>
</table>
## So many projects – so little time

<table>
<thead>
<tr>
<th>Region</th>
<th>Project Type</th>
<th>Time Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>Civil/Military Works</td>
<td>Ancient</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Roman Aqueduct, Italy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parthenon/ Acropolis, Greece</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stonehenge, U.K.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coliseum, Italy</td>
</tr>
<tr>
<td>Europe</td>
<td>Religious</td>
<td>Pantheon, Italy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Salisbury Cathedral, U.K.</td>
</tr>
<tr>
<td>Europe</td>
<td>Building and Monuments</td>
<td>Stonehenge, U.K.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coliseum, Italy</td>
</tr>
</tbody>
</table>
Historical construction activity

From thedora.com
World population & wealth year 1 C.E.

From Worldmapper.org
World population & wealth year 2000 C.E.

Population

Wealth.

From Worldmapper.org
Role of prevailing culture: What was the relationship between the building culture and society?
What were the major institutions of the day?

- Kings, princes, and bishops
- Master builders and guilds
- Developers, public agencies, and regulators
- Designers, contractors, and unions
What were the major human roles in the building culture?

- Designers
- Builders
- Trades/Crafts
- Material Suppliers
- Financiers
What was the building operation itself like?
Some specifics about:

- Project Organizations
- Workers
- Labor Organization
- Designs
- Designers
- Innovation
## Project organizations

<table>
<thead>
<tr>
<th>Project</th>
<th>Century</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pyramids</td>
<td>2000 B.C.E</td>
<td>Chief Architect</td>
</tr>
<tr>
<td>Coliseum</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Century</td>
<td>Separate prime contractors</td>
</tr>
<tr>
<td>Notre Dame</td>
<td>12&lt;sup&gt;th&lt;/sup&gt; Century</td>
<td>Owner’s Reps</td>
</tr>
<tr>
<td>St. Paul’s</td>
<td>17&lt;sup&gt;th&lt;/sup&gt; Century</td>
<td>Specialty Contractors</td>
</tr>
<tr>
<td>Suez Canal</td>
<td>19&lt;sup&gt;th&lt;/sup&gt; Century</td>
<td>International Joint Venture</td>
</tr>
</tbody>
</table>
Construction labor –

- 2000 B.C.E.
- 12th Century
- 13th Century
- Worker’s Camps
- Women in the workforce
- Traveling Workers (Boomers)
Labor organizations
Work rules

- France 12th Century
- Europe 12th Century
- France 13th Century
- England 14th Century

- 1st Artisan Guilds
- Guilds set work rules but not wage
- 14 hour work day summer and 12 hours winter
- One hour lunch and 15 minute afternoon break
Labor organizations
wages

- Guildsmen wages determined by skill AND bargaining power
- Both hourly pay and piecework were common
- Guilds were tightly closed
- Master mason paid 6x normal mason
Labor organizations

Guilds abolished by decree

- France 1791
- Rome 1807
- England 1837
- Spain 1840
- Austria 1860
- Germany 1860
- Italy 1864
Designers
from here to there and back again

- Early Designers - Little Known
- From Master Builder to Specialization
  - And Back Again
- Codification of Experimental/Empirical Knowledge
  - Brunelleschi Conference (15th Century)
  - School of Roads and Bridges (Paris 1747)
Designs
Growing professionalism

- Design
  - separate from execution
- Recording designs
  - Drawings and models
- Size and complexity
Designs – drawings & models
Process innovation
the more things change…

- England 15th Century
- France 16th Century
- Italy 16th Century
- England 17th Century
- Payment bonds and liquidated damages
- Toll roads/PPP
- Expert witnesses/ Peer design reviews
- Lump sum, unit price and T&M contracts
Technical innovation
Du Jiang Yan Irrigation Project
Project innovation
Rock gabion
Hagia Sophia
Project innovation
Building instrumentation
What have we learned?

- What other innovations lie buried in the historical record?

Many, Many, Many
What have we learned?

- How often have the actions of past master builders, designers, and constructors anticipated our current construction practices?

Often, Often, Often, Usually?
What should we tell our students (and ourselves) about our heritage?

- On one hand – it seems there is nothing new under the sun, it’s all been done before!
  - A dispiriting message to be sure
- On the other hand…
Old or new
Near or far

From ASCE.org

ASCE November 2007
Remarkable beauty
Remarkable accomplishments
Remarkable projects and remarkable builders are both our heritage and legacy