The Essentials of ICT in Construction

From Brunel to Broadband

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Welcome
Agenda

- A short history
- Focus areas:
  - Moving towards a common data environment
  - Mobile technologies
  - Geographic information systems
- Conclusions
A Short History
Advances in Structures

Crystal Palace 1851

Swiss Re 2003
1859
1937
Civil and Aerospace

1859
1959
1960
2007
Advances in Bridges

1981

1996

2001
An Engineering Computing Revolution: the Hardware

- 1600 Log Tables
- 1625 Slide rule
- 1800 Hand calculation and man power
- 1940 Mechanical calculators
- 1960 Electronic calculators
- 1964 Mainframe computers for remote use
- 1968 Programmable calculators
- 1970 Mini Computers – Affordable Time Sharing
- 1981 – Today IBM PC and derivatives
- 1981 Beginning of Microsoft's dominance DOS for PC’s
- 1984 Laser Printers
- 1985 Powerful Workstations for CAD
- 1990 Cheap Plotting Devices
If slide rules get any better, we won’t need brains any more.

1625 Computing Power
Computers of the 60’s and 70’s


193,000 additions, 25,000 Multiplications per minute

1964 Mainframe Computing for Local Authorities and Bureaux
The computer room staff:
- 1 Mathematician
- 4 Engineers
- 1 Programmer
- 1 Secretary
- 1 Computer Operator
- 2 Punch Operators
Steps to be taken to use the Computer (1968)

1. Have you already done rough calculations?
   - NO 1a: Do rough calculations
   - YES 2: Will you benefit by accurate calculation?
     - NO 2a: Use rough calculations
     - YES 3: Is there a program to suit your problem?
       - NO 3a: Can problem be restated to fit an existing program?
         - NO: Do calculation by hand
         - YES 3b: Does problem justify a new program?
           - NO: Write new program!
           - YES: Fill in a Data sheet

2. Is the program economical?
   - YES: Do you agree that the program/method is correct?
     - YES: Correct print out
     - NO 6: Hand in or send to computer room

3. Fill in Data sheet
   - 7: Hand in or send to computer room

4. Punch and verify
   - Correct print out
   - NO 8: Process and print out

5. Receive results back
   - 9: Are results sensible?
     - NO: Discuss with computer group
     - YES: Use results

6. 10: Use results

Diagram:

- Steps 1-12 are connected with flowchart arrows indicating decision points and actions to be taken.
just as the automatic washing machine carries out a particular cycle of operations, but you feed it with the clothes you want washed, so a computer programme specifies a set of operations which is carried out on the numbers (data) provided by you.

software, the general name applied to all programs presumably to denote that they are easier to change than the electronic or electromechanical parts of a computer. It is, however, suspected that it would be easier to use a soldering iron on occasions to achieve the desired results...
Can a computer design?

- Adding 2 and 2 together the computer does much better and faster than us.
- But our brains are still infinitely superior to the finest computer that has ever been developed.
- Be aware of the dangers of using it indiscriminately, by asking it to solve the wrong problem, or making the problem so complex the answer would be meaningless.
- Ove Arup was worried that the computer might kill design! Standard programmes resulting in standard designs.
The work on Sydney Opera House really got us going…
VAX 11/780 – Late 70’s to 80’s Computing for Engineers
1981 – IBM PC a Computing Revolution begins
A Engineering Computing Revolution: the Software

- 1965 Finite Element Design for Spacecraft
- Late 60’s to 70’s The real revolution
  - Automated design and modelling for highways
  - Specialist automated analysis software for bridges
  - Start of automating design calculations
  - VisiCalc and the SPREADSHEET
- 80’s Consolidation and Large CAD Systems for Drawing
Late 80’s - 90’s PC and Workstation CAD for Drawings and Models
- Moss
- GDS
- Intergraph
- Microstation
- AutoCAD
2000 Integration and Interoperability
Major developments affecting Computer Aided Design

1975: First 3D building model
- 1965 prepare punch cards & send to the Mainframe Computer Centre and Wait!!!!!!!
- 1965 Electronic calculators one between 50 users
- 1968 Dialup access to mainframe One 8 character per second terminal between 200 users
- 1970 Programmable Calculators one between 100
- 1975 Portable hand held Calculators
Accessibility & Connection

- 1975 + Mini Computer Terminal Screens via cable or dedicated multiplexed telephone line. One terminal between 20
- Early 90’s Stand alone PC’s and workstations
- Mid 90’s connected PC via Ethernet and dedicated telephone
- Late 90’s Dial Up Internet
- 2002 Fast connection to Internet Broadband
- 2005 Fast connection broadband wireless
Towards a Common Data Environment
Typical Issues

Are we working on the very latest drawing revision here?

I’m sure they haven’t even looked at it yet!

The post wastes so much time on critical approvals issues

The Friday rush for the print/post can be a nightmare
A very old slide…
Another way of putting it...
Another way of putting it…
Why bother…?

- Transparency
- Audit trail
- Single source
- Rapid transmission
- Reduced overheads
- E-mail management
- Meeting arrangements
Collaboration?

“Extranets enable organisations to centralise electronic documents, thus allowing organisations to work in a more collaborative fashion. A move away from traditional sequential paper-based systems.”

Predominantly paper-based communication

Electronic document sharing across projects
“Traditional” use of Extranets

- Still very much paper-based thinking
- One to many file exchange
- Only the minority of projects use them
The Need for Life-Cycle Thinking

- 2/3 of costs due to a lack of interoperability are borne by the owners/operators (avoidance, delay and mitigation)
- Estimated as £8.50 per ft² of development over a typical life-cycle
- Arising from productivity losses, manual re-entry, information verification…
- Costs during O&M phase regarded as being caused by a failure to manage upstream activities

Source: NIST Cost Analysis of Inadequate Interoperability
Interoperability

"the ability to manage and communicate electronic product and project data between collaborating firms’ and within individual companies’ design, construction, maintenance, and business process systems”
# The Opportunity

## Quality, Progress, Safety, Snagging

<table>
<thead>
<tr>
<th>Project Team</th>
<th>Pre-Project</th>
<th>Pre-Construction</th>
<th>Construction</th>
<th>Post-Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning Applications</td>
<td>Tender Management</td>
<td>Document Sharing</td>
<td>Process Management</td>
<td></td>
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<tr>
<td>Developer/Owner</td>
<td></td>
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<td></td>
<td></td>
<td>Occupier Management</td>
<td>Facilities Management</td>
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<tr>
<td></td>
<td></td>
<td>Document Management</td>
<td>Public Interface (www)</td>
<td></td>
</tr>
</tbody>
</table>

- Document and Drawing sharing
- Public liaison
- Quality, Progress, Safety, Snagging
- Work Orders Asset ID
Whole-life cycle approach to IM

Library object used in concept GA – simple plan view

Object carried into design development. 3D view for spatial fit. Properties added e.g. cost, specification, analysis requirements

Object properties completed progressively e.g. actual cost, delivery dates, location, installation programme

As-built changes incorporated & data set updated as necessary

Object included in handover data set with corresponding population of facilities management system
Traditional systems procurement

- Pre-Project
  - Website
  - Collaboration Tool

- Pre-Construction
  - Contact Management
  - Document Management
  - Content Management
  - Data Dictionary/Schema Management Systems
  - Project Taxonomy
  - Document Workflow
  - Portal
  - Business Continuity
  - Design Tools

- Construction
  - As before + GIS
  - Risk Management
  - Financial Management
  - Integration to Corporate IS
  - Integration to Partners

- Operation

- Complexity

As before + Contact Management
Document Management
Content Management
Data Dictionary/Schema Management Systems
Project Taxonomy
Document Workflow
Portal
Business Continuity
Design Tools
Strategic systems procurement

All information captured
- Quantity: too much
- Quality: too detailed
- Cost: excessive

Information needs defined
- Quantity: no waste
- Quality: right format
- Cost: optimum

Information transitory
- Quantity: missing info
- Quality: wrong format
- Cost: excessive
The Need for Standards

- Key to Success is in Establishing & Data standards - these should include:
  - Format
  - Content and Granularity of Data
  - Accuracy of Data and its Currency
  - Classification defining components and assets
  - Common origin & Grid, 1:1 scale, associative dimensions
  - Methods of spatial reference
  - Note these are DATA Standards NOT Drawing Standards
Common Data Environment (CDE)

- Facilitating data sharing and collaboration
- Create once use many times
- Managed data with engineering integrity
- Trustworthy data with known provenance
- Consistent publication from a common source
- Drawings and documents as an output from a controlled source
Managed Data System
Controlling Project Data integrity
Including Reference Files, Components, Cells Blocks, Models, Drawings etc

Design Team
Construct Team
Manage Team

Common Data Environment Stack

Managed Common Data Environment

Managed Information Chain
- Manage, Maintain & Operate
- GIS etc
- As Built Information
- Construct
- Plan Construction
- Design
- Survey
- Digital Maps

Common Data Environment Stack

Published Documents

Traditional Document Management Extranet (e.g. Buildonline)

Project Data Environment
Project Data – Models, Databases, Components, etc

Project Document Environment
Paper or Electronic Paper with Metadata
Building Information Modelling
Do we like change?...
Mobile technologies
Where we are today
The missing link
The COMIT Community

- Construction industry companies
- Technology providers
- Academic and research institutions
- Publishers and trade associations
What could mobile technologies be used for?

- Goods received notes
- Site to design comms
- Task allocation
- Site diaries
- Monitoring staff
What could mobile technologies be used for?

- Maintenance inspections
- Drawing delivery
- Monitoring progress
- Health and safety
- Quality inspections
The COMIT case studies

- Chosen by the COMIT community
- Eight completed
  - Network Rail, Mace, Arup, Stent…
  - Address various processes
  - WLAN, PDAs, Tablet PCs, Tags, Digital Pen and Paper
Network Rail Case Study

Before:
Network Rail Case Study

After:
Costs identified:

- Up front investigation
- Mobile devices and peripherals
- Software development
- Staff training time
- Management time
- Support

= £70,000
Specific benefits identified:

- Reduction in set-up costs: £1,100 to £350
- 2 route miles per day vs. 1.5 route miles
- Accurate location data using GPS
- Historic data available in the field
- Proactive rather than reactive renewals
Return on investment

- Costs = £70,000
- Savings of 70%
- Payback period of just 1 year
Case study conclusions

- All achieved generic and specific benefits
- Costs vary widely: £7,400 - £135,000
- All had payback periods of 1 year
QA Inspections (Heathrow T5)
Mobile Time Sheet Collection
Intelligent Mobile Office
Hand Arm Vibration & Intelligent Tools
Where can I find out more?

Construction Opportunities for Mobile IT

www.comitproject.org.uk
Geographic Information Systems
Utilities are the UK's Veins and Arteries …

- Communications
- Gas
- Oil/Petroleum
- Sewerage
- Road drainage
- Power
- Steam
- Water
- District heating
- Street lighting
- Traffic control
...but we know very little about where they are.
Buried Assets in the UK – The Scale

- 275,000 km of gas mains
- 353,000 km of sewers
- 396,000 km of water mains
- 482,000 km of electricity cable

PLUS

- an estimated 2,000,000 km of BT and cable companies (20 in central London alone)
- highway drains and surface water sewers
- traffic management cabling (lights, signs, etc)
- utility service connections to property
Buried Assets in the UK – The Key Facts

- 10% of congestion on major roads is due to road works
- 4 million km of underground pipes and cables
- 1.5 million holes dug each year by utilities PLUS road building and repair work by highway authorities
- Records of underground assets are incomplete and inconsistent
- There is no standard approach to sharing records
- Current locating technologies are not 100% effective

Source: MTU 2005
Utility industry annual direct construction costs associated with street works are currently about £1.5 billion.

Third party damage costs of the order of £150 million.

Social costs of street works, as high as £5.5 billion.
  - delays to road users
  - environmental damage
  - disruption to businesses
  - air pollution

However, much more research is needed to give truly meaningful data.

Source: MTU 2005
Accidents – underground cable (unintentional contact)

![Image of accident scene]

<table>
<thead>
<tr>
<th>Year</th>
<th>Fatality</th>
<th>Major Injury</th>
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<tbody>
<tr>
<td>1996-7</td>
<td>1</td>
<td>37</td>
</tr>
<tr>
<td>1997-8</td>
<td>2</td>
<td>33</td>
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<tr>
<td>1998-9</td>
<td>1</td>
<td>39</td>
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<tr>
<td>1999-2000</td>
<td>1</td>
<td>36</td>
</tr>
<tr>
<td>2000-01</td>
<td>-</td>
<td>27</td>
</tr>
</tbody>
</table>

Source: HSE
50% increase in traffic on urban roads forecast from 1996 to 2031
- Planned 20% increase in capital maintenance by water companies between 2005 and 2010
- Gas – major mains replacement programme - > 100,000km over 30 years
- Continued expansion in telecommunications network
The ‘Buried Assets Jigsaw’

- Driver for better data integration
- How to exchange in a common manner
- Multi sensor technology to find asset
- Several initiatives working together to a common goal
- What should be made available: Who, what, where
- A common container to hold and manipulate in 3D

 NUAG
 TMA
 MTU
 ICE BSWG
 VISTA
To support the Department for Transport in achieving the relevant Traffic Management Act targets by:

- Delivering agreed data definitions, data standards, protocols and processes, and a timetable for their implementation, leading to the most effective and efficient means of recording, storing, sharing and displaying information on underground assets, and appropriate associated above ground assets.
- Ensuring that everything is in place to enable the successful delivery of the Vision.
- To inform and represent the wider stakeholder community.
All information on underground assets, and appropriate associated above ground assets, will be shared between stakeholders in a consistent way, on demand.
Roadmap required

We need a road map to get us from where we are now …

Our recommendations will help us start the journey

…to where we want to be
NUAG REPORT:

Survey Results:
- Quantitative Data
- Qualitative Data

Review of Results:
- Current Practice
- A view of the Future

Conclusions
Step 1: www.nuag.co.uk

National Underground Assets Group (NUAG)

Welcome

The National Underground Assets Group (NUAG) is a group of relevant stakeholders, including utilities and local authorities, established to support the Department for Transport in achieving the relevant Traffic Management Act targets, and to act as a point of focus and single voice for everyone involved with underground, and appropriate associated above ground assets.

The NUAG Vision

All information on underground assets, and appropriate associated above ground assets, will be shared between stakeholders in a consistent way, on demand.

Future of buried services - latest news release

The National Underground Assets Group (NUAG) has set out its vision for the future of buried services. It aims to develop and implement standardised procedures on how location information is recorded and stored by the end of 2007. This is to ensure all those with an interest in buried services can access and share information easily, to help themselves as well as others carry out works more effectively. The ultimate goal is to have the ability to visualise and distinguish, on demand, all underground asset records in any one given area. Read more about the vision.
Collaboration – Notification of works
Future – Augmented Reality for Asset Management
Step 2: Providing a consistent GPS network

Typical Installation

New enhanced network for the Thames Gateway and Olympic area
Manhole cover
450mm - 550mm

- Standard GPS
  ~10m
- Differential GPS
  ~1-2m
- RTK GPS
  <20mm

There it is!
Precise Surveying
TRIAL - Two month trial on the Victorian mains renewal project
Conclusions
Questions?

- How does IT change the way we work?
- Will it change the UK engineer’s focus?
- What does the future hold?