



Open Digital Cultural Heritage Conference

**Congresso Rospigliosi
25 & 26th February 2008**





EPOCH

EPOCH in context: Perspectives on an inter-disciplinary project

David Arnold
University of Brighton



- EPOCH's Objectives
- Reflections on from Research in Computer Aided Architectural Design
 - Data in – modelling, capture, reconstruction
 - Analysis – structures, physical processes, image generation and visualisation
 - The Changing Profession – how far and fast do we change.- what does it take to change us.
- The role of use-inspired basic research
- Introduction to some highlights where EPOCH has contributed to basic research



- EPOCH is the EU FP6 Network of Excellence on the Applications of ICT to tangible Cultural Heritage (2004-2008)
- About 95 Partners including
 - Universities & Research Centres
 - Cultural Institutions & Museums
 - Antiquity & Monument Authorities
 - Other associated organisations



What did we set out to change?

- “The network will promote the integration of research efforts in five vital subfields:
 - Field Recording and Data Capture
 - Data Organisation, Provenance and Standards
 - Reconstruction and Visualisation
 - Heritage Education and Communication
 - Planning for sustainability of heritage projects”
- You will see evidence of all these here



How have we been trying to do it?

- By structuring the development of tools to address a pipeline of processing from data acquisition to dissemination
- By seeking to develop a more holistic view of CH data at different stages
- By interaction, bringing technologists, CH practitioners, governmental organisations and others together – to develop a better interdisciplinary understanding of working together
- By developing better understanding of how to evaluate the importance of CH to society



- “A major objective of the network is to continually re-emphasise the holistic, interdisciplinary view of the role of all disciplines contributing to a sustainable market sector to the benefit of the quality of life in Europe and of its citizens.”
- There is always more to be done, but EPOCH has definitely brought together a wide range of groups across disciplines



How far might we have hoped to get?

- Really no answer to that question, but we might get pointers from other fields
- Disciplinary groups are separated by culture as much as content
 - The way we work (e.g. publishing before or after an event)
 - The support we enjoy (ICTs attract support, CH is much worse off)
 - Timescales are different (e.g. preservation v expected rate of change)
- Lessons from CAAD – why Architecture?





Architecture and Cultural Heritage

- Overlap in concerns for people and places
- Architecture designs, analyses and builds
- Archaeology records, analyses and reconstructs
- Cultural heritage is much wider than archaeology – intangible and artefacts
- Architecture probably goes further into services, structures, new materials, planning law etc

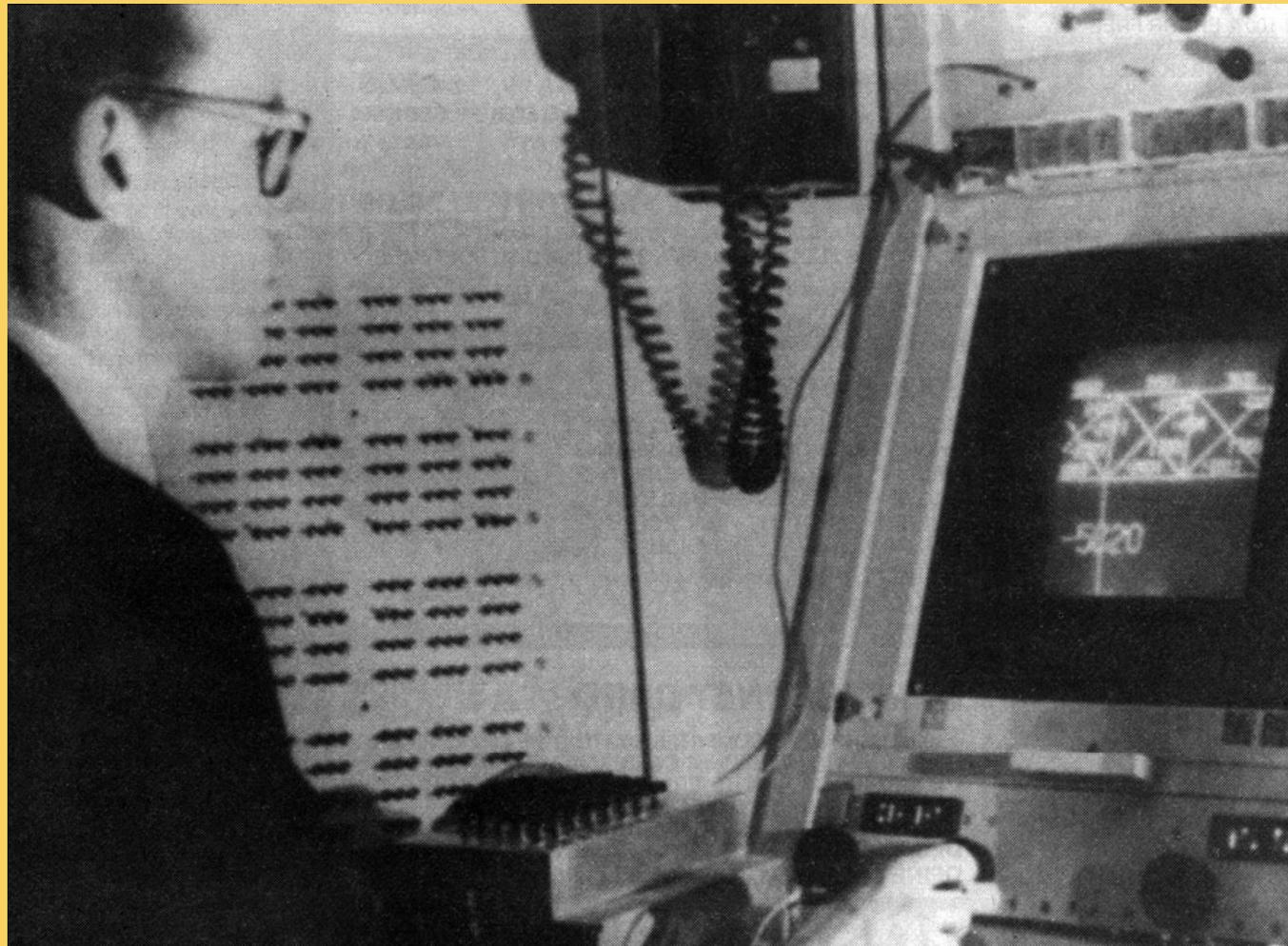


- CAAD - One of the earliest areas targeted by IT
 - Sketch interfaces
 - Sketchpad (Sutherland 1963)
 - Constrained drafting – The Interaction Handler (Newman, 1969)
 - Hidden surface algorithms (60's-70's)
 - Novel analysis techniques (e.g. FEM, Heat-loss analysis (Stibbs and Hawkes), Acoustics in concert halls (Evans))
 - Photorealistic images (70's-80's) (particularly radiosity, but also ray-tracing and e.g. Sunlight and Daylight, Arnold 1974)
 - System Building systems (e.g. OXSYS, RUCAPS)





Sketchpad and the Interaction Handler



Video



- Intelligent tools for “easy” input (cf kitchen design systems – e.g. IKEA)
 - “Snap-to-grid”
 - Constrained relationships
 - Can cause frustration – creativity stretches rules to produce new effects – can you produce custom units for your kitchen?)
- Rule-Based Grammars & Parameterised Procedural Modelling
- Modelling “what will be” is different from compact description of “what is” or evidence-based modelling of “what was”





Shape Grammars and Description Languages

- Experiments from the 70's
 - Yessios – SIPLAN system
 - Grammar describing prototypical housing (e.g. “Streets” or “High Rise”)
 - Definition of target site
 - Procedural mapping using grammar rules and constraints of prototype to site
 - Other experiments in natural language description of form and grammars with 2D elements for production (cf plants later)





EPOCH

Site description language 1973-76

.....

HOUSE 2 FOR 7 [Sunley Homes Ltd - DH45 Malvern]
WALL FROM 10 10 (87) TO 182 10
GABLE END 182 68 (119), 182 215 (39)
WALLS TO 97 215, 97 127 (87), 10 127
GABLE END 10 68 (119), 10 10 (87)
WALLS FROM 174 116 (93) (93), TC 174 176 () (58),
105 176, 105 116 () (93)
SINGLE EDGE TO 174 116 ()
EDGE LINE FROM 182 68 (119) TC 10 68 ()

BLOCK TO BLOCK TESTS (2'S) 97 127 (C) 10 127 | 182 10

GROUND FLOOR * 10 10, 182 127
BUILT IN GARAGE * 101 127, 182 215
FIRST FLOOR AT 40 10 10 > 182 166 < 177 176 < 106 166 <
101 127 < 10 10
END

.....

HOUSE TYPE 3 FOR 7 PERSONS [Sunley Homes Ltd - DH48 Buckland]
GABLE FROM 10 10 (88) TC 65 10 118, 159 10 88
WALL TO 159 149
GABLE END TO 65 149 118, 10 149 88
WALL TO 10 10
[Garage] WALLS FROM * 159 149 (48) TC 108 184
EDGE LINE FROM 65 149 118 TC 65 10 ()

BLOCK TO BLOCK TESTS (2'S) 108 149 (C) 10 149 | 159 10

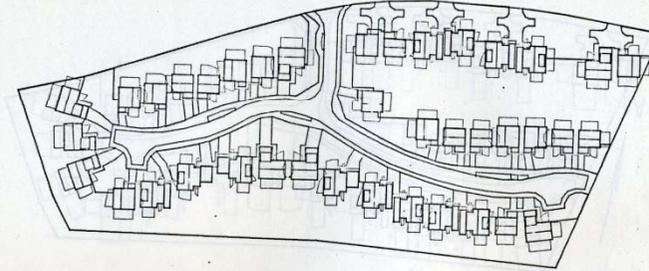
GROUND FLOOR 10 10 > 159 92 < 110 149 < 10 10
BUILT IN GARAGE 110 92 > 159 184 < 108 149 < 110 92
FIRST FLOOR AT 40 * 10 10 TC 159 149
END

.....

HOUSE TYPE 4 FOR 6 PERSONS [Sunley Homes Ltd - DH32 Cheviot]
WALLS FROM 10 10 (91) TO 156 10
GABLE END 156 68 114, 156 126 91
WALL TO 10 126
GABLE END 10 68 114, 10 10 91
[Garage] WALLS FROM * 156 126 (44) TO 88 167
EDGE LINE FROM 156 68 (114) TC 10 68 ()

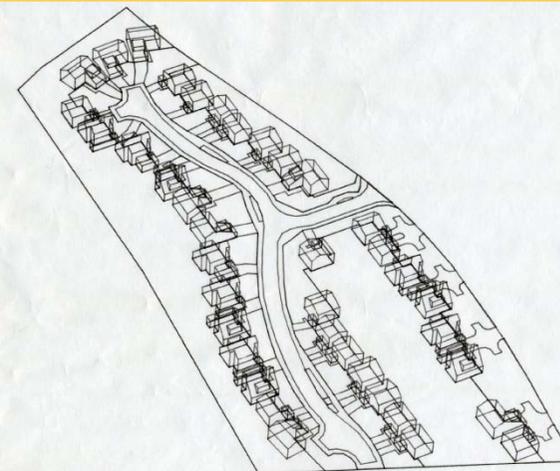
BLOCK TO BLOCK TESTS (2'S) 88 126 (C) < 10 10, 156 10

GROUND FLOOR 10 10 > 156 73 < 107 121 > 110 167 < 88 126 < 10 10
BUILT IN GARAGE 107 73 > 156 167 < 110 121 < 107 73
FIRST FLOOR AT HEIGHT 40 * FROM 10 10 TO 156 126
END



(ii) Results of block to block daylight analysis

SCALE FOR DAYLIGHT GRAPHS | 0-10 IN %
SCALE 1 : 1250 CALCULATED USING INDICATOR 4 AT 1.0 METRE INTERVALS



FORTRAN UNIT NUMBER 7

MART J090DBA1 PLOT COURTD.OBJPIC * * *
START JOB 90 9.05.28 PM 17 DEC 76





Sunlight and Daylight

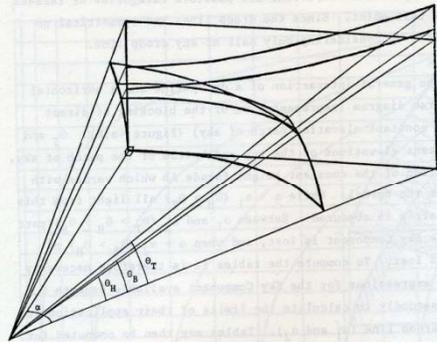


Figure 4(a) 3-D view of the variation of θ_H with α for a constant height straight facade (θ_B and θ_T are constant)

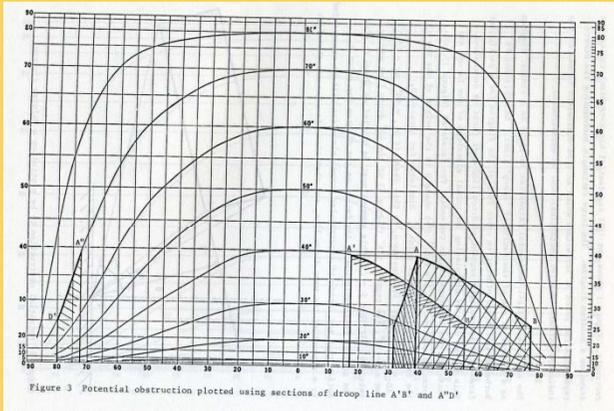
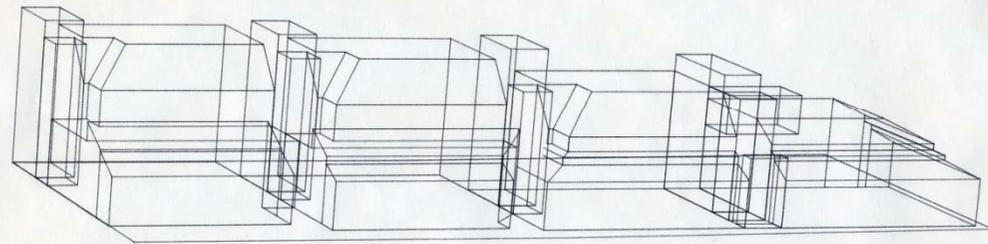


Figure 3 Potential obstruction plotted using sections of droop line A'B' and A''B''

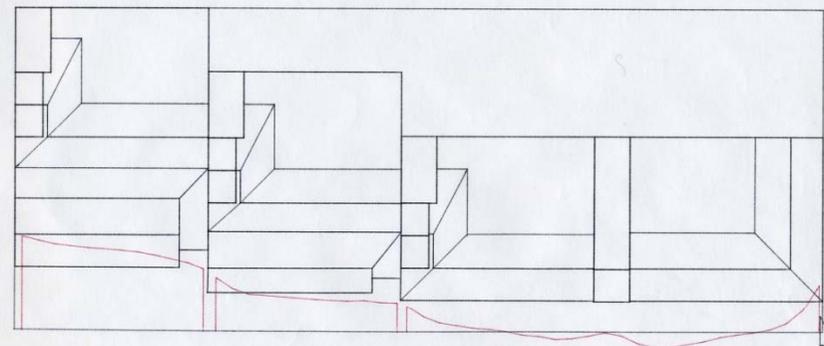
SCALE 1 : 1000
FORTRAN UNIT NUMBER 7



SCALE FOR DAYLIGHT GRAPHS

0-10 IN %
CALCULATED USING INDICATOR 4 AT 4.0 METRE INTERVALS

SCALE 1 : 1000
FORTRAN UNIT NUMBER 7

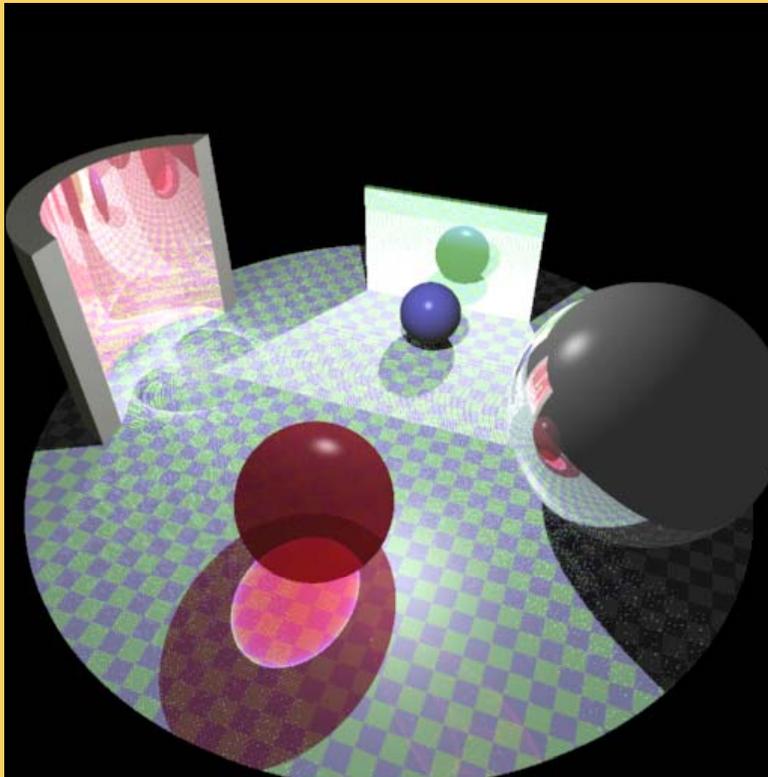


Arnold 1976





Photorealism – Ray-tracing to Radiosity



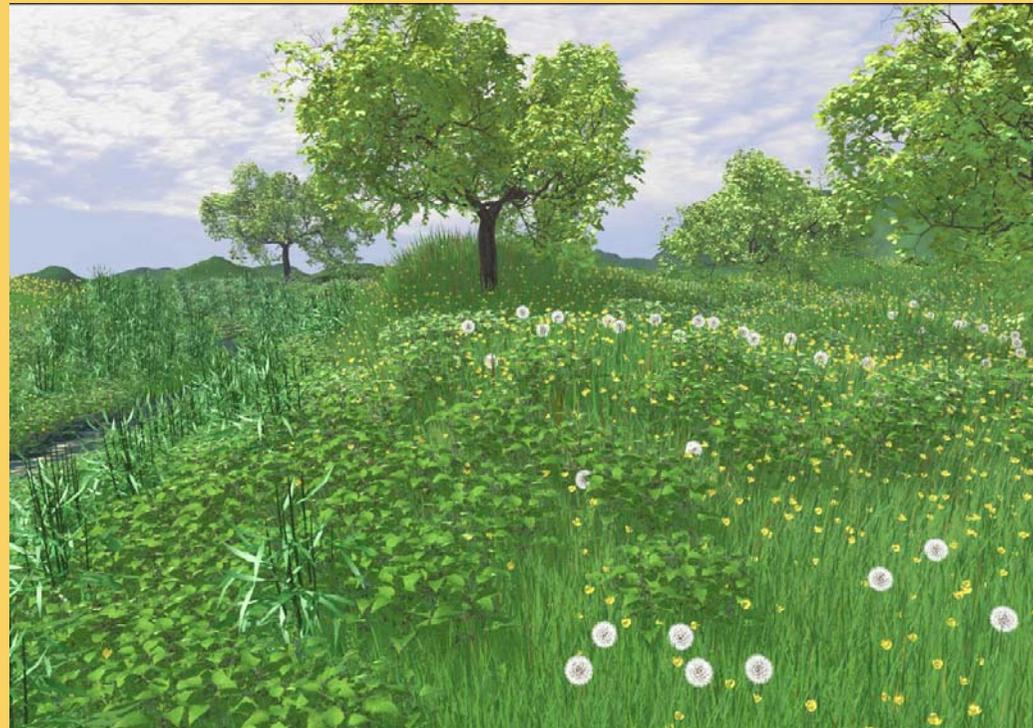
Watt 1999



- Begin to augment architectural modelling in 80's
- Simulation models – e.g. Copenhagen Airport visualisation (CADCentre ~1976)
- Carla's Island (water and natural light; Nelson Max 1981)
- Fire
- Plants (next slide)
- Physics, animation and games engines
- Avatars and Virtual Humans (Norwich VC and Scriptorium)
- Crowds, flocking and collective action



- Long history of I-systems (The Algorithmic Beauty of Plants, 1991(?), Lindmeyer and Prusinkiewicz)
- UK Grand Challenge (In viva; in silico)
- CIRAD AMAP Landscape Design Software



Prezemyslaw Prusinkiewicz et al, 1998



- Many challenges – but an important part of bringing environments to life
 - [Motion capture](#) v kinematics (forward and inverse)
 - Capture (e.g. Millennium Dome Avatars)
 - Animation (e.g. Puppeteering)
 - Representation (surface; sub-surface skin-tone and structure; muscle behaviour; etc)
 - Crowds, data volumes and animation speed
 - Real-time and off-line rendering (e.g. Scriptorium)
 - Speech and facial animation
 - Virtual Humans v other avatars (e.g. the Anglepoise lamp)





Computational results associated with CAAD

- Hidden Lines and Surfaces
- Scene sorting for numerical integration – the space buffer -> hemi-cube
- Ray-tracing to radiosity
- Transparency and reflectance
- Modelling – shapes; layers and connectivity
- Adaptive algorithms for real-time visualisation of large data sets
- Further development applied to CH (e.g. Debevec et al “The Parthenon” 2004)





CAAD is everywhere after 40+ years

- Initially targetted at replicating manual processes (e.g. helping CAD drafting)
- New support
 - Providing new analyses (e.g. Structural design tools; Heat loss) for enhanced design
 - Providing new design techniques (e.g. system building – the flat pack building)
 - Linking to other processes
 - Visualisation is integral to planning and marketing
 - Link to GIS, Quantity surveying etc





Some examples



David Arnold, University of Brighton



- Apart from CH, results inspired by CAAD are relevant elsewhere and vice versa
 - Games
 - Entertainment special effects
 - Engineering applications
 - Geographic and cartographic applications
 - And, of course, Cultural Heritage



- Pattern of development
 - Initial replication/automation of repetitive manual processes – then move to augment human skills
 - New analysis that was not previously possible
 - Move from bespoke to standardised systems
- Misplaced selling for “Economic Production” – more benefit in market advantage
- Interoperability and standardisation take a very long time
- Need to educate the community (cf games 1973 – late 90s for widespread standard games controllers)



What is use-inspired basic research?

- Approaching topic from the perspective of an Engineer – we make things
- Stages in Use-inspired Basic Research
 - Be inspired – develop and refine a vision – and a direction
 - May quantify benefits (Normally pseudo economic – from experience this is asked for by research sponsors, but, historically, normally inaccurate...)
 - Make progress – and relate it to the theme
 - Over time
 - Get adopters – i.e. trial with “users” – and refine
 - Change normal practice and become embedded
- Observation of and research on systems in practice is also user-based research, but different methodology

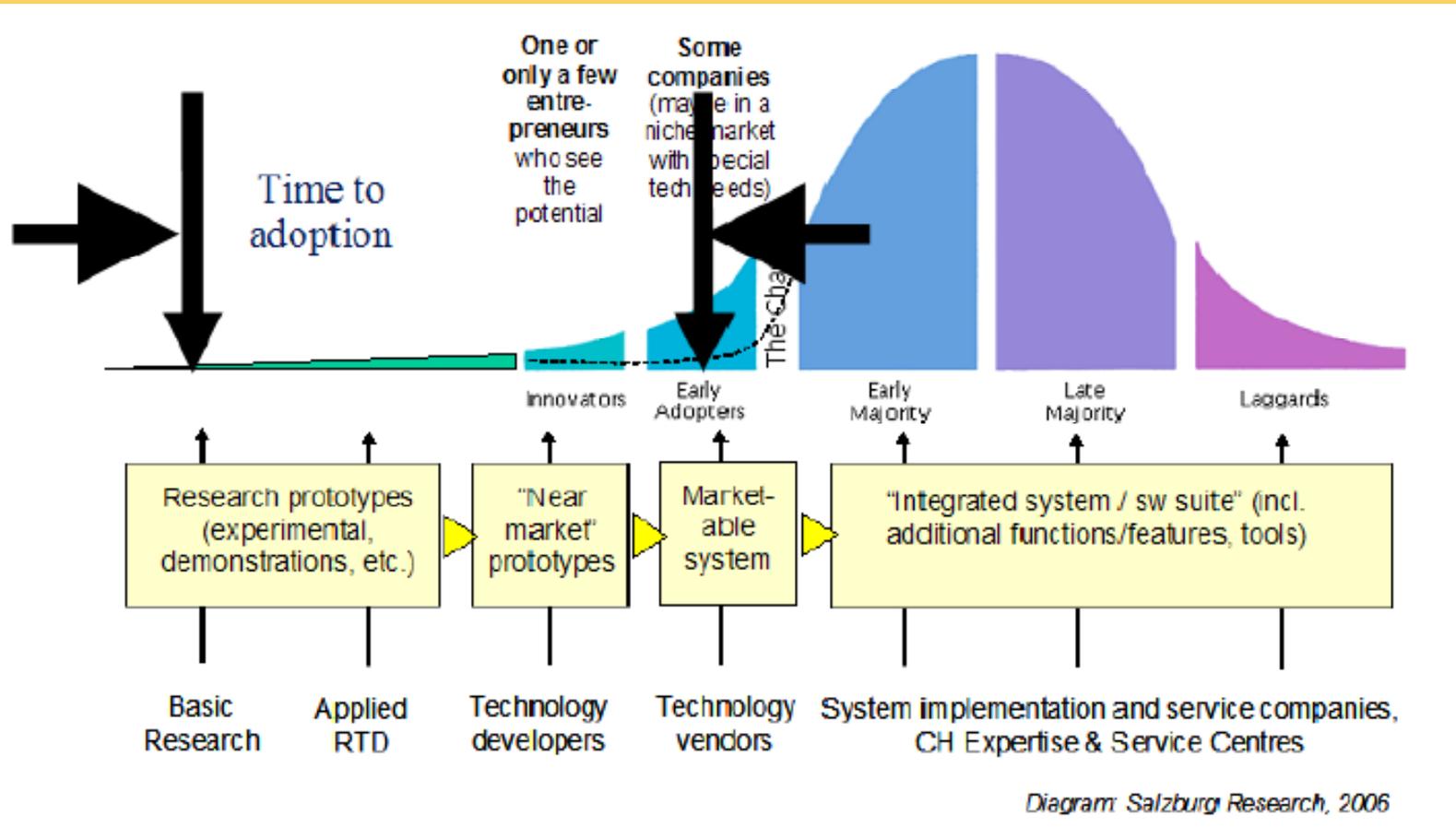


- Donald Stokes (1997)

Research inspired by:		Considerations of Use?	
		No	Yes
Quest for fundamental understanding	Yes	Pure Basic Research (Bohr)	Use-inspired basic research (Pasteur)
	No		Pure Applied Research (Edison)



Adoption process for new technologies



- Rate of adoption is limited by human development not technology development
- Architects can now design differently and can make almost any shape. Do they?
- Actions are required to support adoption
- Professions are intentionally conservative - Changing the way a profession trains and practices is a long term process
- Changing CH professionals is even slower!





Research for CH Processing “pipeline”

- Again initial work in replicating practice
- CH Processing “pipeline”
 - Data Collection – primary and metadata
 - Data organisation – collection formation
 - Search and research
 - Reconstruction and hypotheses
 - Communication to the public
 - Derivative works
- New techniques and making ideas practical
- Professional practice will change more slowly than technical developments





EPOCH results

- This is what the next two days are about!
- Exhibits in another room
- Significant technical progress over a range of pipeline areas (example on next slide)
- Experimentation with integration and standards
- A community (not just here, but elsewhere)
- Publications which will remain available
- Real advances in understanding and helping develop the business of cultural heritage



Grammar Example: City Engine (ETHZ)

Makes earlier ideas practical – adding 3D and constraints
Currently being used for major project on “Rome Reborn”

```
building → SplitY{ columns | entablature | I(roof) } sanctuary
```

```
columns → RepeatX{ column }
```

```
column → SplitY{ base | shaft | capital }
```

```
base → I(corinthian_base)
```

```
shaft → S I(corinthian_shaft)
```

```
capital → I(corinthian_capital)
```

```
entablature → SplitY{ architrave | frieze | cornice }
```

```
architrave → RepeatX{ I(architrave_tile) }
```

```
frieze → I(frieze)
```

```
cornice → RepeatX{ I(cornice_tile) }
```

```
sanctuary : orient == front → SplitXY{ wall | wall }
```

```
sanctuary → wall
```

```
wall → I(quad)
```

Van Gool et al
ETH Zurich



- This event is a chance to:
 - Network including with a number of ongoing EU projects in FP6 and FP7
 - Share information on what's been achieved and what remains to be done
 - Discuss how we take EPOCH's results forwards
- Above all it is a chance to celebrate 4 years of working together





EPOCH

Thank you
and
enjoy the next two days.

