Heritage Imaging at UCL

Alejandro Giacometti, Adam Gibson, Mona Hess,
John Hindmarch, Lindsay MacDonald, Kazim Pal,
Stuart Robson, Melissa Terras, **Tim Weyrich**

University College London

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— and many more…

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Cultural Heritage Acquisition

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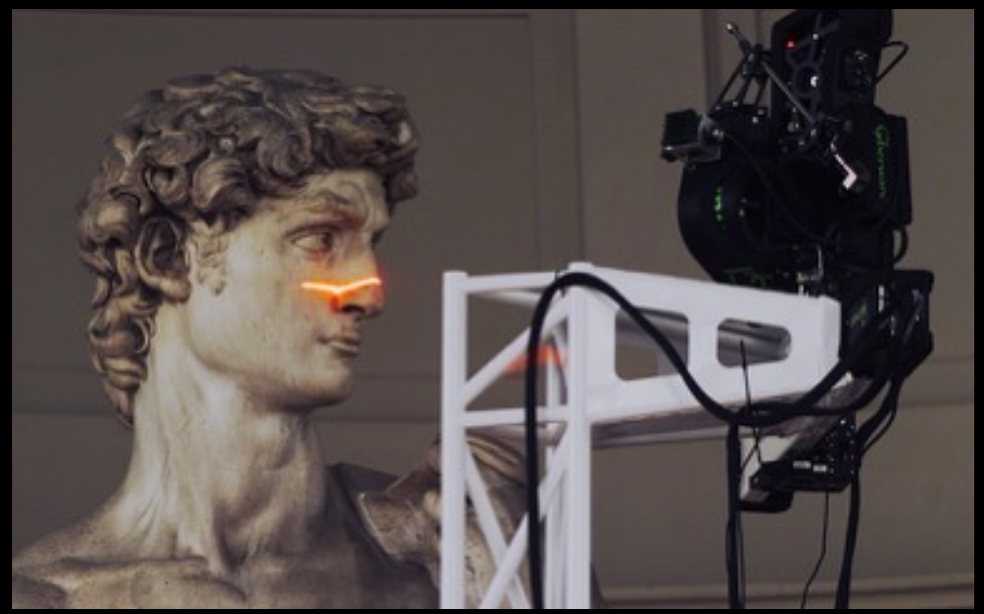
- Digital acquisition is now prominent in CH applications
  - Monitoring / Documentation
  - Visualisation / Analysis
  - Digital Surrogate
  - Archival



Levoy et al.

- We investigate principles and system designs with respect to
  - Quality, Usability, Scalability, Cost effectiveness, etc.

Stability Monitoring

- Ivory panel suspected of movement after transport
- 3D laser scanning revealed: 300–400 µm change induced by humidity variations

Hess, M., Korenberg, C.,
Robson, S., Entwistle, C., Ward, C.,
with British Museum

Non-Invasive Analysis

- Mould of unidentified bust at Science Museum

Non-Invasive Analysis

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- Mould of unidentified bust at Science Museum
- Reconstruction and “inversion” from laser scans

Mona Hess, Ben Russel,
Stuart Robson

Non-Invasive Analysis

- Mould of unidentified bust at Science Museum
- Reconstruction and “inversion” from laser scans

James Watt

Mona Hess, Ben Russel,
Stuart Robson

Visualising Spaces

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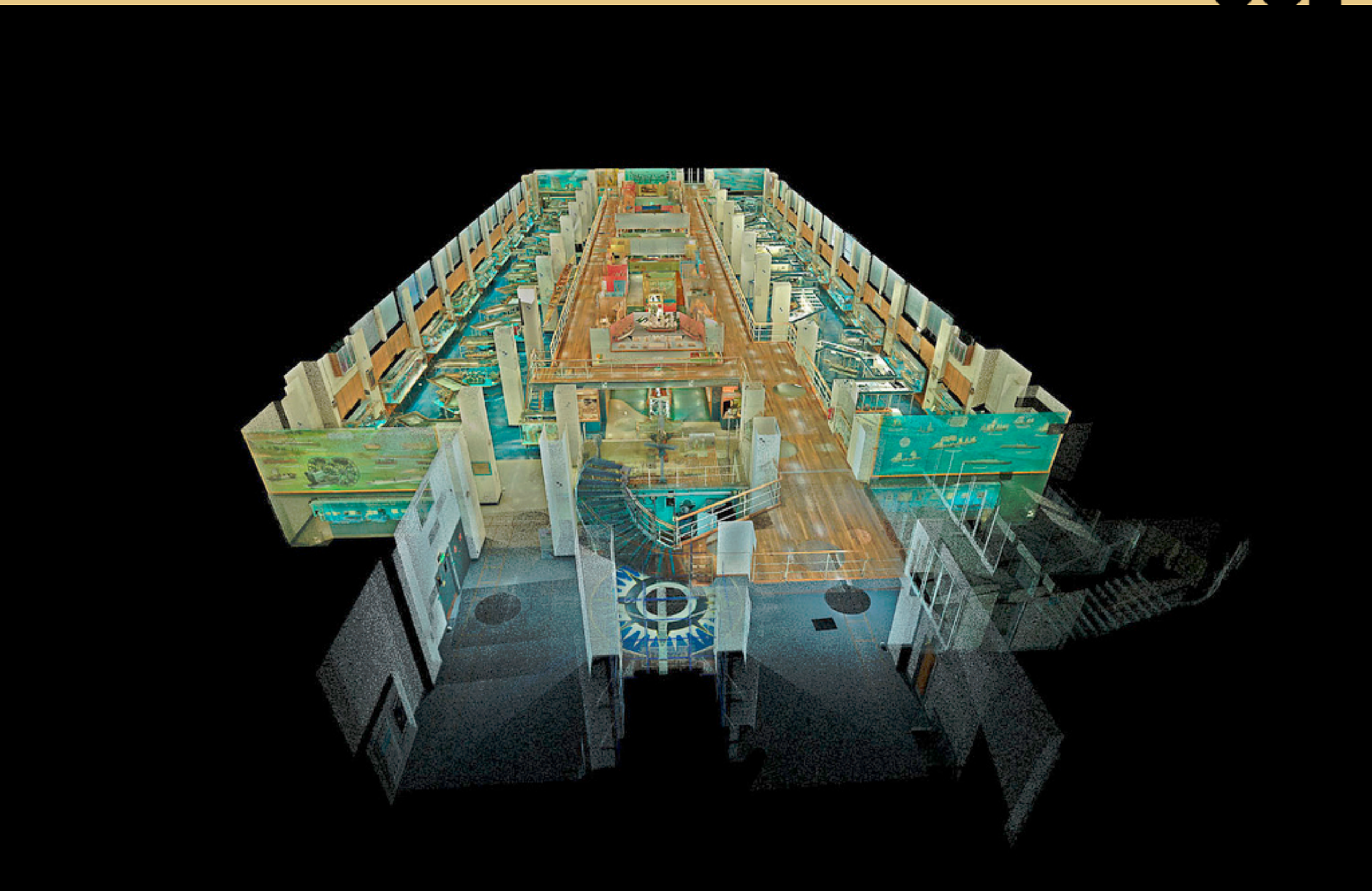

Visualising Spaces

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Visualising Spaces

A Prugnon, J Hindmarch, Matthew Shaw, William Trossell, Anita Soni, Prof Stuart Robson

http://www.sciencemuseum.org.uk/about_us/history/shipping.aspx

Digital Surrogate

- To what extent may a 3D scan replace the original?

Tonya Nelson, Stuart Robson, Margaret Serpico,
Mona Hess, Ivor Pridden, Giancarlo Amati
and Arius Technology Inc.

Digital Surrogate

- To what extent may a 3D scan replace the original?
- With Petrie Museum and Arius Technology Inc.:
  - Development of workflow
  - Development of presentation software
  - Evaluation of scanning technologies
  - Evaluation of audience engagement
- 130+ objects scanned, 70+ virtual surrogate 3D models
- Exhibitions and iOS apps

Tonya Nelson, Stuart Robson, Margaret Serpico,
Mona Hess, Ivor Pridden, Giancarlo Amati
and Arius Technology Inc.

Digital Surrogate

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processed 3D scan

post –processed

reference photograph

Digital Surrogate

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Digital Surrogate

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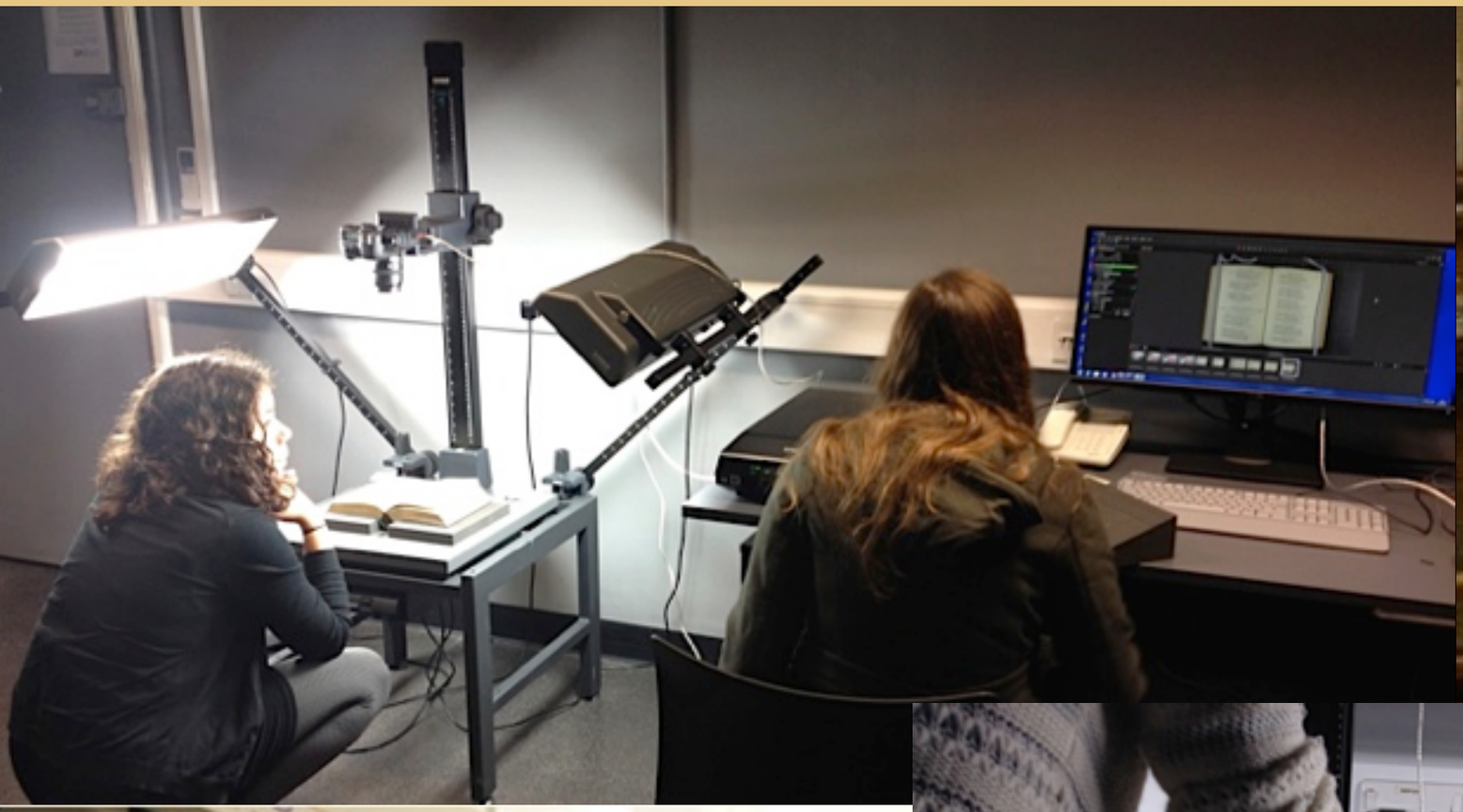
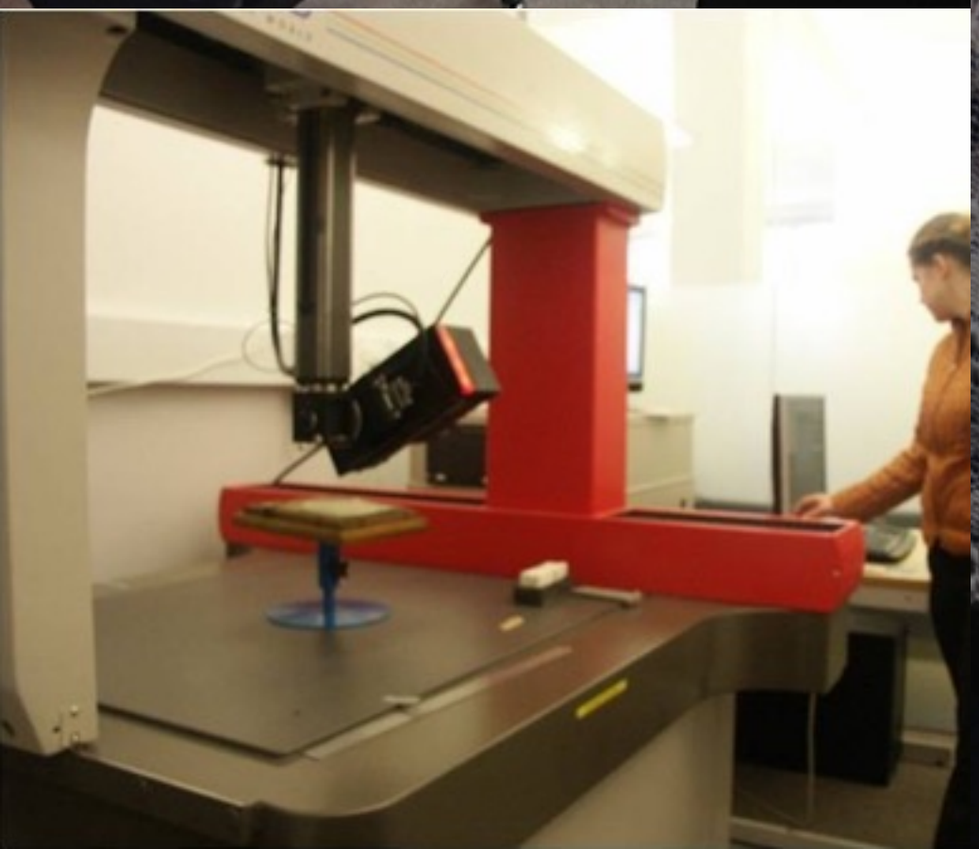
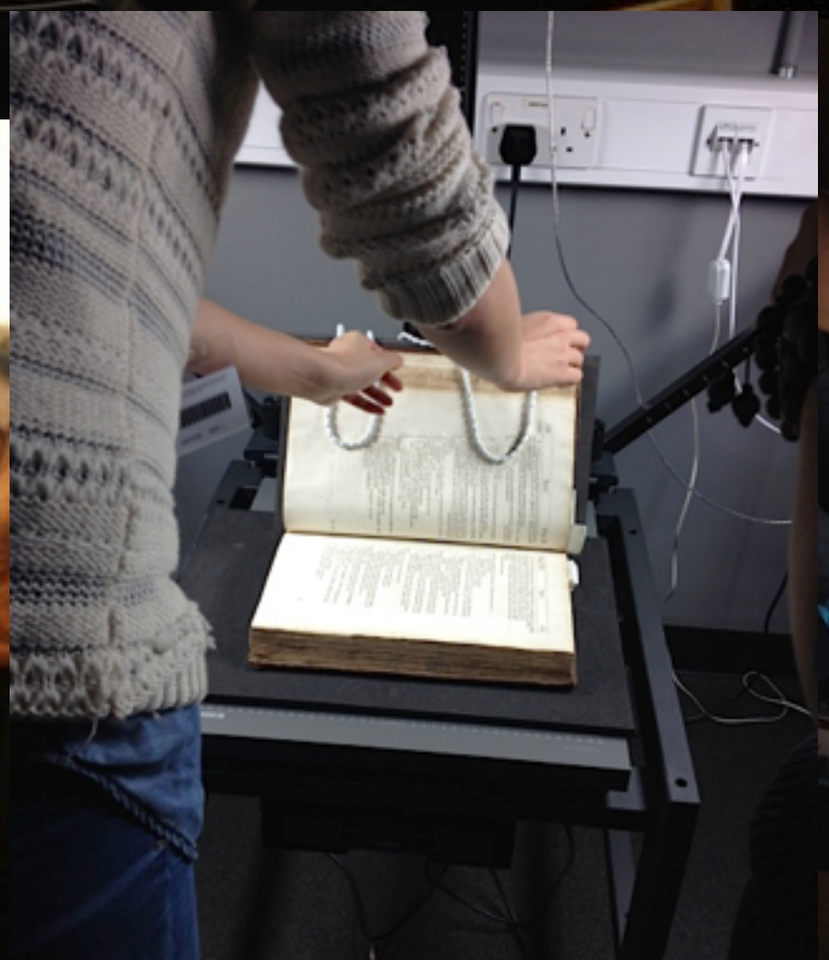
	Colour	Surface geometry recording, detail [mm]	Automation for processing?	Cost (GBP), Hardware + Software
3d colour laser scanning	YES	YES/ 0.1 mm (high resolution geometry)	NO	GBP 250,000 and up
Photogrammetry (professional software)	YES (high resolution texture)	YES/ 0.1mm (high resolution geometry)	NO	GBP 2,000 + SLR camera
PTM/ RTI (2.5D)	YES/ 0.003 mm	NO	Some models	estimate GBP 3000
Handheld 3D laser scanning	NO	YES/ 0.25 mm	NO	GBP 10,000 and up
3D laser scanning (e.g. Nextengine)	YES (low resolution texture)	YES/ 0.4 mm	NO	GBP 5,000 and up
Photogrammetry / Structure from Motion	YES	YES / 1 mm	YES	SLR camera + freeware or GBP 100 and up
Low cost 3D scanning (based on IR game sensors e.g. Kinect)	NO/ YES (specific software only, but low resolution)	YES/ 1-3 mm	NO	Sensor + software + Laptop: GBP 1000 and up

Mona Hess, Margaret Serpico

Training







Complex Materials

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- An inlaid metal bag at the Courtauld Gallery:
  14th century Islamic craftwork from Northern Iraq
- UCL created a 3D model from laser scans and photogrammetric image reconstruction

- Rich appearance of materials, however, only visible in lighting-dependent data

Hindmarch, J., MacDonald, L., Terras, M., Robson, S., & Gerstein, A.
with the Courtauld Gallery

Light-Dependent Imaging

- Common imaging approach: PTM / RTI dome

Hindmarch, J., MacDonald, L., Terras, M., Robson, S., & Gerstein, A. with the Courtauld Gallery

Light-Dependent Imaging

- Common imaging approach: PTM / RTI dome
- Records images of varying incidence

Light-Dependent Imaging

UCL

- Common imaging approach: PTM / RTI dome
- Records images of varying incidence
- Standard RTI viewers skilfully superimpose images
- Improved reconstruction by “fitting” physical reflectance properties



Hindmarch, J., MacDonald, L., Terras, M., Robson, S., & Gerstein, A. with the Courtauld Gallery

Complex Materials

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Hindmarch, J., MacDonald, L., Terras, M., Robson, S., & Gerstein, A.
with the Courtauld Gallery

RTI On One's Desk

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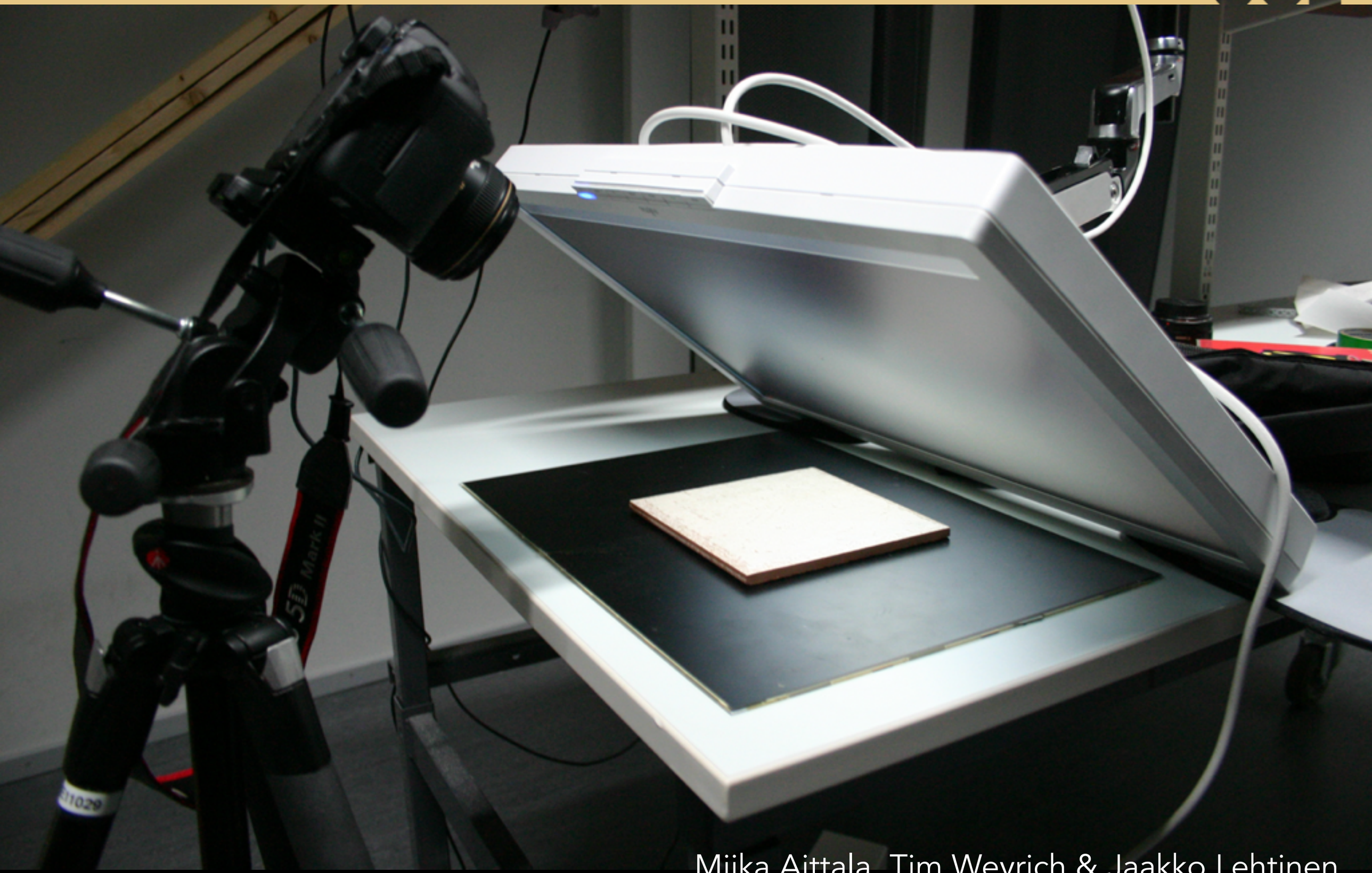

Miika Aittala, Tim Weyrich & Jaakko Lehtinen

RTI On One's Desk

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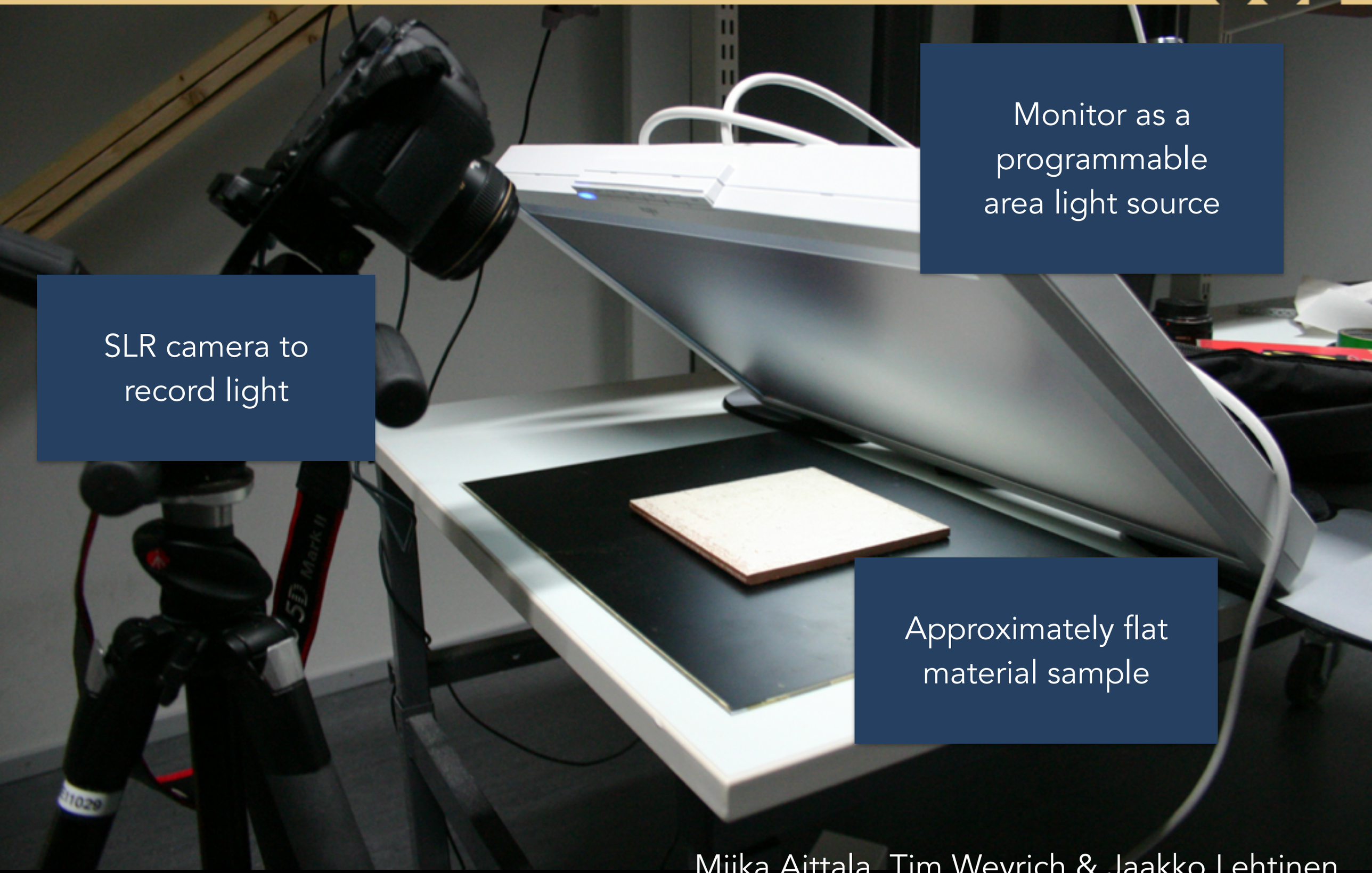

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RTI On One's Desk

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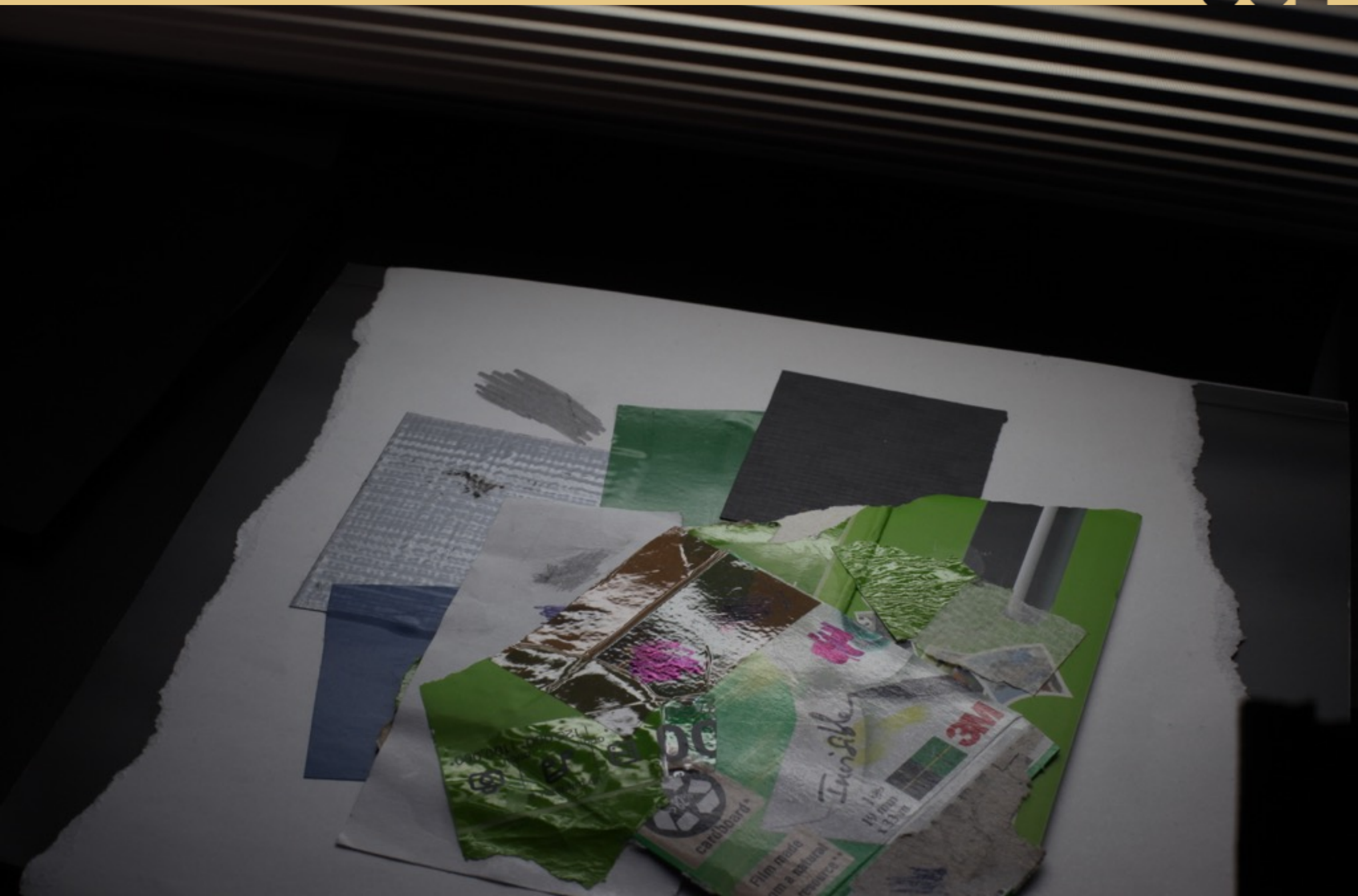

RTI On One's Desk

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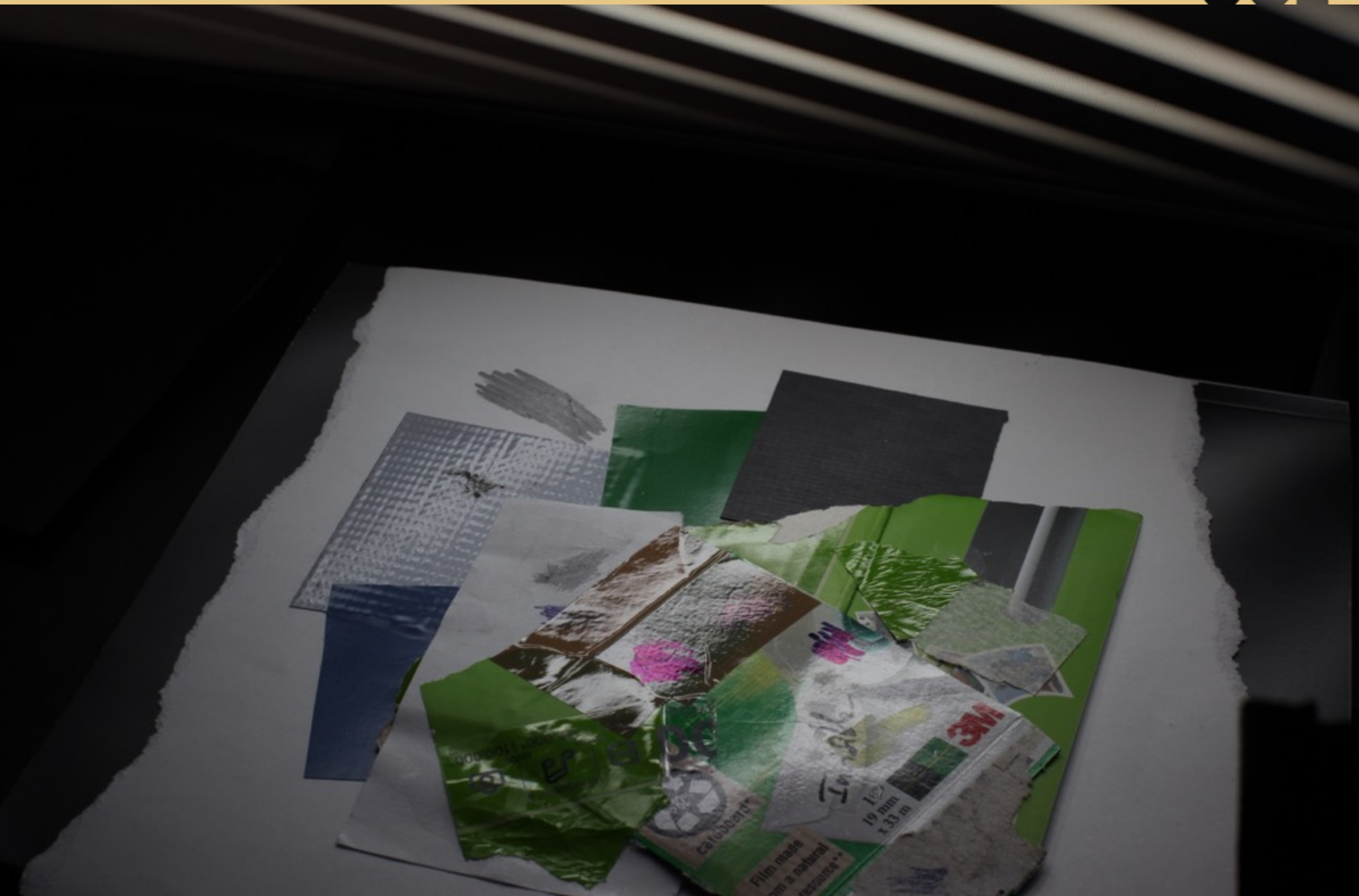

RTI On One's Desk

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RTI On One's Desk

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RTI On One's Desk

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RTI On One's Desk

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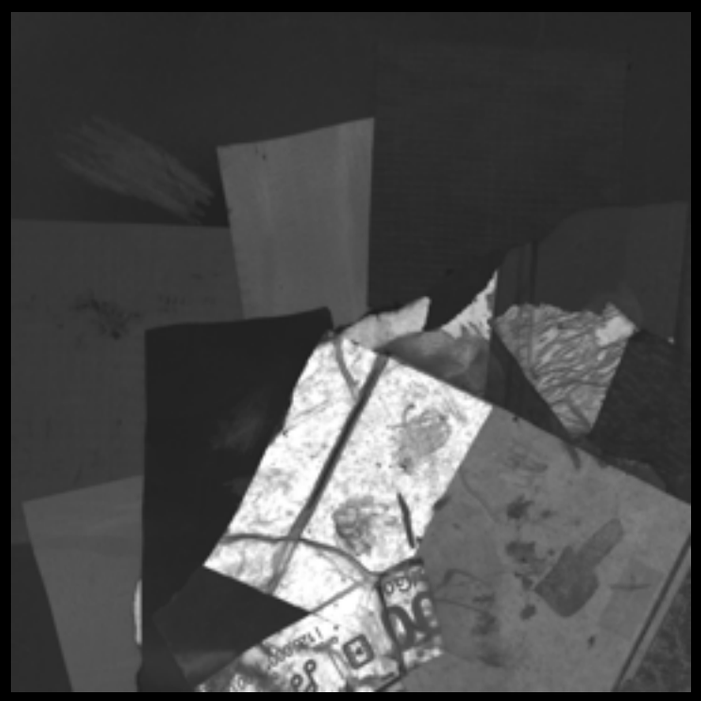
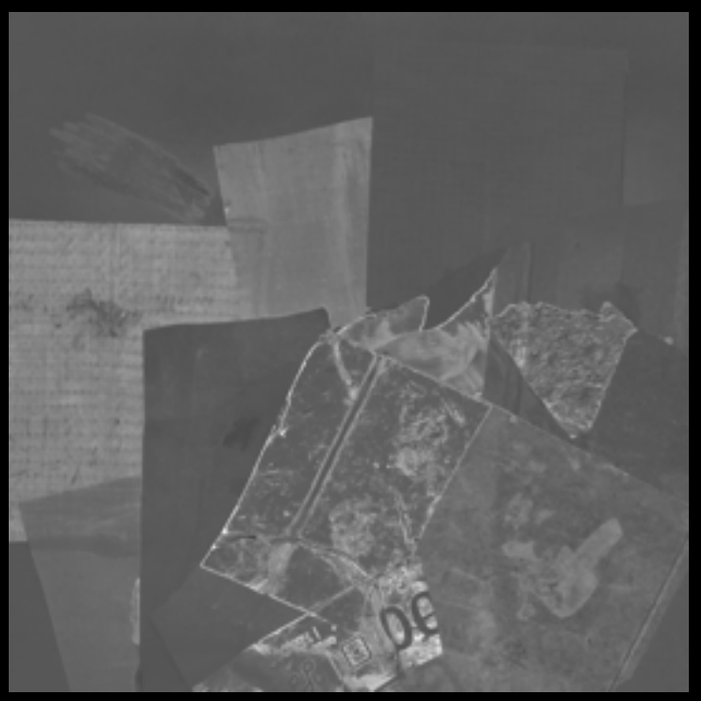
Diffuse Albedo

Surface Normals

Specular Albedo



Glossiness



Kurtosis

RTI On One's Desk

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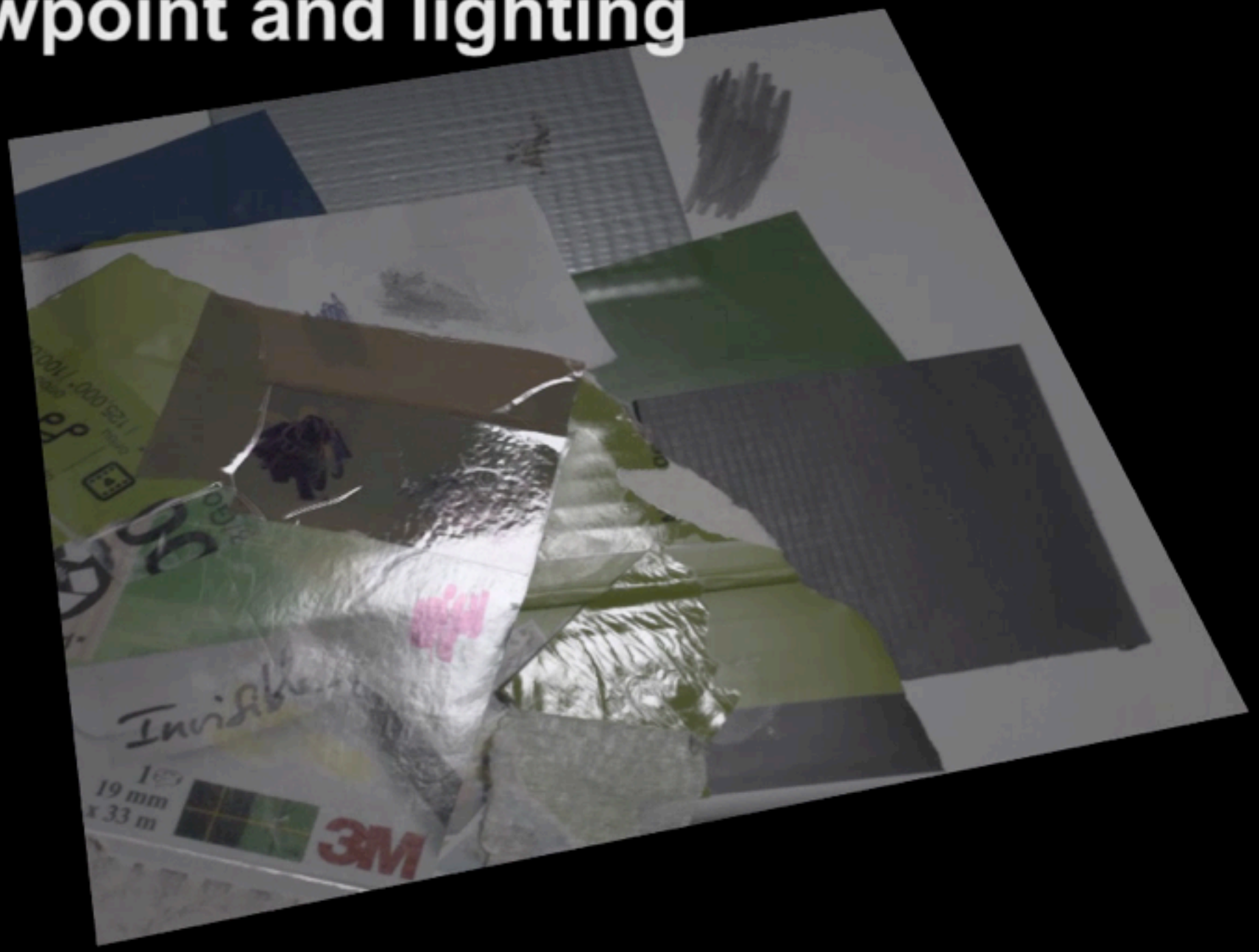
Free viewpoint and lighting



Miika Aittala, Tim Weyrich & Jaakko Lehtinen

Problem-Aware Digitisation

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- Digital surrogate can be an elusive goal
  - holistic acquisition is labour-intensive
  - quality requirements unclear
  - uncertainty about future use cases

- Few projects design acquisition around (humanities) research questions and problems

Problem-Aware Digitisation

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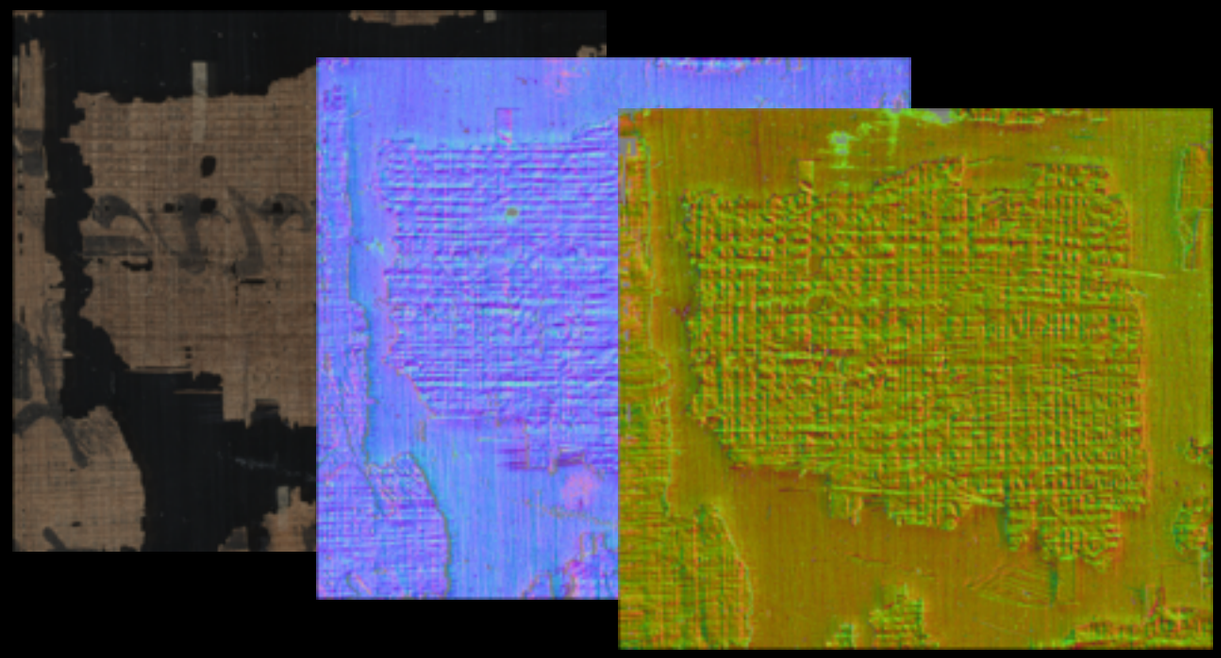
Let *CH questions* guide system design and data analysis

- Implications on
  - what data to acquire
  - quality requirements
  - usability
  - scalability



Stephen Quirke & Tim Weyrich

- Informs system design and trade-offs
  - technology, workflow, processing, rendering, …
- Allows for targeted algorithms and computational analysis

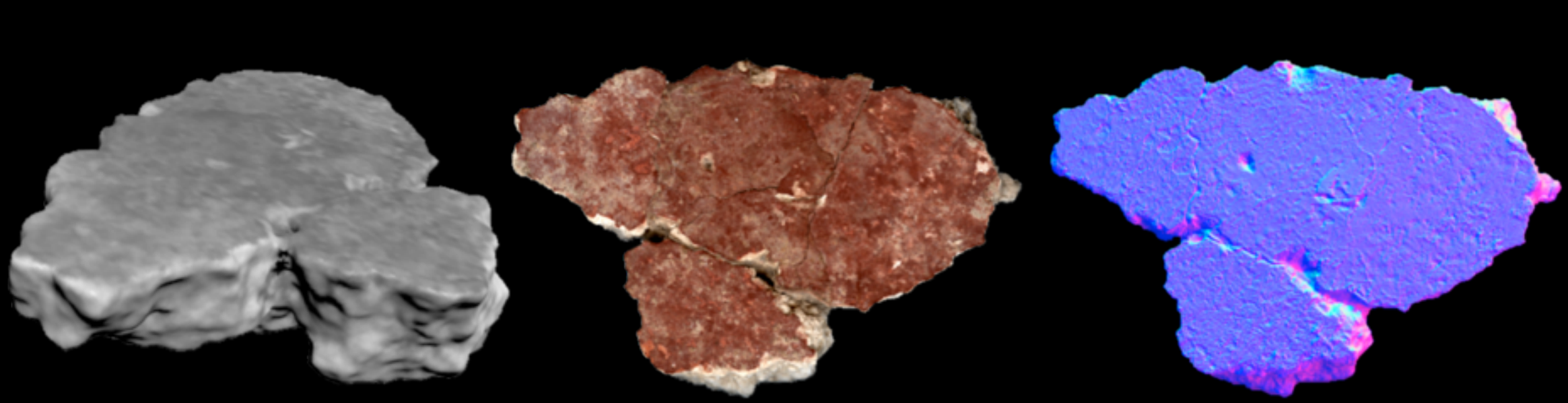
Problem-Aware Digitisation

Example: *Theran Wall Paintings of Akrotiri, Greece*

- *Major archaeological excavation since 1967*
  - *Well-preserved by ash*
  - *Our focus: the wall paintings*
  - *material excellently preserved*
  - *but shattered in pieces by earthquake*

Data Requirements

- Relevant fragment characteristics translate to:
  - accurate overall shape (3D geometry, ± ⅛ mm)
  - high-quality colour reconstruction of front (albedo)
  - fine surface detail on flat surfaces (normals)



Benedict Brown, Corey Toler-Franklin, Diego Nehab, Michael Burns,
Andreas Vlachopoulos, Christos Doumas, David Dobkin, Szymon Rusinkiewicz, Tim Weyrich

Acquisition & Processing

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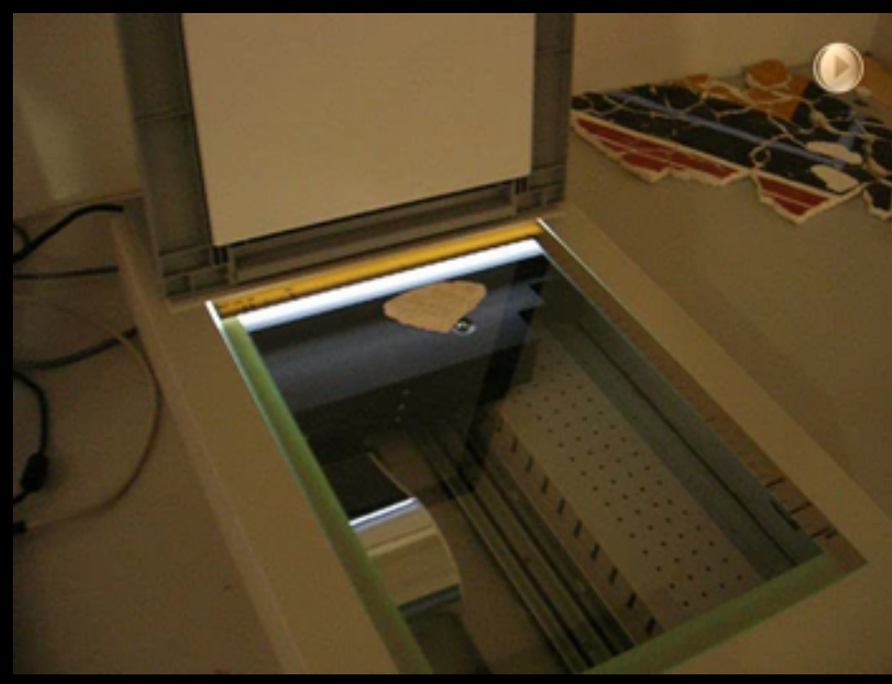
- Low-cost, bespoke acquisition rig
- Automated processing enabled by
  - highly specialised scanner setup
  - tightly controlled workflow
  - allowed for custom algorithm design
- Workflow developed with conservators

⇒ high usability



Digital Restoration

Example: *The Great Parchment Book*

- 1639 survey of estates of Irish county of Derry
- Important source on the Protestant colonisation
- Damaged by a fire in 1786
- Has been unavailable to researchers for 200 years

Nicola Avery, Alberto Campagnolo, Caroline De Stefani, Kazim Pal, Matthew Payne, Philippa Smith, Rachael Smither, Ann Marie Stewart, Emma Stewart, Patricia Stewart, Melissa Terras, Laurence Ward, Tim Weyrich, Elizabeth Yamada with London Metropolitan Archives

Requirement Analysis

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Key Requirement

- Transcription of *content*

Lesser Requirement

- Nice flattened display version

NOT Required

- Recovery of realistic colour / surface reflectance / sheen
- Re-staging of reading experience (virtual reality)
- Spectral ink analysis
- …

Imaging

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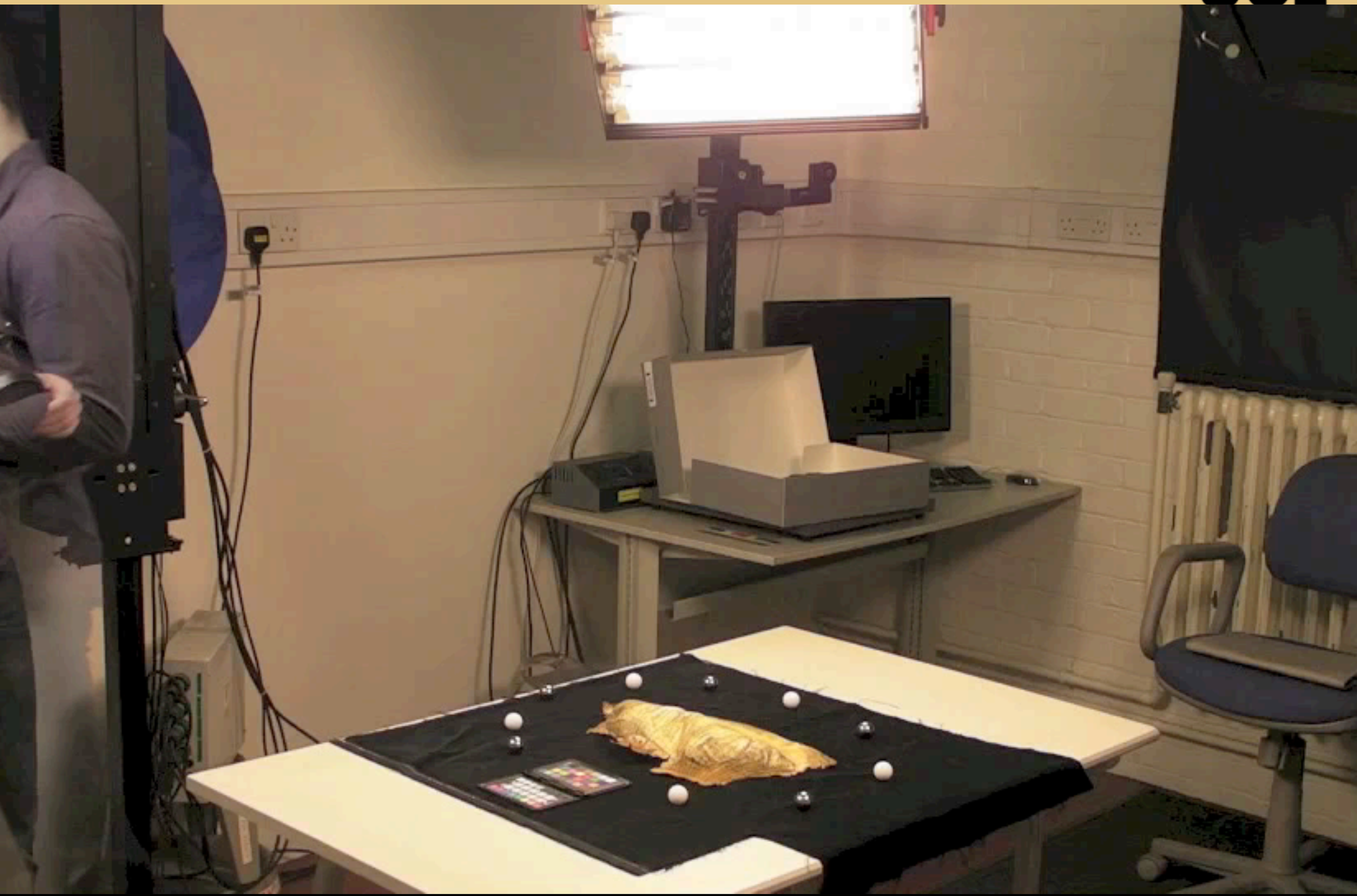

Global Flattening

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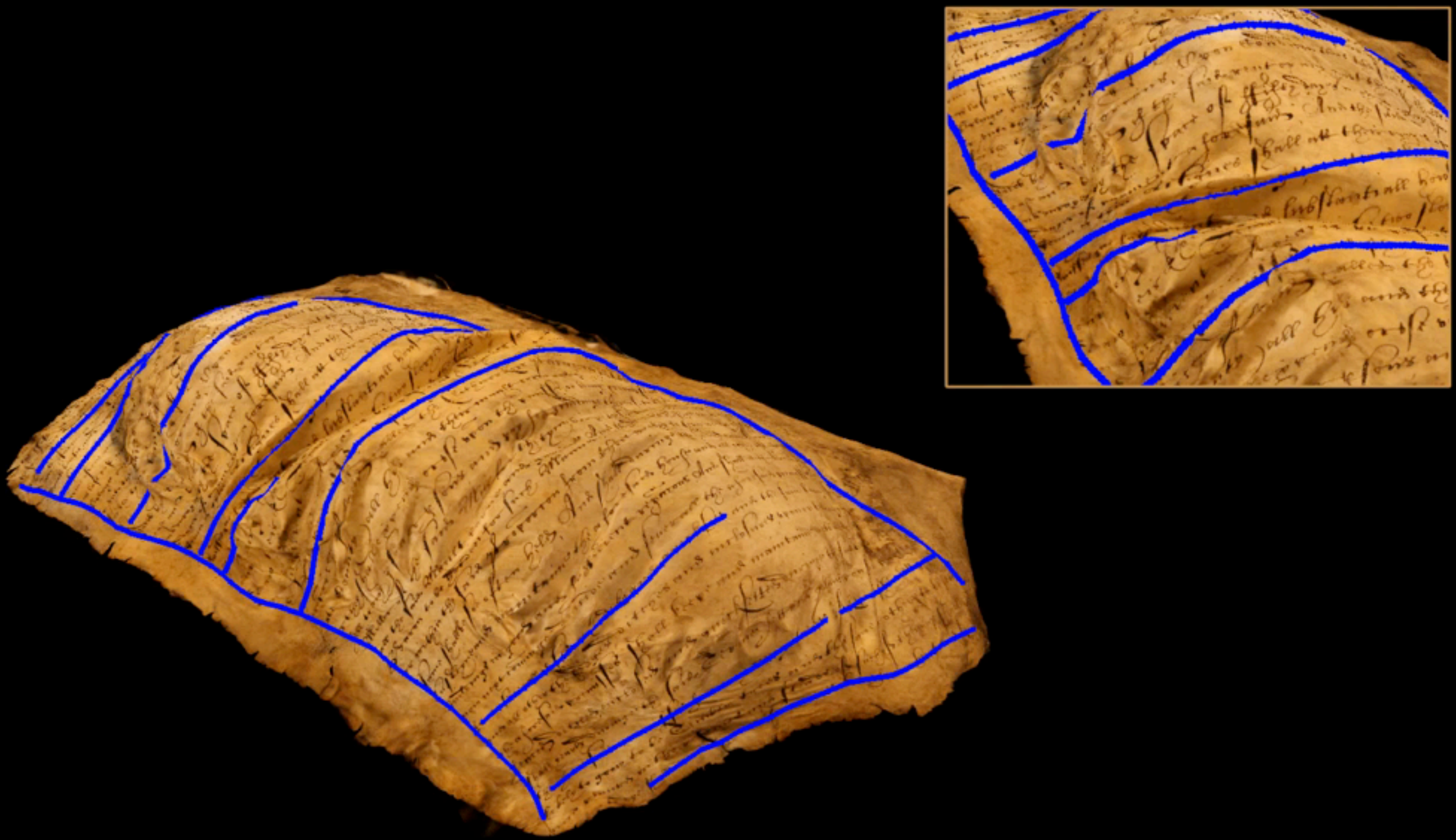

Kazim Pal, Christian Schüller, Daniele Panozzo, Olga Sorkine-Hornung, Tim Weyrich

Digital Conservation

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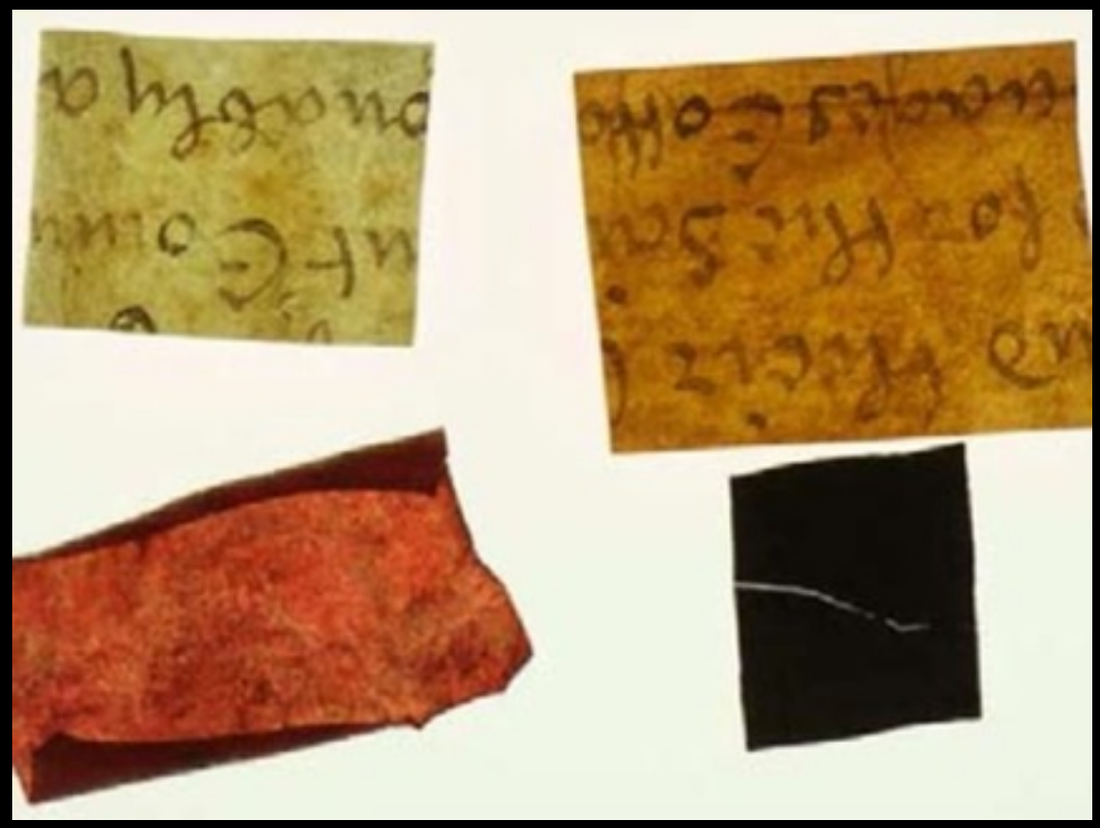
Example: *Multi-Spectral Imaging of Parchment Damage*

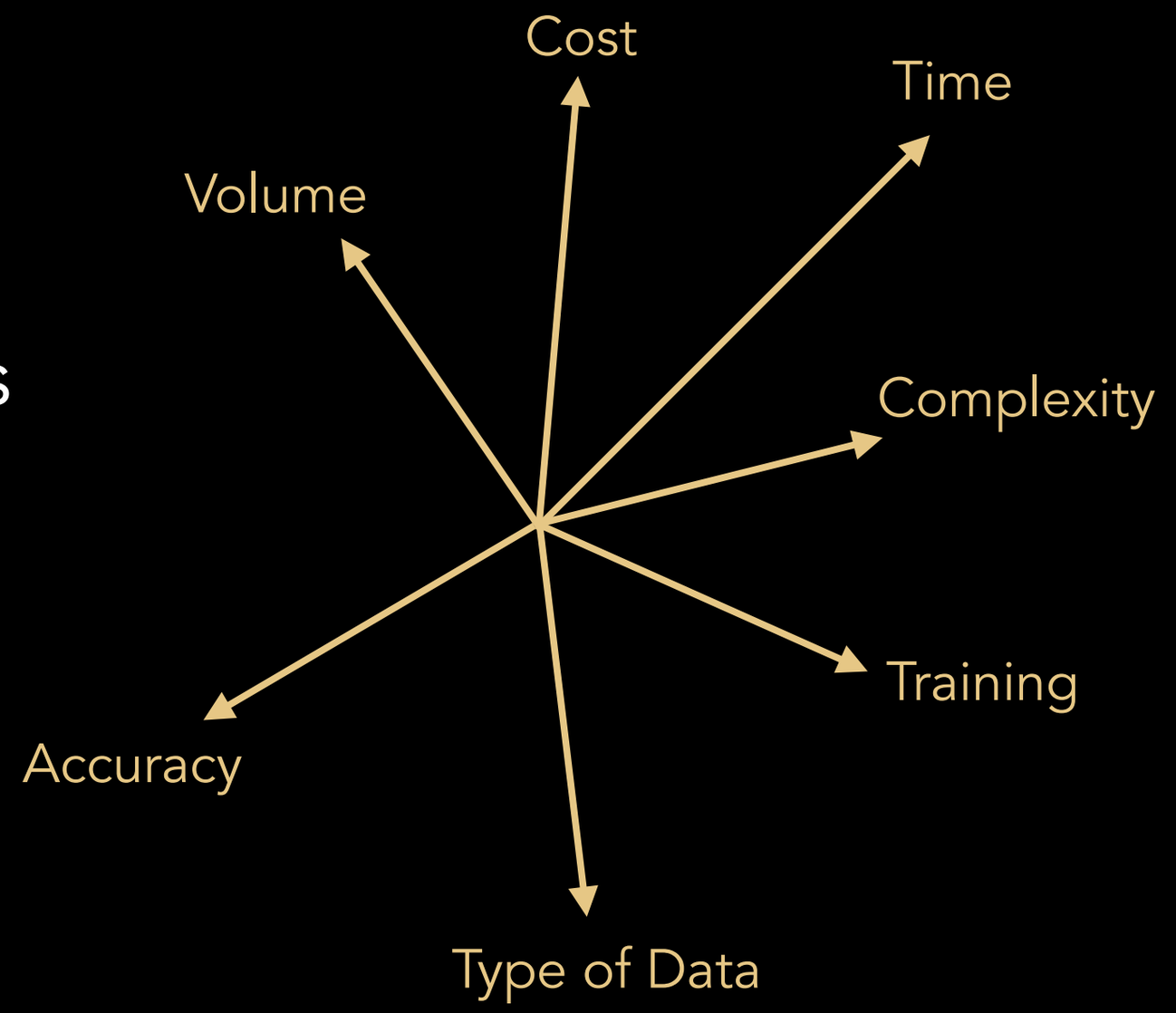
- Before/after studies for various modes of damage
  - fire damage
  - wine and blood stains
  - humidification
  - mechanical abuse
  - …
- Ongoing analysis; ultimate goal: inversion of damage



Alejandro Giacometti, Alberto Campagnolo, Lindsay MacDonald,
Simon Mahony, Melissa Terras, Stuart Robson, Tim Weyrich, Adam Gibson

Conclusion

- Design space for digitisation efforts is complex
- Best practice is highly object-dependent…
- … but also subject to scholars' research questions
- Ongoing work toward general guidance and modular solutions
- Open access of designs will be key



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Q&A

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