



Miniature Flexible & Reconfigurable Manufacturing System for 3D Micro-products (Micro-3D)

Funder: EPSRC (EP/K018345/1), 1 July 2013 – 30 June 2017

Academic Investigators:

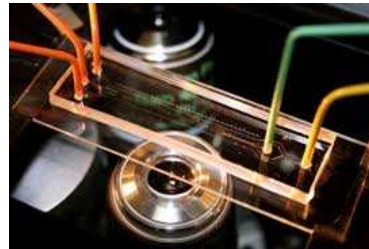
- **Prof Xichun Luo**, Prof Yi Qin & Prof William Ion, University of Strathclyde
- Prof Jane Xiangqian Jiang, University of Huddersfield
- Dr. Xianwen Kong & Dr. Matthew Dunnigan, Heriot-Watt University

Industrial Collaborators:

- UPM, Renishaw, Gyrus Medical, Contour Fine Tooling & STMicroelectronics.



Head-up display
(quanquili.org)



Microfluidics
(ddw-online.com)



Artificial heart
(discovermagnzine.com)

EPSRC

Engineering and Physical Sciences
Research Council

*Digital Technologies for Manufacturing Innovation: Embracing Industry 4.0,
30 November – 1 December 2015, University of Nottingham, UK*

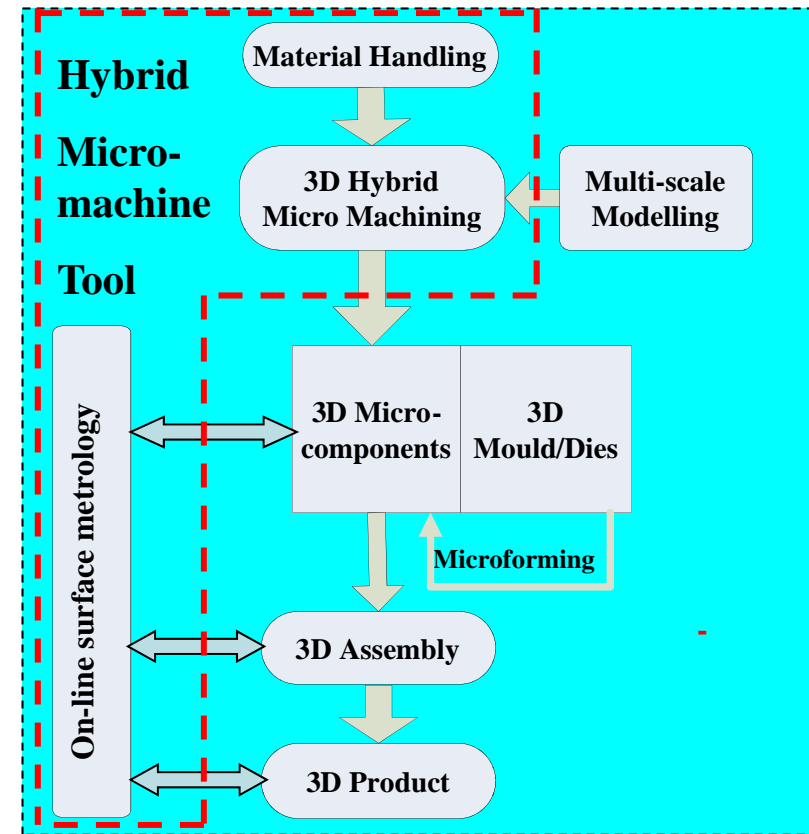
Project outline

Aim and objectives

Research and develop **miniaturised units** and **hybrid processes** integrated with machining, metrology, materials handling and assembly so as to establish highly **flexible manufacturing capability** to enable customised emerging **3D micro-products** to be produced in a fully automated manner at **low cost**.

The objectives are to investigate and create:

- Novel hybrid micromachining processes;
- Reconfigurable material handling & 3D micro-assembly systems;
- In-line metrology;
- A miniature hybrid micro machine;
- System integration and evaluation.



Concept of FRMS

Targeted product accuracy:

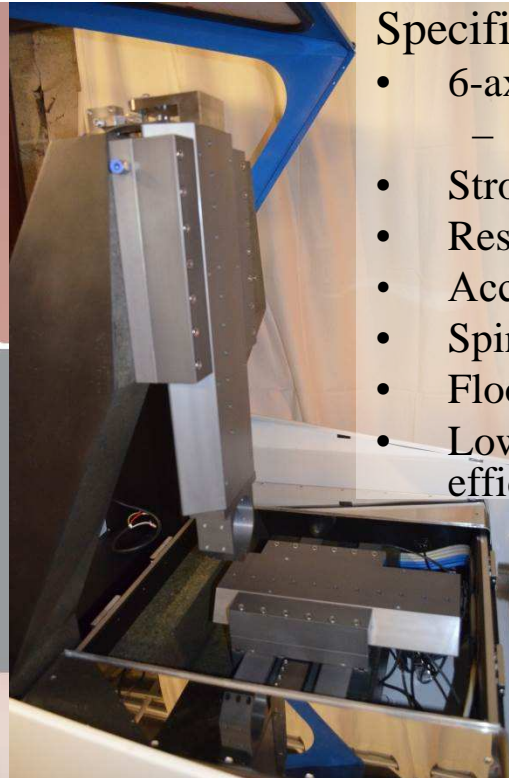
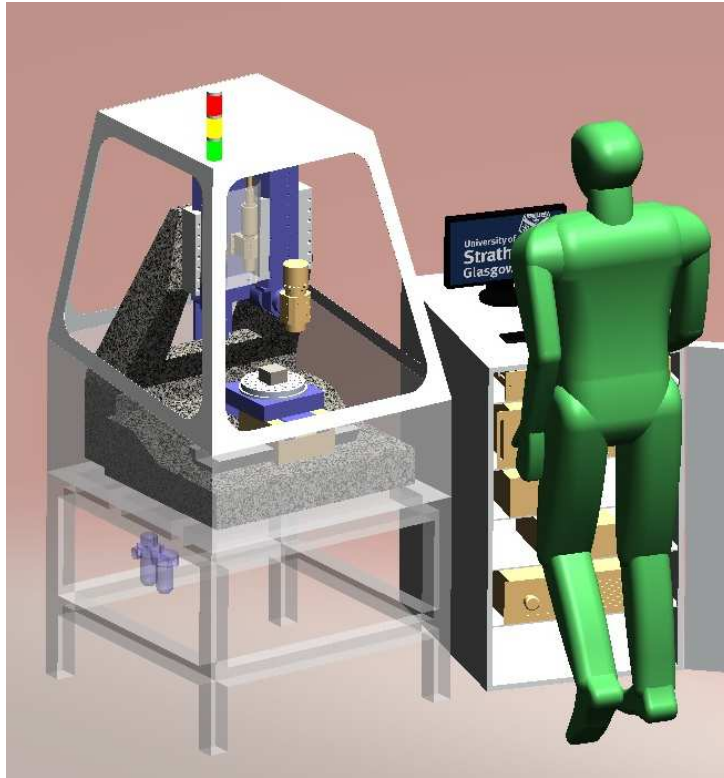
Dimension: <math><0.2 \mu\text{m}</math>

Form: <math><50 \text{ nm}</math>

Roughness: <math>< 2 \text{ nm}</math>

Affordable precision

Project impact

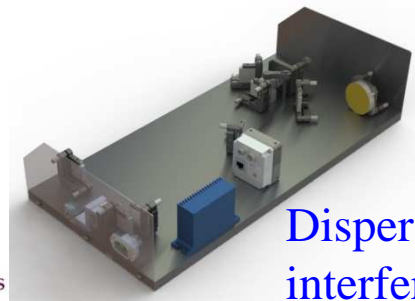


Specifications:

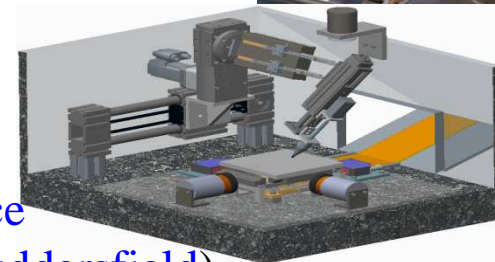
- 6-axis machine (X, Y, Z₁, Z₂, B and C):
 - Milling · Grinding · Laser machining
- Stroke (X, Y, Z): 300 × 150 × 150 mm
- Resolution: 1 nm
- Accuracy: < 0.2 μm
- Spindle speed: 180,000 rpm
- Floor space: 0.85 m × 0.75 m
- Low cost, energy consumption and high efficiency



6-axis Hybrid micro machine tool (to be commissioned in March 2016 at Strathclyde)

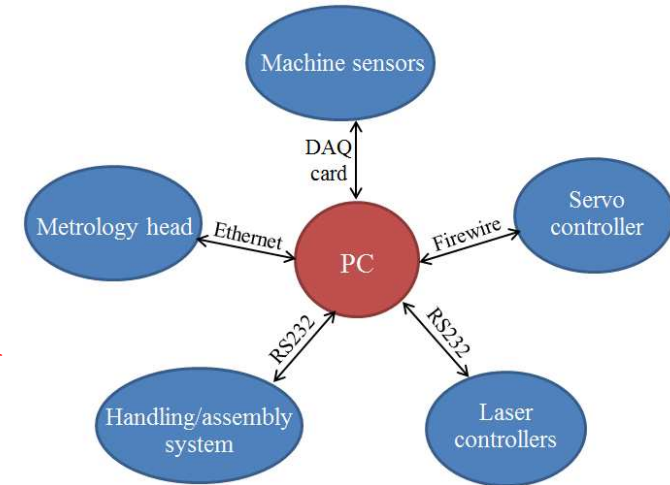


Dispersed reference interferometry (Huddersfield)

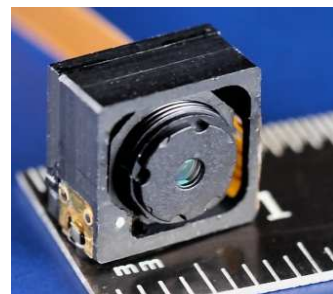


Materials handling & 3D micro-assembly station (Heriot-Watt)

- Hybrid system integration
- Fully automation production
- Autonomous manufacturing
- Continuous funding for future research & commercialisation
- Smart phone market (> \$270 billion in 2015): Hybrid system integration
- Medical device market (predicted to reach \$115.8 billion in 2020)
(2 new industrial sponsored PhD projects just started at Strathclyde)
- Automotive market (low cost diffractive optics , freeform optics)



i-phone



Mobile phone camera

<http://www.electronics-eetimes.com/>



Artificial knee joint

(after D Walker, SPIE Proceedings)



For more information

- **Micro-3D project, Hybrid micro machine tool:**

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