Agenda

- Welcome
- Introductions
  - Dr Stephan Hofmann: Electrical Engineering
- Mflex: SmartInk Dynamic Function Row
- Update from CIKC
- Guest Speaker: Prof Alan Barrell
- Buffet and networking
Introductions
Growth of novel nanomaterials

1D: Nanowires, Nanotubes
2D: Graphene, BN

Novel in-situ characterisation of nanomaterials

In-situ XRD
In-situ optical spectroscopy
Environmental TEM
High-pressure XPS

Device Integration & Applications

Interconnects
X-ray sources

Transparent electrodes
OLEDs
Heat sinks

Batteries & supercapacitors
Energy harvesting
Low power/autarkic sensors
Biomimetics
Functional interfaces & adhesives

Interconnects
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Novel integrated active/passive photonic components
MEMS/NEMS
Spintronic devices
The manufacture of Nanomaterials is crucial as basis for emerging products. Application driven demand includes:

- Energy harvesting & storage
- Barrier layers & packaging
- Transparent & flexible & wearable electronics
- LC displays
- Foldable displays
- Smart windows
- Lighting
- Thermal management
- Smart Sensors
- …

Nanomaterial manufacture and integration technology is vital. The main challenges are:

- Interfacing and Industrial standards
- Integrated processes/compatibility

Example: CVD graphene nanomaterial manufacture and integration technology is crucial as basis for emerging products.

![Graphene on the final substrate is sold](image)

- Substrate integration
- Graphene Growth
- Graphene Transfer

Growth equipment is sold

Integrated Graphene Growth

Main challenge: Interfacing and Industrial standards
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Is time travel possible?

Amazingly, the known laws of physics don’t rule it out. According to Einstein’s theory of general relativity, it is theoretically possible to create a “wormhole”, which means we can tunnel through space and time to other eras. Obviously, nobody knows how to do it yet, and the results would be a bit mind-boggling. Suppose you jumped into a time machine, travelled back to when your grandfather was young... and accidentally landed on him before he met your grandmother. Then your parents could not exist, and neither could you — yet there you are, having flattened grandad. Many scientists think this “grandfather paradox” rules out time travel. Another bit of evidence is that we have yet to meet anyone from the future who has successfully travelled back in time — unless, of course, they’re here, but don’t like to talk about it. There is a way anyone can see into the past, though: look up. Gazing at Polaris, the north star, is to see it as it was back when Elizabeth I ruled England.

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What is the strongest material in the world?

If you think it’s diamond, then think again — though you’re not too far out. The title of world’s strongest material has recently been awarded to graphene, which, like diamond, is made out of nothing but carbon atoms. Arranged in a “honeycomb” pattern and held together by incredibly powerful bonds, these atoms really don’t like being pulled apart. Tests on sheets of graphene suggest it’s so strong that a paper-thin layer could support the weight of an elephant balancing on the tip of a pencil.
EPSRC Centre for Innovative Manufacturing in Large-Area Electronics (LAE)

http://www.largeareaelectronics.org
Integration of Printed Electronics with Silicon for Smart Sensors (IPESS)

Project goal:
- Multifunctional, multi-parametric sensor integration with printed electronics and unpackaged Silicon devices

Applications
- Initial focus on gas sensors
- Extension to physical, chemical and biological sensors

FET sensor array → Analogue front end (op-amp) → Multiplexer → Silicon microcontroller and radio → Indicator / output

Prof Henning Sirringhaus
Cavendish Lab
**IPESS capabilities**

Printed analogue electronics
- Solution processed p-type, n-type and ambipolar small molecule and polymer OFETs with mobilities 1-10 cm²/Vs
- Solution-processable n-type oxide FETs with mobilities of 5-80 cm²/Vs and good operational stability

Chemical Sensors
- Low-voltage, printable FET sensors for gas sensing and chemiresistors with integrated heaters
- Expertise in sensor readout and signal
- Sensor arrays to improve selectivity
- Platform for a wide range of integrated sensor applications

**Goal:** large-area, multifunctional patterns using simple methodologies

Patterning (embossing, moulding, etc.) and possibly surface modification

Filling large features with material of functionality 1

Filling large features with material of functionality 2

**Applications**
- Conductive patterns
- Sensor arrays / LED arrays
- Photonic structures / waveguides
- p-n junctions

Prof Natalie Stutzmann
Imperial College
PLANALITH

- Ability to fabricate high aspect ratio \((10^6)\) nanogaps using dissimilar (high/low workfunction) electrodes
- High speed planar organic photodetectors and planar OLEDs have been demonstrated

Prof Thomas Anthopoulos
Imperial College
ARPLAE

Goal
• to address fundamental rheological barriers to achieving high resolution features in high yield contact printing processes

Objectives
• improved understanding of functional ink formulation and its interaction with the image carrier and substrate
• development of rigorous techniques for characterisation of fluids in high deformation rate shear and extensional flows
• development of industrially deployable performance metrics

Prof Rhodri Williams,
University of Swansea
Printed Energy Harvesting Project (in definition)

Scope: Part-printed energy harvesting/storage system designed for high volume manufacture. Thin. Flexible

Harvesting: RF, PV,
Rectification Printed diodes
V multiplier Caps/diodes
Storage: Supercap/Secondary battery
Protection circuit
Charging circuit

Looking for industrial interest, guidance
National Conference

- 2 days
- In the UK
- To include presentations relating to Centre projects
- What would your company like to see on the programme?
Interacting with the Centre

- Sign up at www.largeareaelectronics.org
- Come to **networking events** for industry, academia
- **Sponsor a PhD studentship** on a topic of interest to your organisation
- Work in the Centre using **KTP** or other exchange schemes
- **Secondment of Centre staff** to work in your organisation
- Propose a **Feasibility Project**
- **Collaborate** with us on a TSB or Horizon 2020 or other publicly-funded project
- Join a **multi-company technology programme**
The need

- Explain to end-users/designers/undergrads/schools what Large-Area Electronics is and what it can do

The opportunity

- Put your technology into a **smart compelling** demonstration of UK companies’ capabilities

Status: Progressing towards securing funding

Would you like to have your technology included in the demonstrator?
Energy Harvesting for Autonomous Systems

**Timeline**
- Competition opens: 02 June 2014
- Final date for Registration: 18 September
- Submission deadline: 25 September 2014
- Registration for “Design Option”: 04 July, 2014

**Summary**
- Type of Competition: Single Stage
- Project composition: Business led & Collaborative
- Funding available: Up to £2.5m
- Project Size: £300k - £500k
- Business:Research Split: 70:30
- Approx % Funding: Up to 60% (50% for LSE)
- Anticipated Project length: Up to 30 months

**AMSCI 2014**
Factories of the future

SME instrument (70% EC funding rate):

**Phase 1, 6 month feasibility 50K€ funding**
- the deadlines in 2014 are 18/06/2014
- 24/09/2014
- 17/12/2014

**Phase 2, budget 500K€ to 2.5 million €**
- the deadlines in 2014 are 09/10/2014
- 17/12/2014
EPSRC Funding Calls

Design the Future – Autumn 2014

• Methods/tools to accelerate the adoption of new materials and technology by designers
• Techniques and technologies to enhance creativity and effectiveness of designers
• Technologies to improve engineering design in a manufacturing context.

1. Are these topics of interest to your company?
2. Would you like to propose/suggest topics for a research project in this area?
Opportunities for Large-Area Electronics meeting developing global needs for remote and point-of-care diagnostics and patient monitor

Professor Alan Barrell
Opportunities for Large Scale Electronics Meeting
Developing Global Needs for Remote and Point of Care Diagnostics and Patient Monitoring

EPSRC Centre for Manufacturing in Large-Area Electronics
Cambridge Innovation and Knowledge Centre

Alan Barrell – Madingley Hall
June 24th 2014

Connecting with the NHS and Other Markets
Global Needs for Remote and Point of Care Diagnostics and Patient Monitoring - Preview

- Global Healthcare Trends – Overview
- NHS and other Western Health Systems – Context and Challenges
  - Medical Technology and Digital Dimensions – Connectivity
- Specific areas of Patient and Clinical Need and Priority
  - Some Examples / Case Studies
  - Special Needs and Opportunities in the Developing World

Access to Markets – including the NHS – Co-Creation and Partnership
Global Healthcare Trends and Challenges

World Population Growth

Medical Research and Progress

Education, Expectations and Aspirations – but some negative lifestyle trends

Living Longer – not always Healthier – Burdens on Health Budgets
Cost savings & Revenue Generation

NHS Budgetary Challenges
Demand is outpacing available funds – A serious productivity gap....Regional example

How are we going to cope with an ageing population with ever increasing demands on health and social services?

Quite simply: we need to get more from the same or less

In the UK – National extrapolation gives a £20 Billion "productivity gap" in three years

National HC Budget £120 billions – 70% on Long Term Conditions

Low investment in Prevention
Healthcare Costs

Healthcare expenditure

- Escalating
- Global
- BRIC nations

% of GDP on Health
- USA 19%
- Germany 12%
- UK 7-8%
- Philippines 2.8%

Opportunities for Medical Science and Industry
Innovation is the only answer but changing behaviour in a workforce of 1.4 millions is problematic.

Adoption and Diffusion of innovation – slow in healthcare generally – this is nothing new.
Quality, Innovation, Prevention and Productivity
QIPP – finding and spreading the best practices

“the NHS needs to recognise that improving quality and value for money go hand in hand”

A “Global Truth” for Health Care Systems
### Bloomberg Businessweek

**At the Patent Cliff’s Edge**

<table>
<thead>
<tr>
<th>Year expiring</th>
<th>Drug/Company</th>
<th>2010 Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>Lipitor (Pfizer)</td>
<td>$10.7b</td>
</tr>
<tr>
<td>2011</td>
<td>Seroquel (AstraZeneca)</td>
<td>$5.3b</td>
</tr>
<tr>
<td>2011</td>
<td>Zyprexa (Eli Lilly)</td>
<td>$5.0b</td>
</tr>
<tr>
<td>2012</td>
<td>Diovan (Novartis)</td>
<td>$6.1b</td>
</tr>
<tr>
<td>2012</td>
<td>Plavix (Bristol-Myers Squibb, Sanofi)</td>
<td>$9.4b</td>
</tr>
</tbody>
</table>

_DATA: BLOOMBERG, COMPANY REPORTS_

- Patent cliff
- Tighter regulation
- Higher drug failure rates
- Lower approval rates
- Fiercer competition
- Reimbursement
The Biomedical Industry

- Pharmaceutical – drugs
- Biotechnology – drugs, technologies and services
- Regenerative medicine/stem cells - therapies, technologies and services
- Medical – devices, diagnostics, equipment, services
New Era of Personalised Medicine

- Drug failures
- New reimbursement models
- End of the blockbuster?
- Patients/Volunteers
  - Records
  - Samples
- Data mining
- Pathology
- Imaging
- Pre-clinical
- Clinicians
- Clinical facilities
- Diagnostics expertise
Medical Devices/Equipment

- More sophisticated
- Closer relationships between developer and end-user
- Co-development
- Embedded labs in hospitals
- Beta-testing
- Market pull vs technology push
Regenerative Medicine

- Proximity to patients
- Access to clinical expertise
- Proximity to clinical facilities
- UK TICs

Strength in Cambridge and Technology Development Opportunities
Industry-Academic Partnerships in Practice

- Fill gaps
- Complement in-house capabilities
Moving to “Connected Healthcare”

Shifting and flexible locations for diagnosis and delivery
Medicine beyond 2020 - drivers for change in developed economies

- New diseases/new discoveries
- More informed and empowered population
- Demographic changes
- More individualised prevention and treatment
- Different models of care
  - Care closer to home / near patient testing
  - More creative use of ICT (monitoring, communication…)
  - New treatments for chronic disease (eg diabetes)
  - Ethical issues eg de-medicalising care of the dying
- Incentives to stay well and be treated out of hospital

Dr Robert Winter – Now Director
Cambridge AHSN
To develop a Sustainable System in UK and other Western Healthcare programmes will mean….

- Care closer to home – and *Care* at the forefront of mindset
- Earlier intervention
- Fewer acute beds
- More standardisation *integrated care*
- Empowered, informed patients – “The Patient Revolution”
- “No decision about me without me”

*Dr Robert Winter Cambridge AHSN*
The Future - Supported Self-Care
Today and The Future - Three Converging Revolutions
Impact on “Things Medical” +++++

Open Innovation enables....

Transfer of tacit knowledge

BIO TECH
Pharmaceuticals
Diagnostics
Research/Info Tools
Industrial

INFO TECH
Hardware
Software
Communications

NANO TECH
Electrical
Structural
Biomedical
Energy & Environment

Genomics
Bioinformatics
Proteomics

Biosensors
Biochips

Bioelectronics
Microfluidics
Nanobiotechnology
Drug Delivery

Nanodevices
Nanosensors
Nanoelectronics

Transfer of tacit knowledge

Transfer of tacit knowledge

UNIVERSITY OF CAMBRIDGE
Institute of Continuing Education

CAMBRIDGE
Judge Business School
Centre for Entrepreneurial Learning
Addenbrookes Biomedical Campus – Strategic Focus

5 Propositions for World Leading Research and Practice

- Personalised Medicine
- Biologics
- Diagnostics & Devices/Equipment
- Regenerative Medicine
- Connected Health
Revolution in Communication and Learning 1991!

The World Wide Web and the Digital Revolution – the greatest ever enablers of communication. And the revolution goes on. Impact in Healthcare ++++
Of course, the trend is affecting high tech fields too

International community of leading spine surgeons
“SpineConnect is the leading collaborative knowledge network for spine surgeons to collaborate on difficult and unusual cases.”
Every day, over 750 spine surgeons from around the world:
- Develop novel approaches to treatment,
- Address the top challenges in spine healthcare,
Information Delivered to the Cell Phone in Your Pocket – E-Health and M-Health – Telemedicine Regional Programmes
The Digital Health Revolution supporting the Patient Revolution Worldwide

And enabling instant transmission test data and feedback to the patient
Information Delivered to the Cell Phone in Your Pocket
And made available to ALL you want to share it with.
Patient empowerment and shared decision making

Simple View

More Sophisticated View

Telemedicine and Connected Devices
And then there is.... The Internet of Things. Also known as....

- Internet of Everything
- Internet of Anywhere
- Industrial Internet
- Machine to Machine
- Internet of Sensing*

*Sensors and Sensing in Diagnosis and Monitoring
Developing World Needs are Special

Remote locations and Vast Territories
Scarce and thinly spread Resources

Massive Opportunities for Diagnosis and Treatment enhancement

Blood born diseases and infectious diseases could be seriously impacted by remote diagnosis and care
China – Health Reforms and Progress in a nation of 1.35 billion citizens
One example of major Opportunity in the Developing World
China Healthcare Market Size

A powerhouse industry...

China has the world's largest online population, with
130 million residential broadband accounts
E-tailing produced more than
$190 billion in 2012 sales
China's e-tailing industry has posted compound annual growth since 2003
120%
More than 6 million e-merchants list products on Taobao
Singles Day 2012 generated $4 billion in online sales, surpassing Cyber Monday in the United States

...with huge growth potential...

China's broadband penetration is only 30%
Online sales could reach $650 billion by 2020
By 2020, e-tailing could potentially lift China's private consumption by an additional 4–7%
In Tier 4 cities, the average online shopper spends 27% of disposable income through e-tailing
E-tailing could boost labor productivity in China's retail sector by 14%

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MEDTECH INTERNATIONAL
Important Areas where Need for Improved Products will aid Diagnosis and Monitoring – including Remote connecting

- Diabetes Care
- Stroke
- Dementia
- Cardiac Care
- Wound Care and Monitoring
- Continuous Obstructive Lung Disease
- Oncology – Cancer Care
- Chemotherapy
- Ageing issues and Assistive Technology
- Regenerative Medicine
- Preventative Medicine

In the Developing World – Remote Diagnostics and Monitoring and dealing with parasitic and infectious diseases
Some Examples and Areas for Exploration

INNOVATION HEALTH AND WEALTH

ACCELERATING ADOPTION AND DIFFUSION IN THE NHS
Portable Point-of-Care Diagnostics

- Programmable Immunoassay Platform

Awarded stage one funding by East of England SBRI
Portable Multiplexed Platform Solution
- Programmable across multiple assays

- Multi-colour optical scattering & fluorescent detection
- Compatible with clinical flow cytometry processes
- On-the-fly digital processing: compensation; calibration; noise reduction
- Auto-calibration & optional network connectivity

Cell- & Bead-based ‘sandwich’ assay platform
- Integrates all sample preparation steps
- Uses finger-prick of whole blood/urine
- Uses commercially available reagents
Turn-Key Platform Solution

- **Detection Platform**
  - Sensor(s) & Filter(s)
  - Assay Design
  - Hardware & Digital Signal Processing
  - Embedded Real-Time Algorithms
  - Compensation, Calibration, Noise Reduction….

- **CD Microfluidics Platform**
  - Consumable Product Line… (in development)
  - Integrates all sample preparation
  - Bead-based ‘sandwich assay’ platform
    - Leverages 5 years CD development

Embedded Processing Algorithms

Cytometric sensor array + filters

Matchbox sized Configurable Platform

Replaces large Incumbent System
CD Platform Overview

• Proprietary Technology
  – Many of the micro-fluidic features already CE approved:
    • Mixing, Metering, Plasma Separation,
    • Aliquoting, Liquid Sequencing, QA
  – Final feature currently under development:
    • Flow Channel

Use Case #1: Cell count/viability/toxicity
1. Takes 5-100μL cell suspension
2. CD Integrates:
   • Sample metering
   • Mixing with vital stain & calibration beads
3. Flow channel for analyte detection
4. Readout of total cell/ml & % live/dead cells
   ≡ Integrated sealed waste reservoir

Use Case #2: PoC cell-, immuno-assay
1. Takes finger-prick of whole blood
2. CD Integrates Sample Prep functions:
   • Sample metering & Plasma separation
   • Heterogeneous mixing (markers/beads)
   • Aliquoting & Liquid Sequencing
3. Flow channel for analyte detection
   ≡ Integrated sealed waste reservoir
What we aim to do

• To provide advanced intelligent monitoring of lung function to improve clinical care

• To build a global intelligent monitoring and clinical management business.

Non-invasive measurements

Intelligent output

Clinical Monitoring

Drug Testing

Therapeutics Dosing
FIRST PRODUCTS

1) Structured light projected on patient

2) Remote 3D digital imaging

3) Intelligent modelling

4) Categorised output to improve clinical decisions and analysis

3 min data collection

Real-time analysis

Clinical knowledge base

Clinical management algorithm
Ongoing Product Development

Neonatal system

Portable system
Typical data from PneumaScan™
Co-creation – Philips and Leeds General Infirmary
The Allura FD – solid-state flat panel dynamic detector in cardiac imaging

Prototype evaluation led to commercial system launch
Valuable, dynamic scanning and tracking

Excellent example of partnership through evaluation, prototyping and product development
Highlights:

- Highly consistent, truly circular pores on a non-deformable ceramic substrate
- Greater pore density than track etch filters
- High temperature tolerance

Smart Separations’ New Low Cost Filter Technology overcomes the limitations of existing microsieves
New low cost filter technology

Smart Separations has developed a novel ceramic microsieve filter which has many advantages over existing filter designs.

Although microsieves have been made experimentally for a decade or more, and have been used in research and niche applications, adoption into mainstream filtration has been slow. Smart Separations has overcome the limitations of existing microsieves and offers many additional advantages – including lower cost. The filter technology operates within the microfiltration range – 0.1μm to 20μm – with research ongoing to achieve pore sizes outside this range.
Where can companies access...?
Accessing NHS Opportunities and Resources

And there are many outstanding companies existing and emerging with great innovative ideas too!

“There are great people in the NHS with great ideas. Through a focus on outcomes, we are going to enable and encourage them to turn those innovative ideas into reality. This will result in better care and outcomes for patients.”

SECRETARY OF STATE FOR HEALTH, ANDREW LANSLEY
Health Enterprise East (HEE) and the NHS Innovation Hub Network

- HEE is one of a national network of Innovation Hubs
- Funded by the Department of Health, the NHS and own revenues
- Provide Intellectual Property Services to NHS Trusts in the East of England
- For the benefit of patient and the improvement of healthcare
- Based at Cambourn
MedTech Services Update
MedTech Services – what we do

Clinical Access
Focus Groups & Interviews
Observational Research

Need Translation
Technology Scouting
Concept Creation

Access to specialist advice, consultation, evaluation locations, clinical trial possibilities and “co-creation partners”
Improving Health in the East of England

- SBRI East is an East of England pilot in the health sector to help bring forward new technologies for health

- Supporting the achievement of regional health priorities

- Increasing the possibility of their adoption in the National Health Service (NHS)

- Funded and supported by Technology Strategy Board
Improving Health in the East of England

Management of Long Term Conditions Category
Applications funded for Phase 1 feasibility studies include:

- Hand held asthma detection device that enables earlier diagnosis
- Enhancement of existing remote monitoring telehealth system with better Decision Support
- Telephone response / connections in monitoring anti-coagulant therapy
- Real time healthcare monitoring and feedback system (wearable sensor)
- Hand held 3D wound imaging device
- Mobile – Computer – Patient – Hospital linking Project

An early example – see HEE website for latest info
Polyphotonix came this route

Contracts for funding product development

East of England Development Agency

NHS

Project Part-Financed by the European Union

East of England Development Agency
Having a Vision and aiming at Healthcare Across Borders and Barriers

Co-Creating and Connecting for Coherence
Thank You for Listening

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