



# Three Different Forms of Impact in Engineering

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## Case Studies from EEE

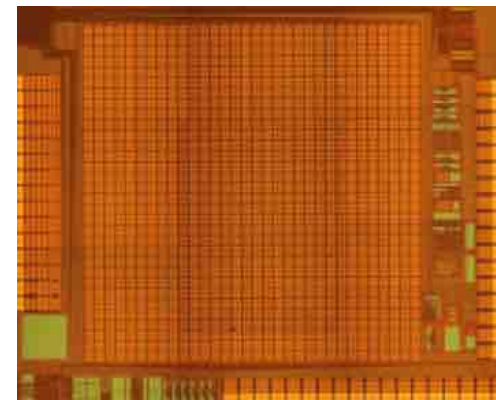
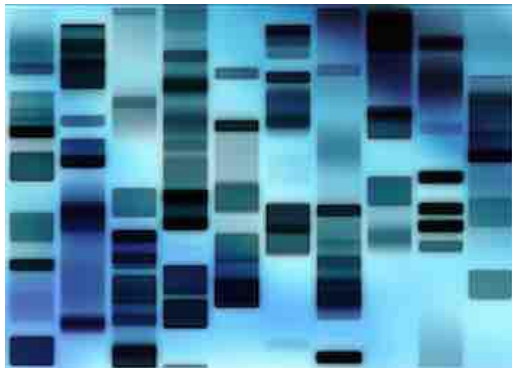
- **Case Study 1 – Low-power Electronic for Health**
  - Impact: **two start-ups**, industrial and health
- **Case Study 2 – Model Predictive Control**
  - Impact: **industrial practices**
- **Case Study 3 – Power Systems Research**
  - Impact: **policy, standards**, industrial practices, societal
- Case Study 4 – 3-D Silicon Structure
  - Impact: two start-ups companies, societal
- Case Study 5 – Reconfigurable Computing
  - Impact: industrial and financial practices, a start-up



## Case study 1 – Ultra-Low-Power Electronics for Healthcare Applications (Startup Companies)



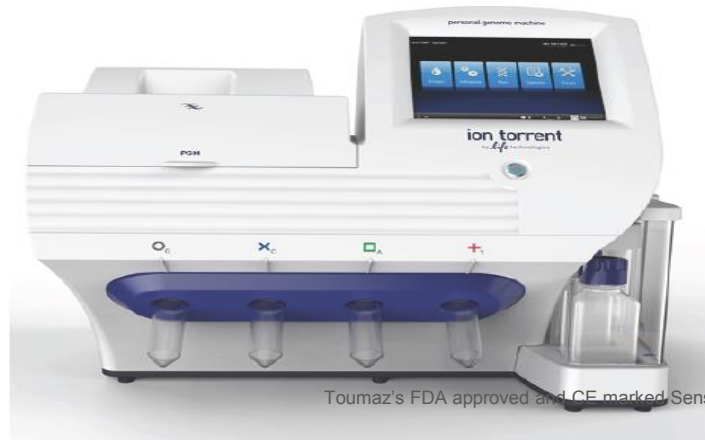
- Research led by **Prof Chris Toumazou FRS**
- Two separate pieces of research:
  - CMOS technology for DNA sequencing based on ISFET
  - Ultra-low power electronic techniques





## Case 1 – Impact

1. **Spinout** company no 1: **DNA Electronics**, licensing technologies to others and winning 6 industrial awards, 45 staff, £25m revenue
2. **Licensed** DNA sequencing **3 patents** to Life Technology (US) for their Personal Genome Machine, sold US\$100m products in first 18 months
3. **Save lives** using Genome Machines, 2 examples



Toumaz's FDA approved and CE marked SensiumVitals® digital plaster.

Life Technologies' Personal Genome Machine® (PGM™) – its core semiconductor sequencing technology is licensed from DNAe.



## Case 1 – Impact (con't)

4. **Spinout** company no 2: **Toumaz Group**, publicly listed value: £52m, revenue £22.3m, 150 staff, won an award
5. Release **SensiumVital® product**, 250,000 sold to a UK company



Toumaz's FDA approved and CE marked SensiumVitals® digital plaster.



Toumaz SensiumVitals® digital plaster in trials at Saint John's Health Centre (Santa Monica, CA) – [http://www.youtube.com/watch?v=uVxO4xh\\_dDs](http://www.youtube.com/watch?v=uVxO4xh_dDs)



## Case 1 – Evidence

- 10 publicly available articles, e.g. Fundamental patents, Forbes, Wall Street Journal, Press Releases

### 5. Sources to corroborate the impact

- E1) “Powering Preventative Medicine”, Ken Davies, 27 Sept 2011, Bio IT World. <http://www.bio-itworld.com/issues/2011/sept-oct/powering-preventative-medicine.html> or <https://www.imperial.ac.uk/ref/webarchive/8hf> (archived on 26/4/13)
- E2) “DNA Electronics Licenses IP to Ion Torrent”, GenomeWeb Daily News, 3 August 2010. <http://www.genomeweb.com/sequencing/dna-electronics-licenses-ip-ion-torrent>. Archived [here](#) on 23/10/2013.

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- E7) “Gene Probe Yields E. coli Clue”, Gautam Naik and Laura Stevens, 9 June 2011, The Wall Street Journal. <http://online.wsj.com/article/SB10001424052702304778304576373650243960700.html> or <https://www.imperial.ac.uk/ref/webarchive/h8f> (archived on 18/11/13).



## Case 2 – Efficient and Economical Plant Management via Model Predictive Control (Changing industrial practices)



- Research led by **Prof David Mayne FRS**
- Fundamental research on control of non-linear systems in late 90's and early 2000
- Mayne, when asked, said his research has **NO** non-academic impact

The feedback optimal control problem is  $\mathcal{P}_N^{\text{fb}}(x): V_N^0(x) = \min\{V_N(x, \pi) \mid \pi \in \Pi_N(x)\}$ .

The solution, if it exists, is  $\pi^0(x) = \{u^0(0; x), \kappa_1^0(\cdot; x), \dots, \kappa_{N-1}^0(\cdot; x)\}$

- Difficulty: Mayne is **NOT** the only researcher in this field – evidence of him being a pioneer
- Show how his research and publications allowed theory being translated into industrial applications



## Case 2 – Impact

- Design of industrial plants by **Honeywell** and **ABB**, **testimonials** from senior management from these two companies, explicit attributing impact to David Mayne
- Citing 5 examples impacted by **Model Predictive Control**

Ethylene production in  
Germany



Basell's ethylene complex in Wesseling, Germany

- Economic benefits: ... millions of dollar from increased production annually
- Improved quality control – 52% reduction in standard deviation of parameters
- Improved reliability – uptime reaching 90%





## Case 2 – Evidence

- Established Mayne among the very top contributors to the field through **prizes he won**

### 5. Sources to corroborate the impact

- E1. Letter, Corporate Fellow, Honeywell Automation and Control Solutions, Minneapolis, USA, **stating the impact of Mayne’s work in nonlinear MPC on their process control business.**
- E2. “Basell Optimize Ethylene Plant with Honeywell MPC and RTO”, [https://www.honeywellprocess.com/library/marketing/case-studies/SuccessStory\\_Basell-Wesseling.pdf](https://www.honeywellprocess.com/library/marketing/case-studies/SuccessStory_Basell-Wesseling.pdf). Archived [here](#) on 23/10/2013.

Explicit statement on Mayne’s contributions

“.... *Professor Mayne has introduced several significant advances in the area, especially in the extension of MPC to nonlinear systems.*” They also stated that Professor Mayne’s contributions in nonlinear MPC “... *has had the greatest impact on (our) industrial practice.*”



## Case 3 – Design & optimisation methods for power networks impacting industrial strategies & government policies



- Research led by **Prof Goran Strbac** and **Prof Tim Green**
- Research in economic modeling of alternative power generation and in high-voltage power electronics
- Combining TWO aspects of research linked by a common theme
- Employed skills in writing patent claims to structure the impacts – particularly useful in this case



## Case 3 – Impact

1. **Influence government policies** by contributing to House of Common Select Committee (2010);
2. **Support the Fundamental Review of Supply Quality and Security Standards;**
3. **Assist National Grid in defining new investment** affecting £3bn worth of network assets now approved by the regulator (2013);
4. **Provide tools** to develop the first offshore **networks design standards** in 2008, saving an estimated £500m by 2013 to date and a projected overall saving of £1-2bn by 2020;
5. **Advance Alstom’s design concept** for next generation HVDC converter stations for offshore wind connection from TRL 1 in 2009 to TRL 4 in 2013 supported by 3 new patents;
6. **Enable UK Power Network to plan network investment** of £1.18bn and make savings of £130m (2013) through applying new technologies and demand response;
7. Facilitate a scheme for **off-grid energy kiosks** for electrification in rural Africa yielding social gains and a business opportunity.



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House of Commons  
Energy and Climate Change  
Committee

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### The future of Britain's electricity networks

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Second Report of Session 2009–10

*Volume I*

### National Electricity Transmission System Security and Quality of Supply Standard

Version 2.2

March 5<sup>th</sup>, 2012



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## Case 3 – Evidence

E1 House of Commons Energy and Climate Change Committee, “The Future of Britain’s Electricity Networks”, Second Report of Session 2009-10, quotations from paragraph 56 on page 24 that leads to recommendation at paragraph 59 (repeated as recommendation 9 on page 64) plus additional remarks on Strbac’s evidence in paragraphs 20, 53, 67, 77, 109, 126 and 140. Archived [here](http://www.publications.parliament.uk/pa/cm200910/cmselect/cmenergy/194/19402.htm) on 23/10/2013.  
<http://www.publications.parliament.uk/pa/cm200910/cmselect/cmenergy/194/19402.htm>

11) **Influence Government Policies** [E1]: The research in [R1] and the results in [R2] form the basis of evidence supplied by Strbac to the House of Common’s Energy and Climate Change Committee. This was included in their report to Parliament entitled “The future of Britain’s electricity networks” (10<sup>th</sup> Feb 2010) [E1]. **In this report Strbac or his evidence were referenced 38 times.** One section extracted from the report states [E1]:

“... Strbac argued that the (existing) SQSS (Supply Quality and Security Standards)



## My Strategy in Impact Preparation

1. To have good impact cases, you need **good materials**
2. **Read the RULES** – answer the examination question
3. Case Study **author** was **NOT** Impact **Provider**
4. **Impact author** – use academics, not professional writers
5. Know the difference between **claim** and **evidence**
6. Evidences are as direct and quantitative as possible – **numbers are more powerful than words**
7. **Do it once** – do it well!