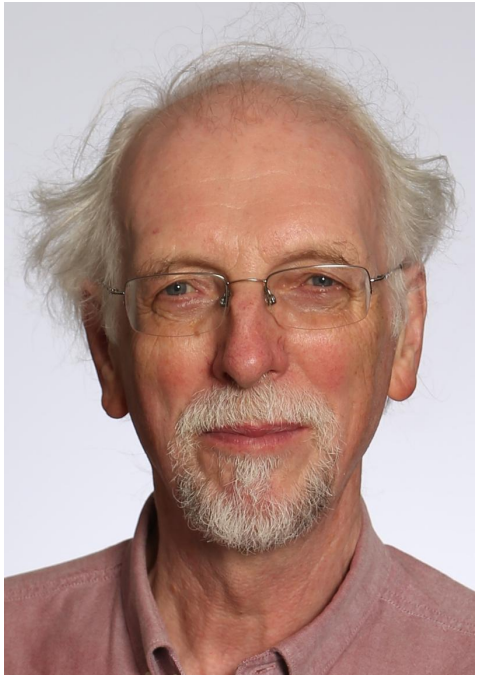

From Research to Product

... The Life-Cycle of the Product

Talk at ...

UK Design Forum

National Computer Museum - 21mar24

Prof. Ian Phillips CEng, FIET, FIMA, SMIEEE

Retired 2017 ...

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R&D: The route from Research to Product?

There is a lot of talk about ...

- The failure of Industry (in the UK) to exploit Science
- And Scientists that fail to address issues important to Industry

  ... The political pressure behind this is Productivity (actually Economic Productivity or Tax)
- UK Gov spent £14.0 billion on research in 2021 (Ex EU funding)

  ... It doesn't see an adequate (tax) ROI from its Industrial exploitation
- Failure of Expectation; potentially leads to lost opportunities, constrained budgets, delayed and inferior products

Just applying more 'Exploitation Pressure' doesn't solve it! ... Why Not?

Understanding the roles & needs in the life-cycle might! ... For all parties involved!

- Recognising Roles and their Linkages are critical, in a **Product life-cycle chain**
- Understanding that all Roles are ultimately fed by **Product-Revenue**
- And Political needs are ultimately satisfied by **Tax-Revenue** *(Economic Productivity)*

"Scientists investigate that which already is ...

... engineers create that which has never been." *- Albert Einstein*

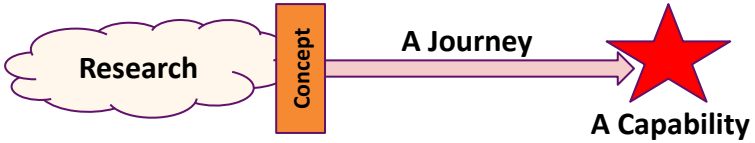
Scientists *Investigate* reality, to find properties of matter that are manipulable, quantifiable reproducible and potentially useful ... and to demonstrate these at reasonable scale.

Engineers *Deliver* using **Available Technologies** (Science, Methods and Tools) to **create specific solutions** for commercial exploitation in valuable market opportunities.

Businesses *Exploit Science for Money*

- Convert Technologies into Products and sell them to Customers.
  - *Products may be components, sub-systems or systems ... depending on the Business.*
- Gamble on Engineers ability to predict the future!
- Investors do not like risk!! So Engineers are constrained to use technologies with high-degree of confidence in their ability to deliver.
- Create the Employment and Revenue, resulting in Tax-Income for the Chancellor.

1: The Pathway to Capability ...

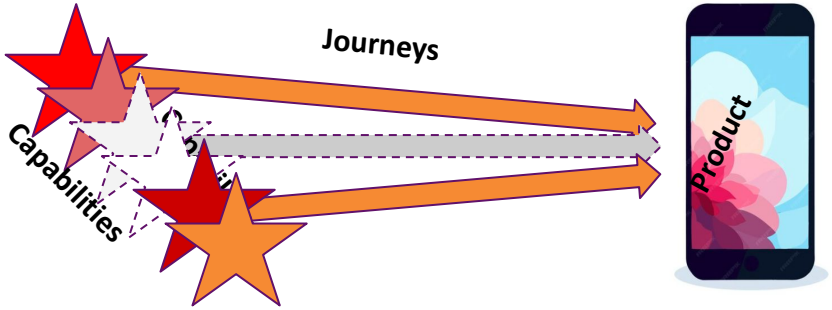


- The **Research-Scientist** needs to demonstrate the reliable; Prediction, Creation, Reproducibility of his/her discovery. To imagine the type of businesses that might benefit from this knowledge & knowhow. And to target an appropriate (Research) Engineer ...
- The targeted **Research-Engineer** has to be able to see how the Technology could could significantly enhance a Future Product in his/her business. And ballpark, how long and how much to get it to an installed **Capability** (Available Technology) (TRL8+) in that business. Maybe prototyping some basic tools to quantify this.
- A **Development-Engineer & Marketer** has to seek approval of the Time and Money from his/her business to invest in moving the **Concept to Capability** ... Including supporting tool design, acquisitions and training, and sourcing materials ... Then do the work!

... When it's a Capability it is ready to be exploited IN a future Product Development.

2: The Pathway to Product ...

- A **Science** is not a Product. It may be incorporated into a Product, or its life-cycle, but is never (significantly) exploitable as it is.
- A **Product** is made to address a Market Opportunity. Making a product is expensive and needs Investors who believe that the resultant Product will meet its projections. Investors are not charities.
- **Business** need to apply **multiple Capabilities** to create **Products**
  - *Many of these are entry barriers to competitors.*
  - *Many are simple, a few are complex all are necessary.*



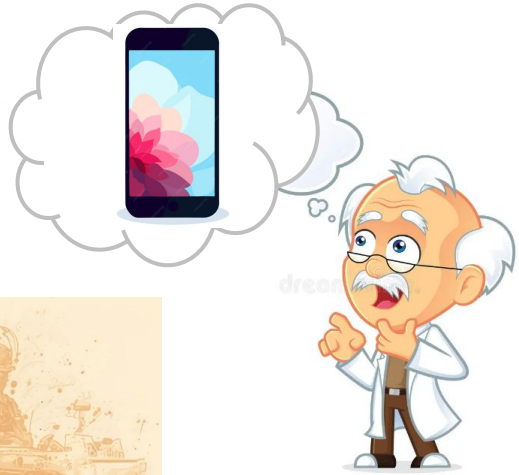
- **Investors** have finite money, so will always choose what they think is the safest bet. More ROI for longer time (Net Present Value). Some will play long, others short ... All will evaluate ***their own*** risk/return ... None of them are charities.

... Business is all about making money for Investors

Differences that need to be understood ...

Between a **Academic Research** and a **Industrial Research** ...

- **Academic Research** investigates and quantifies fundamental concepts (All sorts of things).



- **Industrial Research** investigates and quantifies Research Outcomes from various Sources, to assess their suitability and potential ROI against specific needs of a specific Corporate Product or Strategy.

- **Engineers** deliver and maintain the commercially viable product

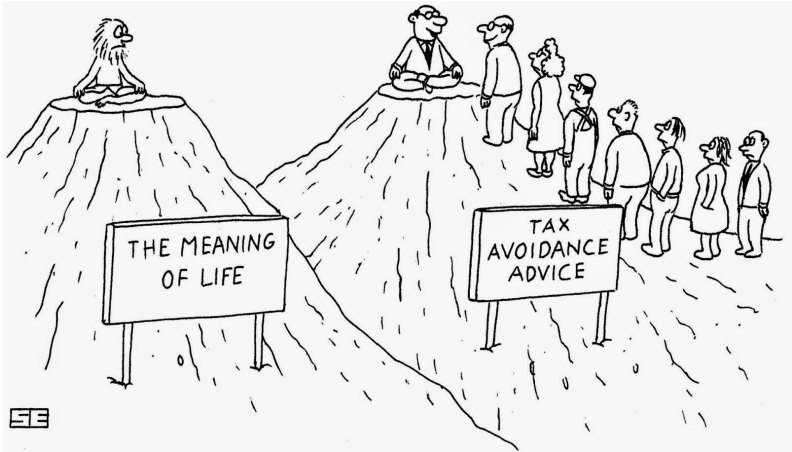
*Businesses **can't** do whatever they want ...*

- **Businesses** are constrained by their markets ...
  - ***Their Historic Product*** *- New things must be reasonably aligned with what they already do!*
  - ***Their Investor's strategy*** *- Usually expect 'more of the same' financial performance*
    ... Very few invest for altruistic benefits.
  - ***Company Law*** *- Directors are Bound to look after their investors money (No unnecessary risk)*
  - ***Their Product Priorities*** *- They usually have a long-list of possible products in the queue*
  - ***Their available resources and skill-sets*** *- which limits what they need to acquire*
  - ***The Risky Product Developments*** *already in place (Subjective)*

  ... Society's needs are not on this list!

- ... **also** constrained by Governments ...
  - *Through Regulation & Taxes -*
    Though Businesses to avoid them as much as possible, in the interest of their Investors

    ... Societal Needs are only achieved through Taxation & Regulation!



Building Bridges ...

The Gap between **Social** and **Scientific** Knowledge ...

- Our Leaders and Influencers are chosen from the pool of **ordinary** people.
  Their educational background and experience is predominantly of a **Social nature**

The Real-Economy[1] is based on Engineering Businesses[2]: Creating, Replicating and Selling ...

1: The rest of it is some form of Gambling or Pocket-Manipulation

2: Including the support of these

... Our 'leaders' understanding of a huge part of our Economy is limited or poor!

Hardly surprising that they consider ...

- All manufacturing/factories are interchangeable
  - *Eg: Munitions and Planes during WWII ⇒ PPE and Ventilators in Covid*
- All background development is done, so we should be able to exploit Science immediately
- That businesses are looking for something new to do, and can switch to it immediately
- That Businesses and Society await **words of wisdom** from our Leaders!

... Hence the nature of Research, Development and Exploitation is misunderstood

***Thinking big**: Orders of Magnitude ...*

To succeed in taking Research into Product, the case for its progress has to be fought against its competitors at every stage-gate. There is no guarantee of its success, but a substantive improvement in performance over the status-quo is the best way to keep it amongst the top of the list of business' alternatives. But how big is 'substantive' ...

If it takes ~4yrs to pass down this pipeline, and if 'normal' evolutionary growth in performance is 50%pa. Then it will have naturally improved by 5x in that time!

- So no point taking Research to a potential Commercial Exploiter unless it offers more than 1 Order of Magnitude (10x) improvement against the status-quo today.
  - *The Product of Cost, TTM, Speed and Power improvements*
  - *Also 10x promise at Research; is much reduced by Product*
- So don't start **New Research** that doesn't have the potential for >1 OoM!

  ... This is another form of Net Present Value (NPV)

Conclusions ...

- **Scientists play a vital role in the Life-Cycle of new Products**
- **Science** may enable a Product to be more competitive;
  ... but it is never a Product in its own right.
- **A Product** (both Tangible and Intangible) is the outcome of the Successful Deployment of many Capabilities resident in the Business producing it. It is a money making vehicle.
- **Our Leaders** (Politicians, Financiers and Media) do not understand Science or Engineering Businesses; yet we all look to them for guidance and support ...
  - *We must do more adult public education*
    - Make the processes of Science and Engineering more understood and more fun
  - *We must do more explanation*
    - Explaining what we are trying to do in 'human' terms to anybody who will listen.
- **Anything less than 1 OoM at research level** will not survive the long-path from Research to Exploitation

Thanks for Listening