Computing: Paradigm shifts, adoption, new digital professionals rising
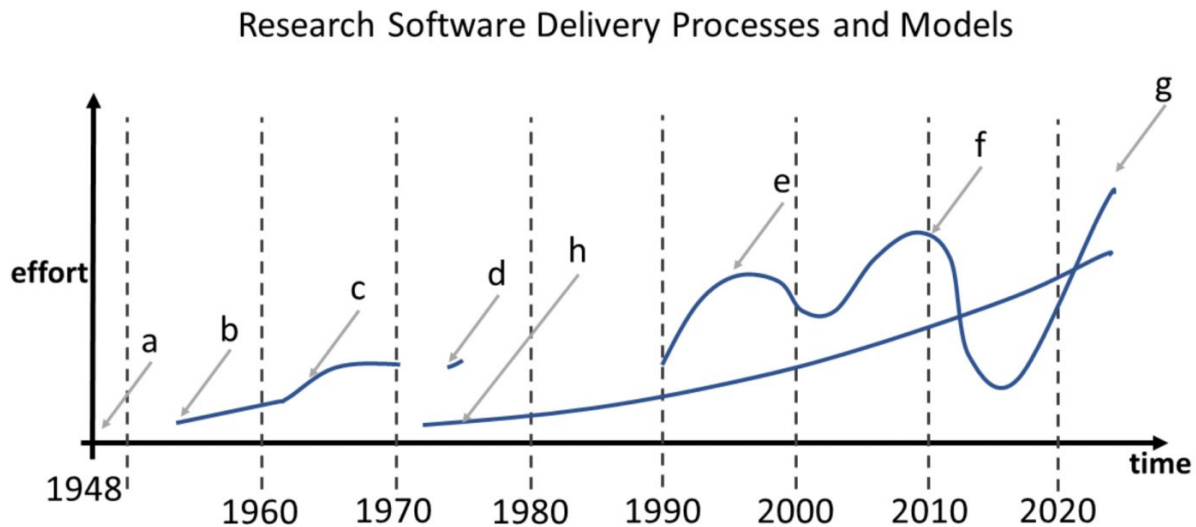
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Figure 1: Loosely based on the Abernathy-Utterback representation of the innovation pipeline of research software delivery models. Each curve is a model taken from experience and anecdotal evidence. Key: a,) The first stored memory computer is created b,) Grace Hopper and others develop programming languages and numerical methods c,) Teams of mathematicians develop research software, e.g., Dorothy Vaughan see Disney's film Hidden Figures d,) Open source repository of numerical methods on punch cards collected from academic researchers by Rutherford Appleton Labs as a funding requirement e,) JISC funds research software development in faculty and IT services at universities where funding is along computing expertise, e.g., HPC, visualisation f,) eScience is funding initially to natural and then to social science for centralised teams funding is along research council remit g,) centralised generalised RSE teams are promoted over other models funded by Universities, RSE identified as technicians and more women join the profession h,) slow steady adoption of RSE in national research facilities.

Dr Joanna Leng, School of Computing, University of Leeds, UK and Dr Phillip Brooker, School of Sociology, University of Liverpool, Emeritus and Prof Wes Sharrock, School of Sociology, University of Manchester, focus on computing: paradigm shifts, charting the adoption and the rise of new digital professions

The historical lineage of research software delivery models is visualised in Fig 1, showing that research software delivery in universities is now cyclic, breaking approximately every ten years.

In recent cycles, the research software delivery model in universities has been systematically centralised and administratively unified, making the model similar to Hick's model of pre-1960s computing labour where programming was gendered towards women as sub-clerical support work, as opposed to being foundational to academic teaching and research practice.

From 1970-2000, research software development became a major aspect of professional academic research, allowing new computer science themes to emerge and increasingly being gendered in favour of men.

Paradigm shifts

A paradigm shift identifies a period in which two rival ways of working compete for control over a whole scientific area. While computers and their related technologies are physical things, our ideas on how we use and develop computing are social constructs, which, in principle, can fluctuate and change over time.

Sociological indicators of the need for a paradigm shift are 1) a disagreement hotspot (negative or unexpected results needing explanation) and 2) the development of new meanings and terminology. During adoption, a variety of possible new paradigms are presented until one is selected and becomes the new established paradigm. The transition is not an individual's decision but is created through the process of agreeing as a consensus within the community or society. Normally, older community members who have benefited from the previous paradigm will advocate for that, while the younger members will advocate for change.

The adoption of digital professions and a digital age

Imagine a paradigm shift as a standing wave, a wave of energy, and how it is absorbed at the shore is its adoption. The adoption of computers by the sciences has been long, 70 years so far, and in the analogy, it is like a flat beach with an occasional storm. AI experts warn us of a coming tsunami.

Those who support the old or new paradigm put forward arguments for their preferences. They often employ sociological tools where one group try to force people into their preferred paradigm. These include forcing, political or educational tools. The desire to implement that paradigm may prematurely foreclose the investigation of alternate possible paradigms. When applied to an emerging paradigm, their intentions are for good causes, commonly to maintain status or jobs or to promote something "good", but there are Those who support the old or new paradigm put forward arguments for their preferences. They often employ sociological tools where one group try to force people into their preferred paradigm. These include

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Forcing tools are bad, especially in early innovation, as they remove flexibility; in the analogy above, they are like a pier that gets in the way of the adoption wave. Controlling the key indicators of a paradigm shift by controlling the debate, developing new terminology, and not publishing negative outcomes does not stop the paradigm shift and cause harm in the long term. Outsiders are prone to misunderstandings and, if parachuted in at a management level, can cause problems, including introducing forcing tools poorly suited to the context.

New digital professions

The old established professions have existed for hundreds of years, creating a natural link between them and academic disciplines. A profession regulates its members; see my article on the development of the RSE profession.

The adoption process includes the creation of new tasks, which, if time- consuming, become new job roles or occupations. Not all these occupations will last or need regulation. Disciplinary-specific software engineering is a computational sub- discipline, so new professions must be generic and sit outside software engineering and traditional disciplines. The current drive to recognise new digital professions comes from outsider communities, those outside the decision-making processes in existing professional bodies or academia. It indicates the need for a paradigm shift or new model.

Colloquially, "professional" means status. The desire for those wanting a new profession is status. Still, it also allows comparison of occupations, which is important for social order and necessary to allow acceptance and adoption at a societal level.

RSE

UKRI, the main UK funding body, recently classified RSEs as technicians. This new social order lowers the RSE status and segregates them into centralised teams, but it is actually a pre-1960s social order. Are older members of the community driving this change? Also, the RSE campaign promoted centralisation, adopting an old system previously used by national research facilities into universities, and ignored the diversity of the RSE role.

UKRI do not prefer any research software delivery model and funding is open to all.

Indicators of the need for a paradigm shift or new model that are obscured:

- Fixing on the term RSE obscures changes in computing technology, the RSE role and the ideology of those who advertise job roles.

- No negative outcomes for RSE are published, a recognised bias of case studies and reporting of funding.
- The lack of representation of RSE in academic decision-making means no objections can be raised or recorded.

Indicators this is backfiring:

- The strong negative reaction of RSEs wanting higher professional status is creating unrest.
- Universities have more complex research environments and different funding models to national research facilities. The central RSE team will not scale and did not scale in the pre-1960 model; the team would need to be enormous and multi-faceted beyond the capacity of the current model/funds to fit the needs of a university. The model needs refinement and new models added which recognise the status of RSEs as research active.
- The UK Government has prioritised tech for its future economy. The centralised RSE teams are adapted to software engineering and are not suited to early innovation. Where is the difference to the commercial sector? Where will the new computer science and academic research themes come from?

References are available on request

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