Engineering the Polymath Innovation in Systems and Services Education[♦]

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High value service industries represent an increasingly important segment in most Western economies. Many of these are enabled by complex information systems whose specification, design and management are intimately entangled with the supported service. While these systems become more ambitious in scope and complex in function, our education systems are not keeping pace. It is not unreasonable to consider the failure to develop 'human capital' will be a limiting factor of economic growth. This short position paper was prepared for a National Academies of Sciences workshop on Education, held in Washington DC, USA on April 18th 2006.

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Innovation in Systems and Services Education[1]

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> "We are like dwarfs sitting on the shoulders of giants. We see more than they do, indeed even farther; but not because our sight is better than theirs or because we are taller than they. Our sight is enhanced because they raise us up and increase our stature by their enormous height"
>
> Bernard of Chartres, 1130 AD

'Service industries' have become a dominant factor in the success or otherwise of modern economies. An ability to specify, engineer and deliver the complex systems that make up these services is increasingly seen as a strategic advantage - both between and within economies. In such an environment, innovation is perceived to be key to the development and maintenance of a competitive advantage. The question we have to address is 'innovate what?'

A number of academic and industrial researchers have suggested that services represent some 'new type of science'. We reject that position. Services are complicated interacting systems, there is no new type of science. What is new is bringing organised science to the problems associated with services. The view of 'system as service' comes from decisions that are made about where boundaries of responsibility and visibility are drawn within these complex systems. Treated as systems, services are amenable to many of the 'traditional' approaches to analysis and control that have been developed in disciplines as diverse as psychology, control engineering and operations research. This is not to trivialise the many problems of specifying, engineering and managing large groups of complex interacting sub-systems, but by recognising them as such, we can begin to discuss these challenges within established scientific and engineering frameworks.

What makes these 'systems' so difficult to work with? We would suggest a number of interacting factors

- an explosion in the number of complicated systems that are being constructed and managed across all modern economies;

- a demand for dynamic coupling of these many systems (for example social welfare, taxation, and healthcare management within the United Kingdom);

- increased integration of subsystems with very different properties and priorities (politically driven social policy with information systems structure for example);

With fewer such systems we might survive by relying on the (relatively few) natural polymaths that emerge from our educational systems – people who combine cultural sensitivity with an ability to abstract and analyse and then manage. Our education systems, both in Europe and the United States simply don't generate enough of these individuals. Worse still, an increasing tendency to specialise as a reaction to

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greater complexity, combined with a steady decline in many of the 'hard' technical skills makes it unlikely that without significant changes we will see fewer such individuals emerge.

Our challenge must be to encourage the development of demand, supported by curricula that pull students with the appropriate mathematical and communications skills through high school, and then equip them with both the social and technical skills necessary to become effective systems engineers and managers. This is not a job for industry or universities alone. To be consistent with the systems approach we advocate, it is necessary to innovate across the complete education lifecycle – without an integrated partnership between government, industry and the education and research communities our services will continue to disappoint.