**The Foundation for Science and Technology**
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# How does science and engineering support the defence of the UK and does defence procurement support the wider economy?

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The previous speaker, Alison Wood, made the point that these two questions have to be considered together and this fits neatly with my main point that any society and its military are inter-twined, they depend on each other. At a minimum the society depends on the military for its security and the military depends on society to finance it, to pay its bills. At the moment the bill is quite small, about 2.5% of national output, but during the world wars the military took over half of national output. The output society can produce depends on the scientific and engineering skills of the society. However, the links between the military and society are wider. These links may be stronger or looser but they are always there; and this is true for science and engineering as it is for anything else.

One example of the links is that the military has to recruit from society and to a certain extent the military can try to remedy the deficiencies of its recruits, as the army still has to do with the lack of basic literacy of many British recruits. Trying to ensure soldiers are literate is something that the army has long done; trying to ensure that they have the advanced engineering skills the military need is more difficult. The army like other large employers of Engineers, like BAE Systems, does its best, but it is hard work. Another example of the links is the Global Positioning System, GPS. This is a military system that has very wide civil applications. It was also a technology that was crucial to the military in the first Gulf War. Armies have always had difficulty navigating in deserts and Desert Storm could not have been fought in the way it was without GPS. But before that campaign most military vehicles were not fitted with GPS, but they could be fitted for the war because there was a large commercial industry producing GPS sets. The links go both ways.

What plays a central role in the link is the gap: the similarities and differences, between the science, technology and engineering used by the military and that used by the rest of society. The size of that gap varies. During World War II it was quite small, furniture factories could be converted to producing Mosquito aircraft, made of wood and fabric. After WWII the gap widened, military equipment became increasingly specialised and different. Then the gap narrowed again as civilian technology overtook military technology. You knew the reverse flow was important when the military had an acronym for it, COTS: commercial off the shelf. Even really arcane technologies that had once been the sole preserve of the military and the spooks, like cryptography, became dominated by civilian research because of their commercial importance particularly in finance. Whereas the defence industry would have designed and built specialised electronic components and software for the military, increasingly the military rely on standard commercial suppliers, though this has caused various problems. One of the problems is with time-scales. The life-cycle of commercial electronics is about 18 months. The average military procurement

cycle is about 7 years. This means when the military system goes into service not only is the electronics obsolete, it may not even be in production. The US Department of Defense has a fabrication plant for producing old chips which are no longer on the market but continue to be used in military systems. Both the gap between military and commercial technology and the timescales have implications for rapid mobilisation and the provision of urgent operational requirements, UORs, for equipment that is needed in Iraq or Afghanistan now. Whereas normal procurement cycles are measured in years, UORs are measured in months, so need to draw on what is available. While the military system is good at producing equipment under UORs fast, unlike their normal procurement cycle, there are difficulties that the equipment produced may not be compatible require special logistics arrangments etc.

Although it does some training of its own, the military draw on the, unfortunately rather limited, scientific, engineering and mathematical skills of the general British population. For Society as a whole globalisation comes to the rescue, we can rely on what is produced by the engineers trained in India and China, unfortunately the military are also more constrained in the general solution, to hire from abroad, by the need for security clearance.

There are a range of things that the military originally did for themselves but then became central to wider society: mapping (the term ordnance survey reflects its military origin), meteorology, air traffic control, internet and GPS. Often, when they become of more civilian than military importance, they are spun off from the military like mapping and meteorology have been.

There is a large scientific and engineering component to other things that the military do for the wider society, Search and Rescue, Coastguard, protection of oil rigs, aid to the civil power in times of pandemic, including maintaining bio-security, providing support during natural disasters like floods, or where there is large scale disruption associated with public order problems or terrorism, or in a previous generation planning to run the country after a nuclear war. To fulfil these functions the military need the skills to interact with the wider society and have a broad spectrum of capabilities. It is useful to have the military provide these functions, but societies without armed forces like Iceland and Costa Rica provide these services in other ways than the military. The military often leave the armed forces at a comparatively young age and have careers later in civil society and they take their skills with them. There are examples like management education and logistics where commercial firms have learned from the military.

The extent of the spin-off of technology from the military to the rest of society is controversial with strong positions on both sides. In a recent book *Is War Necessary for Economic Growth? Military Procurement and Technology Development,* OUP 2006, the author, an expert of innovation, Vernon W. Ruttan, concludes that it is. It is certainly true that lots of crucial technologies have military origins, though it is less clear whether it was their military or their wartime origin that was important. But when military spending took such a large part of national resources as during the World Wars, and subsequently took such a large part of national R&D, this is not surpising. It is quite possible that if those resources had been spent on civil R&D without the secrecy restrictions and diversion of scarce scientific and technical skills to the military, there would have been more innovations.

The military origins of many technologies is not necessarily an argument for support of military R&D. The US Defense technology organisation, DARPA produced the internet. But CERN produced the world wide web, and that is rarely given as a reason to support particle physics. If you want to promote technology there are better and less expensive ways to do it than relying relying on the military to spin it off.

In addition it is very difficult for governments to target innovation effectively. Consider the growth of India as a major software producer. Partly this was the result of an education system that produced very good software engineers, but many say that it was partly the result of the fact that the Indian Government did not treat software as a serious industry. As a result the industry benefited by not having the extensive government support that for long doomed many other Indian industries, particularly in manufacturing.

Because the military is intertwined in society it does have effects on the economy. It does create employment and those jobs can be crucial, particularly if they are in a marginal parliamentary constituency, but if you want to influence employment there are many more effective ways of doing it than spending on the military. Arms exports do have effects on the balance of payments, but their net effect on the economy is controversial and a detailed study conducted jointly by Ministry of Defence and academic economists came to a typical economist's conclusion: it depends.

The scientific and engineering links between the military and society are crucial and they work both ways, but they are complicated and not something that you can control. Buying weapons is difficult enough even if all you care about is getting the best value for money in providing military capability. The National Audit Office regularly documents the problems in doing this. If you complicate it further by trying to fine tune the technological spin-offs, there is a danger that you will incapacitate the decision makers by complexity of their objectives, resulting in even worse procurement decisions.