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SCIENCE AND WAR

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Since its earliest days, science has been associated with war. The inventors Archimedes and Leonardo turned their talents to the problems of fighting, and since the rise of modern science many individual scientists have steered their investigations towards military purposes. But the orientation of science to war was relatively sporadic until the rise of professionalised science under the auspices of the state beginning in the late 1800s. The process of incorporation of science into the war system was greatly accelerated by the two world wars this century, and especially since World War Two science has become an essential part of military races.

In this article I examine the connection between science and war in current circumstances. I focus on the importance of the large scale of military funding of science, the impact of this funding on the direction of technological change and on the assessment of important scientific problems, and the influence of war and the state system on the structure of the scientific community. With this background, the question of whether science is a servant or a part of the war system is addressed. Finally, I discuss the influence of military-related perspectives on the activities of antiwar scientists, and comment on what a truly antiwar science might look like.

Funding

A large fraction of funding for science is directly or indirectly for the purpose of war (1). It is often noted that somewhere between a quarter and a half of scientists and engineers worldwide are engaged on military projects. Because of the high fraction of war-oriented science funding, it is not surprising that many research areas and applications of science are oriented to war. In weather research, for example, military interests play a strong role because of the importance of weather conditions and predictions to military operations. There is also a strong interest in studying weather modification for military purposes. Social sciences are also brought into play. The most infamous example is Project Camelot, in which studies of the potential for internal war in Latin America were undertaken for United States military and political interests (2).

Whole fields of scientific research can arise due to military influences. Operations research, the mathematical analysis of situations to determine optimal courses of action, grew out of the study of military problems by scientists during World War Two.

Directions

War influences not only specific scientific projects but also the whole direction of technological innovation. This in turn influences the ongoing

focus of scientific research, which is at all times influenced by current technologies.

Actual or potential technological development has provided a spur for the development of scientific theory throughout the history of science. In the first several centuries of modern science, technology usually preceded scientific explanation: for example, the invention of combustion engines preceded, and stimulated, the development of thermodynamics. Since the mid 1800s science and technology -- and, more generally, theory and application -- have become more and more symbiotic.

Nuclear power is a prime example of this interaction. The massive expansion of interest in nuclear science during World War Two was of course due to the interest in making a devastating weapon. Nuclear power was in many ways a spinoff from nuclear weapons programmes, depending on physical facilities such as uranium enrichment built for making weapons grade uranium, on the scientific and engineering skills gained through weapons research and development, and on the political advantage in the early 1950s in associating nuclear technology with peaceful purposes. Once nuclear power projects were launched by several governments, they provided a strong force for expanding training and research in nuclear science and engineering. As nuclear power facilities and training in nuclear science and engineering become more widespread, so does the capability of governments to make nuclear weapons.

Another area of technological innovation strongly influenced by military imperatives is computing. In the 1940s and 1950s military interest in computers was primarily in number-crunching to solve problems such as building more efficient nuclear weapons and designing nuclear-war fighting strategies. The emphasis then was on large mainframe computers. In the 1970s and 1980s military interest in number-crunching has remained, but added to this is interest in microprocessors for 'smart weapons' and the like. The development of computing facilities has strongly influenced the nature of scientific research, for example by changing the criteria for elegance and solvability.

Important Scientific Problems

Due to the high degree of military funding for science and the military influence on the direction of technological innovation, what are seen as important scientific problems -- even in the area of so-called 'pure' science -- can become oriented to military interests (3). Nuclear physics, genetic engineering and plasma physics owe part of their prestige to their potential role in war. More generally, the criterion for important science has become success in manipulating and controlling nature, rather than understanding nature and human inter-actions with it. Seeing the world as an object for manipulation is quite suited for the technical-rational mode of governance by bureaucratic elits which is at the core of the modern war system.

For example, in the case of weather research, it is highly prestigious to study complex multi-level global circulation models requiring sophisticated numerical analysis, data acquisition and computing facilities. Indeed, this type of research is virtually synonymous with doing 'scientific' research on weather. By comparison, to engage in local weather prediction by obtaining information from amateurs and relying on experience and understanding of local weather patterns is to engage in a low status activity.

It is no coincidence that global circulation models and similar research, for which generous funding is available, is of at least potential military use. By contrast, local weather prediction which relies on data input from amateurs and which helps local farmers, businesses and individuals is both poorly funded and less attractive to professional military planners because it is not fully under control of military and technical personnel.

The direction of social science research is also influenced by military funding and the prominence of military priorities in society. For example, game theory -- a mathematical framework for studying conflict situations -- has been widely used and adapted for modelling international conflict. This is partly because the conceptual framework of game theory, which assumes discrete 'players', arbitrary fixed choices and a conflict of interests, is congruent with a military model of the world (4). In psychology, the dominant behaviouralist paradigm which focuses on observable and measurable behaviour is admirably suited to the manipulation and control of humans which is essential for perpetuating the war system. As a result, there is much more scientific study of the factors contributing to solidarity of soldiers and of civilians in war than on the solidarity of movements for nonviolent social change.

Structure of the Scientific Community

The modern scientific community is a body of full-time professionals, most of whom work in a bureaucratic setting of university, corporation or government. A large fraction of research is carried out by teams of scientists. Much research is accompanied by secrecy, especially military research. A key feature of modern science is intense specialisation.

These features of modern science are not timeless. Indeed, they have only become routine in the past centry. Before this, scientific research was carried out by amateur, independent thinkers usually working individually. Generalists were much more common.

The professionalised, bureaucratised, government-funded, highly specialised nature of modern science is essentially an outcome of the restructuring of science to serve the modern state. Science has prospered financially by state funding, but has had to pay the price of adopting an organisational form similar to the state, namely bureaucracy, and the price of orienting its work to the interests of the state. Government funding and hierarchical organisation means that the results of scientific research are available to those at the top of the pyramid. A high degree of specialisation ensures that most scientists boring away at their corner of knowledge have little awareness of the wider implications of their work, and little capacity for combining with each other or with the general community to press for a redirection of research.

The bureaucratic organisation of science is supported by an explanatory ideology, which basically boils down to the idea that scientific knowledge is neutral, that a scientist's duty is to produce good research and that the use of science and technology is the responsibility of others, namely scientific or political elites. This ideology provides a justification for uncritically accepting the framework in which scientific research is done. Since one aspect of the framework is the war system -- structures of political and economic inequality, including the nation-state system and their component bureaucracies -- the ideology of value-free science enables scientists to serve the war system with a clear conscience.

Scientific research is an intensely masculine occupation, being dominated by men and by typically male values of emotional aloofness, competition and the aim of domination and manipulation of nature, including humans. Typically male values also notoriously prevail in armies and national security bureaucracies, where the traits of empathy, sharing, cooperation and nurturing are systematically suppressed or excluded. Given this similarity of values associated with patriarchy in science and the military, it is not surprising that science as a professional activity is so easily integrated into the bureaucratic organisational mode and so easily turned towards military purposes.

Is Science a Servant or a part of the War System?

Science is linked with the war system in several ways: by research funding, the direction of technological change, the criteria for important scientific problems and the structure of the scientific community. One way to look at this is as an orientation of science to serve the war system. In this view, science is a servant equally capable of serving other ends.

Another view is that science by its nature is more a part of the war system: by the nature of current scientific knowledge, by the nature of the practice of scientific research, and by the nature of the structure of the scientific community. Before considering which of these views is more useful, it is important to ask, what is the war system?

Modern war is organised violence carried out by military forces on behalf of governments which are the executive power of nation-states. The state is at the centre of war, and indeed Max Weber among others defines the state as a human community which controls a monopoly of legitimate violence within a territory. Military preparations and wars are used to enlarge or defend the systems of privilege and centralised power associated with states. The organisational form of states is bureaucratic: states are composed of a set of bureaucracies to regulate trade, transport, communications, foreign relations, welfare, education, law and much else. The military, the key component of the state for waging war, is a model bureaucracy. In Third World countries, state bureaucracies are often modelled on the military, which is seen as a driving force behind 'modernisation'.

What class or group of people is at the centre of the war system? It is those elites at the top and middle levels of the state bureaucracies, the military and associated corporations. These elites are drawn from what has been called the intellectual class, the New Class or the professional-managerial class. I prefer the term administrative class: the managers, administrators and experts who make decisions about the social, political and economic structures which shape the lives of the populace (5).

The war system then is a global system of unequal privilege and of centralised power which is structured around nation-states, defended by military forces, organised in the form of bureaucracy and staffed by members of the administrative class.

The war system is strengthened whenever these components are strengthened. For example, in major revolutions such as the French or Russian revolutions the old state is crushed and a new and more powerful state is created. Military forces are enlarged; typically such revolutions either result from wars or lead to them. State bureaucracies are greatly enlarged, and

many new jobs are provided for the administrative class (6).

According to this analysis, science is part of the war system rather than just a servant of it. In historical terms this should not be surprising, since the rise of modern science was part of the process of the breakdown of European feudalism and the rise of capitalism, of the nation-state and modern bureaucracy and of modern professional armies. The orientation of modern scientists to the requirements of the state is evident, especially during the two world wars. In World War One scientists clamoured to be able to devote their talents to war-making on behalf of the state in which they found themselves. In World War Two the scientific community was thoroughly mobilised to serve the state for military ends, and this led to the continuing close connection between science and the state in the following decades. The organisation of modern science into a professionalised, bureaucratic form can be seen as a shaping of science into the image of other state bureaucracies. Scientists are no longer independent of the state: they depend on it for funding, professional status, and scientific priorities. The bureaucratic organisation of science puts scientists and the results of scientific research at the beck and call of state elites, including the power elites of science, who are well known to inhabit the corridors of state power as well. The power elites of science are simply another part of the administrative class which has so often benefited from and promoted the war system (7).

Challenging Science in the War System

If science by its directions and organisational structure is part of the war system, then challenging the war system requires not just changing the application of science and the topics for scientific frameworks and its organisational and career structures. Before outlining what such a challenge implies, it is instructive to analyse the activities of antiwar scientists who do not question the nature of science.

To avoid misunderstanding, let me say that I do not wish to denigrate the motivations or goals of antiwar scientists. Undoubtedly, the scientists' movements against war have been based on admirable goals and high principles, and importantly the scientists involved have chosen action rather than acquiescence. But it is important to examine the assumptions underlying antiwar action in order to understand its strengths and weaknesses.

One basic approach taken by antiwar scientists is to appeal to governments and other elites to end their war-promoting activities. One need only read the Bulletin of the Atomic Scientists or most other journals of antiwar scientists to find many careful arguments against military policies of governments, many suggestions for what governments should do, and many appeals for national elites to restrain their war activities. But if the war system is essentially a state-based system of privilege and centralised power defended by military power, it is futile to expect logic and argument to convince elites that they should undermine the system in which they rose to status and power. This is rather like appealing to corporation executives to ignore profit and act 'in the public interest' by producing goods according to what some powerless consumer group says.

More promising are appeals to the general public. On many occasions antiwar scientists have taken their arguments to the general public. But this effort has been limited in two ways. First, mobilisation of the general public has been done via appeals to fear, the fear of nuclear war in

particular. Second, the aim of mobilising the public has been largely to apply greater pressure on governments. In all the antiwar action by scientists there has been no challenge to the institutions underlying war: the state system, bureaucracies, the military, and the structures of unequal power and privilege at the top of which is found the administrative class.

In other words, antiwar scientists have not thought to reconstruct society to remove the sources of war, but rather just to somehow eliminate war within the existing structures. Such a superficial approach is not surprising. The beliefs and actions of scientists as well as others are conditioned by their training, social situation and career pressures. Scientists are trained to be paradigm-bound problem-solvers, specialists within a narrowly defined area. The social system of science does not encourage critical attention to pervasive and subtle political and social assumptions underlying science and society. Furthermore, the career structure of scientists is bound up with the bureaucracies of the war system. It is not easy to accept that opposing war requires re-examination of the foundations of one's profession and career.

Towards an Antiwar Science

A programme for constructing an antiwar science cannot be developed or achieved in a vacuum. It must be part of an overall programme for transforming the war system and constructing social institutions which provide no basis for the waging of war. There are several possible visions of human society without war. The one I prefer and refer to here is based on local self-management, local self-reliance and nonviolence. Instead of the key decisions about people's lives being made by elites in bureaucracies and within the context of the nation-state, these decisions would be made by the people themselves in a humanly scaled system of participatory democracy. Technology, transport, production and communications would be chosen to maximise self-reliance locally: development of an dependence on skills and judgment of people making decisions about their own lives, rather than on outside or superior experts. Finally, social conflict would continue, but resolutions would be sought using the myriad methods of nonviolent action (8).

What would a science look like that was oriented towards helping achieve such a society without war? First, science would be used in a positive way to help create a nonviolent society. The topics for research would grow out of the needs of self-managing, self-reliant communities. The nonviolent alternative to military defence is social defence: community resistance to aggression using methods such as noncooperation, strikes, boycotts and demonstrations. For example, when the Soviet Army invaded Czechoslovakia in 1968, there was no military resistance, but the Czechoslovak people spontaneously opposed the invasion by nonviolent means including demonstrations, strikes and talking with soldiers. One of the key elements of the nonviolent resistance was the Czechoslovak radio, which made announcements about enemy actions, convened the Czechoslovak Communist Party Conference and counselled people on nonviolent methods (9). One example of a worthwhile scientific research project that would strengthen the potential for social defence would be to develop radio and other communications systems which are easy and effective for local communities to use but hard to disrupt by military forces, spy agencies or potentially repressive governments.

Second, an antiwar science would be used to help dismantle existing physical and social structures which support the war system. Antiwar scientists can spread knowledge about how the war system can be dismantled by popular action. In my opinion, disarmament -- or rather transarmament, the switch from military to social defence -- will not come about by government decisions, but will require direct action by people to disable weapons, convert military production to production for human needs, and overthrow systems of structural inequality and centralised power which support and are supported by the war system. To undertake such direct action, people need to know how to disable nuclear weapons, how to run communication systems and electrical power systems. Scientists and engineers, who now tend to monopolise such knowledge when they have it, can aid this process by exposing the workings, weaknesses, and alternatives to the physical bases of the war system.

But more important than dismantling the physical infrastructure of weapons and war-related production is dismantling and replacing the organisational bases of the war system: systems of economic inequality and exploitation, hierarchical organisations, and political inequality based on race, sex, class or knowledge. Scientists -- perhaps especially social scientists -- can make a contribution to this transformation by exposing the role of bureaucracies, the state, patriarchy and the professions in the war system, and by studying and experimenting with alternative structures.

Finally, it is important for antiwar scientists and non-scientists to look at science itself. If the war system is to be transformed, that means a transformation of science from a bureaucratised, specialised, government-funded -- in essence, militarised -- condition to a harmonious part of a self-managing society. Instead of science being funded by the state, it would be one of many activities carried out by locl communities. Instead of science being almost always a full-time professional activity, it would be something that most interested people could participate in. Instead of being organised bureaucratically, science would be done participatively. As a result of the different research interests for science and of the different organisational base, it would inevitably follow that the knowledge frameworks of science would be different to a greater or lesser degree. The criteria for valid and important science would depend less on manipulation and control and more on fostering community understanding of nature and society and on providing tools for sustained a democratic, just and nonviolent society (10).

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