Building the Trident Network

A Study of the Enrollment of People, Knowledge, and Machines

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Introduction

On Saturday, September 19, 1998, the last Trident submarine emerged into bright sunshine from its massive construction shed at the Barrow in Furness shipyard.[1] I watched from Michaelson Bridge opposite the yard, along with a scattering of local people and a few hundred anti-nuclear demonstrators. The ceremony for this fourth and final vessel in the most costly weapons program ever undertaken in the United Kingdom was low-key. The project was now something of an embarrassment to the recently elected Labour government. Already people were forgetting the Cold War, for which the Trident program was intended. Press and media coverage was virtually nil. The story was over, the world had moved on.

The few local spectators watched gloomily. Nuclear-powered-and-armed submarines are not objects of celebration, for all the skill and achievement they embody. They are black, silent creatures, designed to disappear with their deadly cargoes, thereafter to remain unseen by the general citizenry. Townspeople also feared that the launch might add to the stream of job losses already inflicted as the shipyard moved through the program's four contracts.

As ever, the locals tolerated the demonstration, pathetically small this time compared with the torrents of protesters seen in Trident's early years. To add to the sense of redundancy, as we turned away from the launch and looked down the Walney Channel, we saw the gleaming outlines of the four smaller Upholder Class submarines that were completed during the early stages of the Trident program but never brought into use.

This book traces the path that led to the final launch. It is the story of a large-scale technical system, of that system's impact on smaller systems, and, most important, of that system's impact on the local communities of people engaged in its production. It is a story of courage, heartbreak, betrayal, and humor, and of human and technical achievement coexisting

with waste and destruction. What forces, what details, and what nurturing kept the colossal Trident program moving forward?

The Special Relationship: Controversy and Contingency

> The new generation of nuclear submarines was proving so complex, so sophisticated as to rival in scope the great medieval cathedrals of Europe, where tradesmen passed their tasks from generation to generation, each hoping he would be among those to pray inside.
>
> *—Tyler 1986, p. 323*

This statement reflects the experience of the United States in constructing a nuclear submarine fleet. The US program of the 1970s and the 1980s was a vast undertaking: at any one time, the premier US shipyard might have been working on five or six nuclear submarines, each containing more than 80,000 separate welds (Tyler 1986, pp. 54 and 261).

The United Kingdom's program to construct four new-class submarines to provide a platform for the Trident weapons system was much smaller, but it was still the largest and most ambitious technological enterprise ever undertaken by the UK. This program was, within its own terms, a success. Even when the large-scale "weapons succession" process that characterized the Cold War era was largely halted after the collapse of the Soviet bloc, the construction of the Trident system moved ahead, seemingly without encountering either technical or political problems.

Vickers Shipbuilding and Engineering Ltd.[2] (VSEL) performed a remarkable feat of engineering and project management in producing *Vanguard*, the UK's first Trident submarine, largely on schedule and within budget. For comparison, consider that the Electric Boat Company, owned by the industrial giant General Dynamics, the world's largest submarine builder, delivered the first ("lead') US Trident submarine, the *Ohio*, 3 years late and 55 percent over the contract's ceiling price (Schumacher 1988, p. 1).[3] The *Vanguard* and the *Ohio* were produced under different conditions, of course, but this difference in production performance on the lead submarine does suggest the high achievement of VSEL's workforce.

The purpose of this study is to find out how the Trident system[4] became accepted, stabilized, produced, and "black boxed" in the UK, in such a way that it has now taken on the appearance of having fulfilled some kind of "technological trajectory." Where were its contingencies, weaknesses, and controversies, and how were these managed and overcome?

When, in 1981, the United Kingdom decided to follow the lead of the United States and equip its nuclear submarines with the enhanced D5 version of the Trident missile, it was opting for a huge increase in strategic nuclear capability. Just a year earlier, a decision to buy the lesser Trident C4 had been taken in secret by a small cabinet committee and only later announced to the full cabinet and to Parliament. Both decisions were arrived at in a similar way, and both immediately aroused widespread controversy (Ponting 1989, pp. 177–191). Both the Labour opposition and the Liberal Party committed themselves to cancellation of the new program. The decisions were also fiercely opposed by antinuclear groups, which at the time were experiencing a surge in membership and a period of dynamic activism. The high cost[5] of Trident also alienated certain defense and naval chiefs whose own programs seemed threatened by expansion of the role of submarine-launched ballistic missiles. There was even concern among back-bench Conservative Members of Parliament (MPs) about the displacement effect Trident would have on the overall naval budget, with consequent job losses in their constituencies. Moreover, the decision to "buy American" once again (as had been done in the Polaris program) was not popular with many sections of the UK's defense industry, which had to be content with eventual concessions in the sales agreement that allowed UK firms to bid (largely unsuccessfully, as it turned out) for Trident supply contracts. Buying American was also unpopular with those MPs, mainly from the political right, who wanted the UK's nuclear "deterrent" to be more independent and would have preferred to see the UK develop its own program. Finally there was opposition from a strand of trade-union opinion that saw defense dependence, particularly on increasingly large-scale systems vulnerable to cancellation, as a high-risk employment strategy.[6] And some workers were uneasy about their role in an increasingly offensive, rather than defensive, arms race.

The controversy in the United Kingdom contrasted markedly with the situation in the United States, where political and labor controversy was relatively insignificant. Using a social-constructionist approach to examine the "technical"[7] problems encountered by the US Trident builders before the system was black boxed, Spinardi (1994) and MacKenzie (1990) were able to show that the Trident system's technical characteristics and components were products of both social and technical processes. Their approach, which views Trident as a "sociotechnical network," is extremely helpful for the study of the system's stabilization in the United Kingdom, where access to official information is more

problematic than in the United States and access to unofficial information is hampered by secrecy and self-censorship.

The stabilization of the US Trident program involved the manipulation of congressional committees, budgets, and artifacts in a process that has been called "heterogeneous engineering."[8] Public controversy (more specific, workers' opposition to the program) does not seem to have been a major issue.[9] In the US, "heterogeneous engineers" progressively ironed out many sociotechnical difficulties in constructing the system; the UK "engineers"[10] encountered their share of technical problems, but in a context of delicate and volatile political uncertainties. How did these engineers overcome the peculiar political and technical problems that faced Trident?

This book is situated somewhere between the literature on arms control and disarmament and that of science and technology studies (STS). My point of view is that of labor; thus, I refer at various points to the literature of resistance and to alternatives that emanate from workplace knowledge. It is this perspective that I argue connects the disarmament debate with that of STS. This point is illustrated by the decision to adopt the US-enhanced Trident missiles. "Buying American" was seen as the lowest-cost option for the UK to maintain strategic capability (the alternative being a risky indigenous development). When it came to choosing a submarine design and propulsion system, though, the Thatcher government chose the most advanced, expensive, and futuristic platform option, designed and made in the UK, with all the technical risks attendant on utilizing untried technologies. By March 1982 it was decided that an entirely new generation of submarine, the Vanguard Class, would be designed and constructed, and that it would incorporate part of the American Ohio Class design to accommodate a midsection missile compartment. The Vanguard Class would also utilize the latest pressurized-water reactor, a PWR-2, for propulsion; this reactor was still under development at the Dounreay plant in northern Scotland. An enlarged submarine (though not necessarily a whole new design) was essential to accommodate the very latest missile, the Trident D5. With the emergence and adoption of the enhanced D5, the United States had transformed the rhetorical purpose of its Trident system from its earlier deterrent role (an integral part of the strategy of mutually assured destruction) into a deliverer of "counterforce," a defense logic in which nuclear war might actually be winnable through the achievement of "hard-target kill."[11] The UK's decision to abandon the C4 in favor of buying the D5 showed the extent to which the UK had become tied into both US strategy and US

production of the missile. The C4 had been the UK's preferred option, and the extra, escalated destructive capability and political consequences of adopting the D5 system (along with the technical risks outlined above) came to be justified by the logic of maintaining "commonality" with the US. "Commonality," in this context, was a term that encompassed the notion that technical and political goals were inseparable.

McInnes (1986) has pointed out that, once the US adopted the D5 missile, it became clear that existing C4 production lines would be closed down earlier than had been planned. The UK's options were thus restricted: the missiles would have had to be bought earlier than the otherwise might have been, and the cost of maintaining the C4 unilaterally would have been incurred. The alternative was to take on a weapons-system capability that the government had previously stated it did not need, claiming economic and operational necessity as the reason (ibid., p. 51).[12] Though strategic and operational risks were said to be minimized by the decision, this was at the expense of political risks and technical uncertainties involved in accommodating the new missile.

Radical or Conservative Technology?

An STS approach will allow a richer analysis of the construction of the Trident system than is usually found in the literature of arms control. For example, an STS perspective draws our attention to the fact that Trident development has been marked by *interpretive flexibility*: at different stages of development in both the United States and the United Kingdom, the system was variously described as technology that was radical and challenging and as technology that was traditional and utilized existing skills.

In the United States, the lead submarine, the *Ohio*, was the subject of an estimated 100,000 drawings and was described by Commander Edward Peebles, US deputy program manager for Trident Ship Acquisition, as "probably the biggest mobile structure built by man." Admiral Robert Gooding, Commander of Naval Ship Systems, believed that, with their new propulsion and weaponry advances, Trident submarines would be strikingly different from Polaris submarines. Both men were supporters of cost-reimbursement (cost-plus) contracts under which the US government would bear much of the development costs. In contrast, Vice-Admiral Hyman Rickover, head of Naval Reactors Branch, was supported by Admiral Harvey Lyon, Trident Program Manager, in maintaining that the shipbuilders had "built Polaris submarines, and Trident is not that much different" (Schumacher 1988b). Both of these

men supported fixed-price contracts under which the US Navy would, they believed, retain more control over the shipbuilder. The argument seems to have crystallized over the proposed escalation of the program by President Nixon in order to put pressure on the Soviet Union in the Strategic Arms Limitation Talks (Schumacher 1987, 1988b).

In the United Kingdom, Trident was also variously represented as somehow both conservative and radical. Early in 1993, Lord Chalfont, the chairman of VSEL, said that VSEL's design and construction workers were "now capable of producing a piece of engineering like the Vanguard, the Trident submarine, which in putting it together is something like putting a man on the moon in terms of advanced concepts and engineering." This quote is from an interview with Julian O'Halloran for a segment of the BBC1 television program *Panorama* titled "The Peace Penalty: Whatever Happened to the Peace Dividend?" (broadcast March 22, 1993). Chalfont was at that time making a plea for more defense contracts to be placed with VSEL. In contrast, defending the government's non-interventionist policy in the face of mass redundancies[13] at the shipyard, Michael Heseltine, president of the Board of Trade, in an interview for the same TV program, said that the UK could not go on "supporting skilled teams in existence doing the things they were doing yesterday, serving yesterday's markets." When I interviewed him on June 28, 1993, Eric Montgomery, a former trade-union convenor[14] in the UK's Trident shipyard who was campaigning for industrial conversion away from defense, described Trident as "just another boat." Trident could be radical or conservative, depending on what social and/or political objective was being sought. Mary Kaldor explores this point further in *The Baroque Arsenal* (1981), describing the creation of large-scale weapons technology as a contradictory process in which cutting-edge technical development is embodied in conservative products.

Recovering Contingency

In the history of the UK's Trident program, it is the submarine that brings together the components of the whole Trident system. Similarly, it is mainly the submarine builders who informed my study, in which a few of the possible histories of producing a huge sociotechnical system are told. However, these stories were not discovered or chosen randomly. Because this study concerned the construction of the UK's primary strategic nuclear weapons platform, there was a strong motivation in the selection of material to present episodes that would show where

that technology was contingent or unstable. Though all technologies are, I believe, contingent at some or all stages in their history, when it comes to nuclear weapons there is a strong "you can't uninvent the bomb" rhetoric overlaying their development. From this rhetoric it follows that building the four Trident submarines was an inevitable, natural consequence of developing the missile. Drawing on insights from the sociology of scientific knowledge and from social-constructivist studies of technology, and employing an actor-network approach, I hope to show that the production of Trident was *not* inevitable.[15] My methodology centers on re-opening controversies that occurred during the planning and construction of Trident in the UK. One problem is that there are now few visible signs of controversy; indeed, the building of Trident is now presented as a great success.[16] Also, even if the study were confined to the construction of the UK's Trident *submarines*, this still remained a vast and complex network in which problems and controversies ranged from the physical (such as finding adequate boiler-shop space at the shipyard) to the social-psychological (e.g., maintaining the Cold War rationale for the system).

The most visible of the controversies concern Trident's political unpopularity in the United Kingdom in the early 1980s.[17] "The 1980s," Kaldor commented at the time (1981, p. 8), "may turn out to be one of those rare moments in history when real change is possible. Modern military technology is currently in crisis. This is manifested in the 'unreadiness' of the armed forces, the financial problems of the armorers, and above all, the growing disaffection of soldiers and defense workers in many countries." For builders of weapons systems and for the Thatcher government, the 1980s were politically uncertain years.[18] But what was the relationship between the national political controversy over adopting the system and possible controversies over technical choice at the point of production—the macropolitics and the micropolitics, the local and global networks? As I will explore in later chapters, the production of Trident involved savage rationalization and homogenization of skills and resources and rejection of technical "alternatives." If I were to think of Trident as a sociotechnical network (because the local production of the submarine is embedded in a national and a global network), I could not treat national "political" controversy and local "technical" controversy as separate issues.

Early in my research I discovered that a group of workers had mounted a campaign around the shipyard to promote alternatives to producing Trident. Their place in the history of Trident is almost unknown, but their activities, outlined in part III of the book, raised crucial questions

about the construction of Trident. This group, the Barrow Alternative Employment Committee (BAEC), forged its own particular social and technical network that operated within (and because of) the emerging Trident network. In campaigning for alternative technologies, the group was in effect acting to dissolve the barrier that gets created between the technical (here standing for local production) and the socio-political (here standing for macropolitics). As shop stewards at Lucas Aerospace had recently discovered, this barrier also stood between workers, who were expected to campaign over wages and working conditions only, and management (sometimes supported by official national trade unions), which was seen as the legitimate decision maker and arbiter of the content of production.

The campaign by the BAEC brought the national political uncertainties and controversies about the Trident system together with the local problems about technical content, diversity, and employment at the point of production. The Barrow shipyard had been occupied with the design and construction of a series of Trafalgar Class hunter-killer submarines, but they were nearing completion and no other submarine program was envisaged. The members of the committee were living at both the ethical and the economic "sharp end" of the emerging Trident network: as they often pointed out, they and their community would inherit many of the social consequences of the company's exclusive dependence on Trident production.

I decided to follow this group of actors by reconstructing their history. I will refer to the BAEC and to its principal report (titled Oceans of Work) throughout this study. Because this group acted to unite the technical and the social, I have to some extent treated all the episodes recounted here as constituting the context for Oceans of Work. This is not, however, a case study of BAEC or even of Trident production itself; it is a study of the surrounding events. It is a story about how Trident production was organized and ordered. The story can never be complete; as John Law (1994, p. 45) points out, there are "discontinuities in ordering."

Frequent reference to the BAEC and to its report provided a way of creating a narrative about Trident submarine production and about the history of VSEL (the key design/construction company) that did not focus on the views and actions of managers. I have gone about this first by identifying a network within a network (the BAEC) and attempting to describe the relationship between the two and second by attempting to theorize the relationship between the dominant (Trident) network and its marginalized or expelled actants: workers who had been made

redundant and technologies that had been abandoned. (This latter point is developed in chapter 7.) If prejudice, preconception, and social ordering usually prohibit the equal treatment of all actors in narratives about technology (Latour 1987, p. 258),[19] what I try to do here is to even their dimensions up a bit. If in this book the reader can approach the story of the building of Trident by first listening to participants in that network who were marginalized, or whose stories have had to be positively unearthed, the reader can (heuristically) bracket off those "power relations" that led to Trident's "success." In this way, it is possible to explore the "how"—the processes by which power relations were configured and eventually rendered fixed and "inevitable"—by asking questions as if power is something that circulates rather than being fixed.[20] Thus, the investigation takes place in a time before roles and power were distributed, before "facts and machines are blackboxed" (Latour 1987, p. 258). We are then able to see the ordering, not the order (Law 1994, p. 26).

One consequence of retracing the footsteps of these actors is that we are able to "forget" (or postpone the knowledge) that they were later marginalized, or that others later came to be pivotal. We can become immersed in their story, in their activities, almost as they did. By reopening controversies and searching for alternative accounts, we can see how power inequalities were constructed and maintained, how power relations had to be policed, and how divisions between the technical and the social had to be continually reinforced and expanded.

My allegiance to an actor-network approach survived one important hurdle. Terry McSorley, a former shipyard worker and a founder of the BAEC, read chapters as they were being written. Commenting on the part about treating actors (in this instance the committee and the shipyard management) symmetrically and as equals in order to explore the circulation and potential accessibility of power, he said (referring to the activists' approach to the company): "Treating all the parties as equal—that's just what we did on the committee!" On the face of it, there was hardly any chance that a small committee of workers, struggling for acceptance even among their own trade-union organizations, would be able to alter the direction of production at the UK's premier nuclear submarine shipyard. But in spite of its apparent "powerlessness" (in actor-network terms, the apparent poverty of its associations with key players), the committee carried on, mustering resources to promote its alternative production strategy and its call for the content and the context of technology to be considered together in the interest of maintaining employment.

My study of the BAEC relies mainly on in-depth interviews with its most active members. The committee was certainly not homogeneous. Each member had a somewhat different view of the campaign,[21] and the committee also reflected the various trades and skill groups in the shipyard and the different stances of their unions. But two issues were common to all accounts of the strategies used. It was agreed first that the campaign should concentrate on protecting jobs, and second that all the campaigners should be active VSEL workers. By exploring and questioning the technical content of production, the committee members transcended sharp differences between trades, between unions, and between white-collar and manual sections, and they therefore formed a unique political alliance in the shipyard.[22]

Following the actors has also implied a degree of "snowballing"—picking up other interviewees from existing contacts. The snowballing also extended to the stories. For example, one of the issues raised by the BAEC in the 1980s was VSEL's failure to develop and exploit the Constant Speed Generator Drive (CSGD). This set me off: Who were the actors in the development of the CSGD? A trip to the Patent Office revealed the names of the inventors. A journey to Wales unearthed a rich story about the evolution of the technology and tensions between the English and Welsh production sites and also the (then nationalized) parent company, British Shipbuilders. This tension concerned the direction of technical development and the conflicting sociotechnical demands of the civil and defense markets. This story, told in chapter 3, was the sort of road not taken that, as David Noble (1984, p. 146) has pointed out, can help us understand the society that denied it.

All this prompted an attempt to amass all the available literature on the company (VSEL and its forerunner, Vickers) and its technological history. The rich diversity of the company's products, repeatedly mentioned by former managers and workers in interview, was only partially reflected in the official company histories. Other forms of literature, particularly sales brochures that emanated from the former engineering division, revealed just how important a feature of the Barrow-based business this diversity had been. It became important to try to understand this discrepancy between official and unofficial histories. National politics (nationalizations and denationalizations), in addition to pressure from the Ministry of Defence (MoD) to bring about single-purpose production, are part of the multi-stranded impetus for the disappearance of general engineering at the shipyard. Non-submarine work, though often profitable, came to be seen as a distraction from "core business" (that is,

large MoD contracts). But the local engineers, proud of in-house skills and design achievements, talked freely about the former diversity of their work. This construction of "core business" and the associated shrinkage of products is discussed in chapters 2 and 3.

Shipyard workers sometimes signaled their ambivalence toward building Trident, an unease that was picked up in local street surveys conducted by anti-nuclear groups in the 1980s. I tried to uncover more about this ambivalence, looking at how workers were persuaded to see Trident as aligning with their own interests. This led to a study of the 1986 privatization and the company's share-option scheme, an exercise in local "enrollment" of employees into a new experience of capitalism and into tighter production goals.

My extensive use of cuttings from the *North West Evening Mail* should be explained. Because the community of Barrow and the Furness peninsula of Cumbria as a whole are geographically isolated, the local newspaper played a significant role in both reflecting and influencing local opinion. Like it or loathe it, most local people read this daily tabloid, and its sales have always relied considerably on VSEL workers' buying it at the factory gate. In fact, in 1990, when VSEL increased its shift hours between Mondays and Thursdays, allowing workers to finish early on Fridays, the *Mail* altered its production schedule to bring out the Friday edition in time for the new midday shipyard exodus.

The *Mail*'s editorial policy was ambivalent. It supported VSEL and Trident, both because they provided jobs and because they had made Barrow a major player in maintaining the national defense.[23] Yet the *Mail* also ran many prominent features about the devastation caused by the redundancy program of the early 1990s, when workers were leaving the town to find work.[24] The *Mail* also tried to shame VSEL into justifying the profits it amassed while thousands of workers were being laid off. Because it was widely read by workers and their families, VSEL's management (and to a lesser extent the trade unions) attempted to use the *Mail* as a mouthpiece. The *Mail* was therefore a rich source of information for an investigation into how workers were persuaded to see their interests as aligning with those of the company and the Trident contracts. In addition, the *Mail* could not ignore the effects of what I have called "disenrollment"—the jettisoning of people and machines from the network.

The concept of technical and human disenrollment from networks is developed in later chapters, which consider how both people and machines can be rendered redundant. Science and technology studies

have tended toward the heroic, examining how new technologies are built, how human and nonhuman participants become engaged, and how the network is finally stabilized. But what of networks in decline or reduction? What of the actors being expelled from the network? I have developed the concept of disenrollment to describe the cruel functionality of redundancy, and to examine how this can reinforce a network and assist in the stabilization of what remains. Many of the individuals I interviewed reflected on redundancy and its effect on individuals and the community. Many became angry when they talked about the company's method of implementing redundancy and its formalized attempt, by giving each employee a numerical score, to make redundancy appear inevitable and immutable. And this construction of a sense of inevitability about redundancy led me back to the initial questions about the aura of inevitability that came to surround Trident itself.

Organization of the Book

Chapter 1 reflects on how large-scale technologies have been theorized and how some of these approaches can be helpful in examining the Trident system.

Chapter 2 concentrates on the process of technological shrinkage at VSEL Barrow and the construction of "core business," both of which facilitated the production of Trident. This largely historical chapter tries to disentangle the enormously complex developments within the huge Vickers empire.

The changing ownership and patterns of production within Vickers—one of the UK's largest engineering companies—have had a strong influence on the direction and the content of its technologies. The case of one such technology, the Constant Speed Generator Drive, is traced in chapter 3. The aim here is to document how one potentially profitable technology was marginalized in the process of constructing core business.

Chapter 4 is an account of how Vickers was taken out of British Shipbuilders and privatized in the biggest management buyout yet seen in the UK. This privatization is set in the context of the impending Trident contracts and the need to construct both a purpose-built site and a purpose-built workforce to ensure production.

The reconstructed story of the Barrow Alternative Employment Committee follows in chapters 5 and 6. These chapters explore the efforts by BAEC to generate and promote alternative technologies that

could be built by VSEL without compromising its skills base, focusing on the factors that facilitated and hindered the committee's endeavors.

The heavy waves of redundancies predicted by the BAEC campaign are discussed in chapter 7, where it appears that pain and dislocation are implicit in building such a large-scale weapons system as production falls away. The theoretical issues this raises for actor-network studies are examined here and in the conclusion, where I suggest ways in which science and technology studies might address processes such as production, redundancy, and technological shrinkage.