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Round Table comment

In the papers given here there is frequent mention of «useful knowledge». It is always informative to ask what the opposite of any idea or object might be. In this case useless knowledge does, in fact, exist. The question that follows, then, is useless to whom and why. Useful knowledge it would seem is connected to increases in productivity and, in turn, to economic growth. Ideas always abound. Many theories are available with ideas often shared widely. In only certain cases, though, do those ideas that knowledge is useful, yielding the desired economic results. Concentration on knowledge turns the spotlight away from the importance of the practical, the role of the market in dictating what, under the circumstances, makes implementation of certain technologies that spring from knowledge practical and beneficial and others not. In short, the existing circumstances dictate what is useful knowledge. The adoption of new technologies is never straightforward since, whatever that way of doing things may be, new entanglements, spillovers, cross-fertilization create unintended consequences which of course then dictate what new technologies will in turn gain acceptance or, in other words, what knowledge will be useful.

In the past historians trying to understand how and why ways of doing things changed distinguished invention and innovation. They also sought to divide technical from technological change. The loss of those distinctions is not necessarily bad. Still it is wrong to ignore such separations since what drives novelty on the one hand and what drives the implementation of new methods are different. Renaissance thinkers made much of 'creation', of the role of the artist in making something that was new. The idea was most prominent in the discussion of individual painters, sculptors and architects thanks to the work of Giorgio Vasari (1511-1574) and the subsequent promotion of the approach by art historians. The evidence is overwhelming that it takes more than just a creative person or spirit to invent. Simultaneous invention occurs. Since two people chose to work on the same problem at the same time in different places with no contact with each other have produced the same solution there must be more than individual creativity at work. The most notable case is the Hall-Héroult process for producing aluminium, developed independently by two men in France and the United States in the 1880s. Creation of some new technology is not enough to make for universal adoption. No matter how creative the inventor and invention, there are typically some who resist accepting the brilliant new idea, even long after the new practice is in common use. Those resisters are not invariably wrong to resist.

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There may well be a curiosity among people to explore new ways of working and producing and that curiosity may be more or less widespread at different times. But what may be true generally is not what generates the observed specific technical changes and their diffusion. The discussion of knowledge transfer, something that permeates much of the discussion, is certainly of value. Knowledge transfer, however, is not technology transfer. For the latter there must be much more than just knowledge moving.

An invention can prove to be a massive breakthrough, creating an entirely different economy. It can be a simple change a craftsman made. It can be anything in between. The are big ideas, and there are not so big ideas and very much lesser ideas or practices. In order to understand the roots of specific inventions, no matter their impact or source, the starting point should be well before the specific invention emerges. The big ideas do count and they include how inventors and innovators understood nature. For the history of European technology that means that exploring the history of technology requires knowing about Aristotle or even Plato or even Hesiod. While beginning with the big picture to understand the small is advisable that does not denigrate working from small ideas, from highly circumscribed information to uncover explanations for major breakthroughs. Exemplarism of Aristotelians and most prominently in the middle ages, an idea strongly endorsed by Thomas Aquinas (1225-1274), promoted data collection, learning about nature to see God's handiwork. That thinking and practice could and did lead to technological change. Along with gathering knowledge the work of craftsmen had value in the eyes of theologians in the middle ages. Hugh of St Victor (c.1096-1141) in his *Didascalicon* of the 1130s adds to the list of the arts, that is the seven subjects of the quadrivium and trivium, a list of the mechanical arts. Woodworking might not have been exactly as important as geometry, for example, but certainly it was worthy of praise. The monastic religious culture of the middle ages did not ignore technicians and their work. It is wrong to disregard the medieval background to the strides made in technology in Europe in later centuries. It is easy to make too much of some altered consciousness which suddenly created the urge to invent in the sixteenth or seventeenth or any later century. Perhaps it is wise to see that urge as something less time-specific and more a common feature of the human condition. That was a logical outcome of the views of Adam Smith (1723-1790) who assumed that people are both lazy and competitive and so inventive.

The role of public authorities, institutions that could engender as well as administer technological change, in putting knowledge to use is an enigma and for no other reason than the sheer variety of what they did. They had the potential to promote or thwart technical advance. Government authority geographically could cover large areas of land or just regions or just towns. Administratively it is easy, looking back, to imbue states with powers they only gained in later centuries. Considering their limited powers in the years before 1800, it is wise to be sceptical of what appears in the documentation they produced. The laws laid down frequently were not enforced. The establishment or extension of territorial states in northern Europe from 1400 on was not so revolutionary since they were modeled on city states in Italy but their effective rule was constrained by the sheer size of the realms they claimed. Cities could and did, through guilds for example, have a greater role

than territorial states in the creation and dissemination of new technologies. However, there was always a tension between cities and tradesmen. They shared some interests but also had what could be diametrically opposed goals.

Technology transfer might better be understood as adoption or adaptation of some different way of working. Transfer, by definition, means that the technology already exists. Transfer, then, is not original. That was and is why there is a distinction made between invention and innovation. The distinction implies that discussion of technical change must include existing social and cultural and market conditions. It also implies a need to understand the old technology undermined by the new. What is novel must be similar to what already exists to be acceptable. For example, with printed books, their creation being a major breakthrough in Europe at the end of the middle ages, producers went to great lengths to make them look like manuscripts. More generally, the importance of standardization in the adoption of a technology is often understated. It was not just machines like the Jacquard loom which produced a predictable, that is standard, product, that made both production and acceptance of the product easier. Music notation in the eighteenth century became more consistent so that musicians with little or no knowledge of a piece could play it in groups, understanding from the printed page what was needed of them. Like the original manuscript book, the codex that emerged in the last days of the Roman Empire, the printed book became standardized in size. Booksellers' catalogues could describe an easily understood commodity. Written works appeared from the fifteenth century on that served to establish categories and so make possible useful instructions. Medieval cookbooks served as models for how-to books but written works came to cover many more topics, in all cases moving slowly toward standardization of categories, of ways of describing and even of ways of illustrating technologies. Those works were a product of technical change and at the same time a way to ease the transfer of knowledge and of technology.

Trying to comprehend and then to describe the process of technological change and its impact is a difficult task. Explaining it is then extremely demanding. Many of the contributions in the papers offered indicate the value of thick description, of looking closely at relevant documentation, piecing together events from those documents and presenting the information in a comprehensible way. Placing that description within the context of time and place, making the small picture part of the big picture is, after all, doing good history.