The Role of Universities in the Rise of Modern Industrial Society

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The establishment of universities that taught mathematics from the eleventh century onwards throughout Europe made a decisive contribution to the development of science that paved the way for the industrial revolution.

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Georg Oesterdiekhoff has made an important contribution to the problem of what he rightly calls "the most fascinating riddle in world history" - why the industrial revolution occurred in Europe from the 18th century onwards and not in Asia. His answer is that the Europeans became more intelligent. This enabled them to work out the laws of the physical sciences that were the basis of the technological advances of the Industrial Revolution, such as the invention of the steam engine.

I believe Oesterdiekhoff is right in his answer that the Europeans became more intelligent. However, he does not offer an explanation of *why* the Europeans became more intelligent from the 17th century. I suggest the answer to this problem is that the Europeans established schools and universities. As he writes: "Exposure to modern culture, especially to modern school systems, seems to be the most decisive cause of the IQ gains. Without considerable schooling humans never gain abstractive and deductive reasoning abilities." It was probably the widespread establishment of schools throughout most of Europe, mainly in the 16th century, that was largely responsible for the increase in intelligence from the 17th century onwards.

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I suggest that the principal reason for the development of understanding of the physical sciences was the widespread establishment of universities throughout Roman Catholic Europe from the eleventh century onwards. The first university was Bologna, founded in 1088, and the second was Oxford, founded in 1096. From the twelfth century numerous other universities were founded. These universities taught mathematics and employed mathematicians as professors, and it was these who made the advances in the physical sciences that formed the basis of the later technological inventions of the Industrial Revolution.

Oesterdiekhoff states that "The decisive transformation from the theological disciplines to the new physical sciences took place during the 18th century. Protagonists (forerunners?) had been Galileo Galilei, Johannes Kepler, René Descartes, Isaac Newton, Robert Boyle, and others..." I would modify this by proposing that the crucial beginnings of the advances in the physical sciences took place in the 16th and 17th centuries and by noting that these were made by men who had been educated in schools and universities and largely made by men who worked as professors in universities. Oesterdiekhoff might have begun by naming Nicholas Copernicus (1473-1543), "the founder of modern astronomy" (Thorne & Collocott, 1985), who was educated at the University of Cracow where he studied mathematics and optics, and for some years was a professor of mathematics in Rome. It was this education and experience that formed the basis of his thinking that became his revolutionary heliocentic theory of planetary rotation set out in his *De Revolutionibus* (1530).

He was followed by Galileo Galilei (1564-1642), who was educated at the University of Pisa where he studied mathematics, and worked subsequently as professor of mathematics at the University of Padua where he carried out research on astronomy and made his refinements of the

Copernican heliocentic theory that he published in his *Dialogo sopra* in 1632. His contemporary Johannes Kepler (1571-1630) studied mathematics at the University of Tübingen and subsequently worked as professor of mathematics at the University of Graz where he worked out the laws of planetary rotation published in his *Mysterium* (1596) and "made many discoveries in optics, general physics and geometry" (Thorne & Collocott, 1985).

René Descartes (1596-1650) was educated at the Jesuit College at La Flèche where he studied mathematics on the basis of which he was able to work out his theory of coordinate geometry (1637). Robert Boyle (1627-91) was educated at Eton, possessed a private income and did not need to take a university professorship. He worked as an independent scientist and discovered Boyle's Law (1662) which stated that the pressure and volume of a gas are inversely proportional. Isaac Newton (1642-1727) was educated at Grantham Grammar School and at the University of Cambridge where he became professor of mathematics and worked out his theory of gravity published as *Philosophiae Naturalis Principia Mathematica* (1689).

The important point is that all of these mathematicians and scientists were educated in schools and universities and it was in these that they acquired the knowledge and interests that formed the basis of their discoveries that constituted, as Oesterdiekhoff correctly states, "the modern sciences, the sciences *sensu stricto*, (that) appeared during the 17th century and spread across Europe after 1700." Without the universities, it is doubtful whether the modern sciences would have appeared in Europe.

These European schools and universities had no counterpart in China or India. China had some colleges but all they did was train young men in Chinese history and literature for the examinations for the mandarinate. This raises the question of why Europeans established universities

that taught mathematics while the Chinese and Indians failed to do so. The answer to this is that the European universities were established by the Roman Catholic Church, principally for the education of priests. A university was by definition an institution that had received a charter from the Roman Catholic Church, frequently as an edict from the pope as in the case of the universities of Pisa and Florence. There was no comparable church in China or India that might have established universities. It was the failure to establish universities that explains why the Chinese and Indians failed to make the advances in the physical sciences that were made in Europe in the sixteenth and seventeenth centuries and led to the technological advances of the Industrial Revolution from the second half of the eighteenth century onwards.

Reference

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(1985). Chamber's Biographical Dictiorary. Edinburgh: Chambers.