

Scientific and Organizational Knowledge

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Abstract: An analysis of the development of the concept of knowledge is provided involving the consequences of the scientific and the management revolution. The situation of conceiving knowledge in the industrial society is outlined. An analysis of important factors leading to the present situation is provided focusing on the role of the IT-revolution, esp. Artificial intelligence and knowledge based systems and organisational learning as a key factor of value creation. Finally the present situation is outlined ending with a conception of what knowledge management is.

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1 Introduction: Knowledge and the Scientific Revolution

In the scientific revolution it became possible to produce knowledge that was both empirical and explanatory. One had theories. Francis Bacon had also wanted knowledge that was useful. In the following centuries science developed and a science based technology did too. Through application of theoretical knowledge and insight into causal connections it was possible to produce useful knowledge. During the industrial revolution such knowledge became an important source of value creation. The idea was that scientific knowledge made new products and processes possible. Such products and processes made possible new forms of economic production, and thus the factors of production achieved higher productivity in terms of economic value. New industries such as the chemical and the electrical were examples. This also involved the creation of a new system of research and education. During the last centuries then the prototype of knowledge has been scientific knowledge. This type of knowledge is both useful, empirical and explanatory. Actually the three properties hang together. A first example of an explanation of a natural phenomena using measurement and the formulation of a natural law as an equation is found in Descartes' Meteorology, where he explains the double rainbow by using the law of refraction and considering the way rays of light pass through droplets of water. This was of course not immediately useful. Another theory that could be used developed by Descartes on mathematical principles was geometrical optics. A few years later Robert Boyle studies the properties of air using his air-pump, and thereby produced knowledge that was immediately useful. Our present daily use of such a simple device as a bicycle pump "implements" the Boyle law of the relation between pressure and volume. The insights of an exact chemistry and the investigations of the laws of electricity and electromagnetism gave rise to new

industries. Understanding the chemical nature of the growth of plants created the basis for a whole new form of science-based agriculture.

2 The Development of the Business System

The development of a more and more complex business system during the second half of the 19th century necessitated the development of new forms of organisation and management. Mass-production and scientific management are examples. The ideal again being the scientific form of knowledge, now not based on theories from natural science but rather from social science. The idea behind these developments was that social knowledge was applicable when it was prescriptive and based on reference to basic needs and desires and basic principles of rationality including prudence. The goal was to achieve efficiency seen as the optimal state in terms of the use of resources for the satisfaction of needs. In the area of economics we find attempts to develop useful knowledge that could guide decision making both at the level of the firm or organization or at the societal level. Schmalenbach developed theories of accounting that could help informed decisionmaking in a business by showing the flow of both goods and money, and thereby give a picture of value-creation in the company. The economics of Marshall and Pigou was meant as providing some guidance – maybe not successful – and Marshall's last big work "Industry and Trade" was an attempt at creating a theory of the business system, that could guide industrial policy. Management theory was developed as helping solve basic problems of work organization. At the same time social and educational theorists such as George Herbert Mead and John Dewey started the development of the creation of forms of knowledge that could be termed "actionable", that is social knowledge that could guide action.

3 The Forms of Knowledge in the Industrial Society

With the advent of the scientific revolution and the emergence later of industrial society the concept of knowledge had two forms. Science produced knowledge – in the sense that if one wanted to see an example of what knowledge was one would look at one of the well-established disciplines of science. Philosophy reflected on what knowledge was – the theory of knowledge, epistemology, became the preeminent philosophical discipline itself – and was of course caught in the problem of whether it itself delivered knowledge – even if it was not itself an empirical discipline. The typical "total" theory of the situation was given voice in the position of the neo-kantian philosophers, who thought of philosophy as a sort of meta-discipline that would give a precise place to the various scientific disciplines. These in turn each had their domain or object of study and their specific method. The nexus of object of study and methods constituted the discipline, and philosophy gave a systematic picture of the whole situation.

4 Philosophy, Science and Technology

So real knowledge was scientific knowledge. Philosophy gave a sort of meta-knowledge, non-empirical. There were of course also other forms of knowledge, common-sense knowledge and knowledge that was interpretative, but such forms of knowledge did not express actual empirical connections, and it was therefore not applicable and thereby able to create knowledge. According to the understanding of the situation as we typically find it in the industrial society, it is science that has and produces knowledge and philosophy – especially epistemology – that elucidates what knowledge is, eventually with the help of the history of knowledge, which is then understood as the history of science. A good example of this situation is found in the James Conant – Thomas Kuhn ideas of science as connected to paradigms and inscribed in a distinction between the basic/pure sciences and the applied sciences, that were understood nearly as identical with technology – the idea of technology as applied science.

5 The Situation in the Knowledge Society

In the last decades the situation has changed. This is due to two interesting developments. First the development of computers. Early on the idea of using computers to do intellectual work emerged. Charles Babbage of course came on the idea of a computer by analysing the division of intellectual labour. But it was Alan Turing who at the very early development of electronic computers came on the idea. The name of the project was "artificial intelligence". As a result of work in this area the idea of creating knowledge-based systems emerged. Also known as "expert systems". Suddenly one could imagine and in embryonic form see systems that would implement knowledge and knowledge processes. Knowledge was to be represented in the systems and the systems would do such things that knowledge workers – experts – were doing. Knowledge had to be formalised and it had to be acquired. Knowledge representation formalisms were developed and techniques for knowledge acquisition too. One model was that knowledge took the form of rules and facts, and that the use of knowledge was deductions using rules of inference. With a system for implementing logical deductions one could therefore develop knowledge based systems. Knowledge was thus in a way taken out of the "hands" of both philosophers and scientists and placed in the hands of system developers. The adequacy of the systems were based on whether they could perform as experts or not. This was actually a version of the old "Turing test", and it also gave rise to a fruitful discussion about what constituted expertise and competence. The idea of knowledge-based systems came after an initial period where "intelligence" was understood as a sort of general problem-solving capacity. When this proved very difficult to implement the idea of "intelligence" as rather the possession of knowledge and the ability to use it to solve problems came onto the scene. Secondly we have seen the development of new forms of value creation in the business sector. This typically involves an organisation developing in such a way that one can only describe it as becoming better and better at what it is doing, and at the same time saying that it is creating knowledge and learning. Intellectual work in the forms of research and consulting have always been part of an industrial economy. But it has been seen as

creating the infrastructure for value creation, and not being in itself a creation of economic value. Teams and organisations have always been able to learn and thus become better and better. They have thus created forms of implicit knowledge in the shape of capabilities. When such organisations become creators of forms of capital that are essential to the economy they take a new form. They become creators of structural or intellectual capital. A football team is a good example of learning and the creation of implicit knowledge. We can look at the individual players. They might be good or bad. If good they have a high value on the market for football players. But the team also can be good or bad, and not only as it has good or bad players. Suppose we have some fairly good players – looked at individually – they might make an extremely good team, and vice versa. Some extremely good players – looked at individually – might make a fairly bad team. The team adds value, and the team can maybe have a high value on a market for teams (or in contexts that are market-like, like competing for sponsorships, media-contracts etc.). We can say that knowledge in this case takes the form of the results of organisational learning. A typical business example would be a software company. If it improves performance again and again after doing a job it learns, and it creates knowledge. Very often, as we all know, non-formalised and maybe even tacit knowledge. Knowledge that we find in the organisational routines and structures, that are – to a certain degree – independent of the actual persons involved with the organisation. This form of knowledge becomes more and more important, actually becomes the dividing phenomenon in many cases. Take two software companies. They may have access to exactly the same scientific knowledge. The same programming languages, routines and principles. All employees have the same scientific training. Still one company may be good the other not so. The difference is one connected to a different form of knowledge.

6 First Conclusion

Thus today we have at least three sources for conceptions of knowledge. The traditional scientific-philosophical (which can take various forms as seen in the myriad of different positions in epistemology), the concept we find in the idea of knowledge-based systems and the form of knowledge which is the result of organisational learning.

7 Knowledge and Learning

The scientific conception of knowledge often involves a specific conception of learning. Research is seen as the discovery of knowledge. Knowledge as the facts discovered. Learning is the acquisition of this knowledge, so that one knows the facts. The acquisition is done via transmission from the discoverer to others. Learning is based on communication. The organisational conception of knowledge has a different conception of learning. Here learning is seen as the structuring of experience, as a common interaction in which learning and knowledge creation is of the same character.

8 Conclusion: Forms of Knowledge and Knowledge Management

If there are several forms of knowledge around we face a management issue. The forms we find are not forms only in the epistemological sense of both ordinary daily knowledge like, that I know where my left hand is located now, and also the scientific form that there are quasars, but forms essentially connected to the development of new abilities for value creation. If there is essentially only one form of knowledge we have no issues about how forms of knowledge relate to the economic and organisational structure of our society. But if in both society as a whole and in organizations like firms, we have essentially several forms of knowledge interacting in the creation of value then we face a new situation. It might not be actually new, but new in the sense that it is evident to us – which it was not earlier. The recognition and handling of various forms of knowledge and the insight into their various role in the creation of value, especially their interaction, is the essence of knowledge management. To be able to actually do knowledge management then, one has to be able to see and understand various forms of knowledge and to understand how their interaction is the source of value creation in the knowledge society.

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