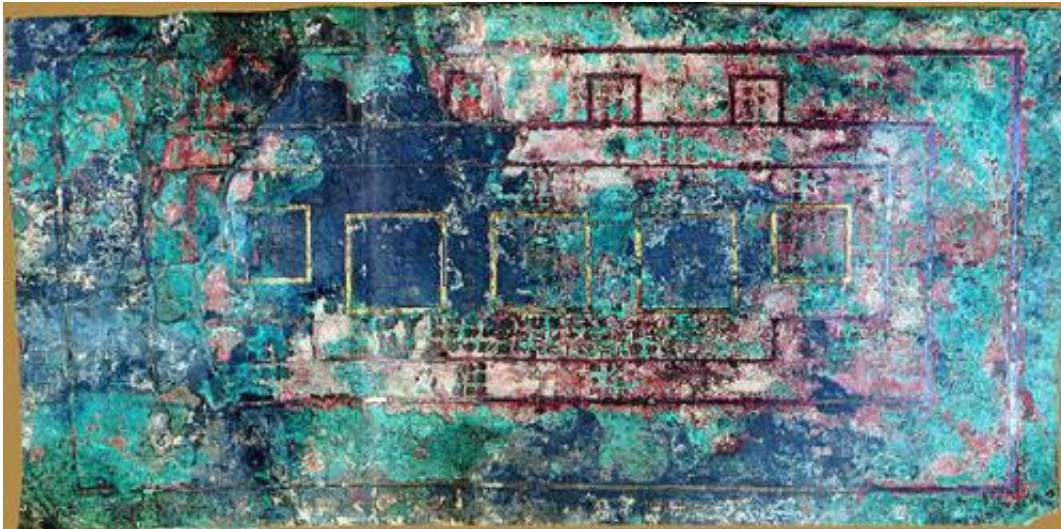


How large-scale technology projects affect knowledge

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The Zhao Yu Tu ("The map of the area of the mausoleum") was excavated in Pingshan the Hebei south-central province in the late 1970s. Silver and gold inlays on a thick copper plate provide information on the locations of the five mausoleums, in which the King of Zhongshan Cuo(344-313 BC) as well as his wife and concubines are buried. Credit: World Map Co. Ltd., Supervised by National Administration of Surveying, Mapping and Geoinformation

What do an accelerator complex at Cern, a manufacturing center in 19th century Philadelphia and lotus cultivation during the Qing dynasty all have in common? All such activities generate knowledge and know-how. And all of them require planning. Goals need to be set, skills and materials promoted or identified. Guidelines, models, recipes and

blueprints are generated to coordinate and organize. Historians from the Max Planck Institute for the History of Science in Berlin (MPIWG) have begun to question the role of management and organization, arguing that this viewpoint not only transforms our understanding of the historical developments of technology and science, but also offers new insight into recent debates on large-scale research and technology projects.

"How central modes of planning impact knowledge production can be seen particularly well in Chinese history", says Dagmar Schäfer who is heading a new department at the MPIWG, "we find here an outstandingly continuous documentation on the many ways people 'planned'." Architectural drafts, astoundingly modern in their technical designs, were used in this region of the world in ancient times. A bronze plate, excavated in the 1970s in Hefei, has gold and silver inlays depicting the contours of the 4th century tomb of King Cuo where it was found. Engraved measurements suggest that the plate was used in construction. Inscribed along the left hand side, an official decree identifies the plate as part of a complex imperial administrative apparatus. Bureaucracy translated the messy realities of life and death into the grand visions of the contemporary elite.

Long-term visions and messy realities

"Grand projects increase the need for logistics and organisation" explains Schäfer, "Thinking big forces people to reflect on expertise and skills. Significant to the Chinese case is that the elite's concerns about ordering state, society and self, spread throughout areas of intellectual and practical engagement. Views of nature express a special concern in systems, structures and processes." The question how one should plan and which knowledge, or information needed to be documented, conveyed or systematized, became central to political and intellectual debates. Was thinking in bigger schemes better than tending to details? How could flexibility be achieved and creativeness promoted and control

still be maintained?

In eleventh-century Song (960-1279) China, the renowned Chinese philosopher Zhu Xi (1130-1200), for instance, assumed that the key to the success of big schemes was to bring order to the small things: that is everyday needs. For him, the proper placing of the ancestral shrine in each individual's home was a first step towards organizing society and state. The principle of big planning was to understand the major effects that could result from small details. Some contemporaries of Zhu Xi believed in grand set-ups and the detailing of things. As the Song state gradually lost political control over the Northern plains, — where the traditional source of cattle and horses used to provide locomotive energy for civil transportation and warfare were reared — these men opted for the institutionalization of offices and publication of pharmaceutical literature to promote state-run large-scale livestock holdings. This peculiar Chinese case also shows that each approach to planning brought forth distinct formats and fields of knowledge and know-how. To facilitate large-livestock holdings Chinese scholars of the Song created a field called 'methods to counterbalance diseases or malfunctions', which, besides veterinary care and medicine, included hydraulic engineering, crop selection, and moral training, as well as philology and philosophy.

In the past as much as in the present world, planning meant juggling complex situations but also deciding whether long-term vision require long-view hindsight, or taking a risk. Accordingly people gathered empirical data, performed divination or calculated measurements. "Often we can see how the shadows of yesterday's plans turn into iconic templates for the future." The diagrams, illustrations and textual descriptions that candidates for service in state veterinary care of the 10th century produced in training became the guidelines in the 15th century. Similarly documents on — imagined or real—hydraulic projects of the past became the blueprints for future aims.

Modern China takes pride in a long tradition of water management, enhancing ancient traditions with modern engineering practice and ideals: faster, higher, bigger. While scientists and engineers ponder whether superlative interference necessarily produces the best results, the enactment of such projects – making things work—brings forth new insights and idea. Such projects, however, also show that within the most rigid of planning, there is still room for creativity and spontaneity. The world's highest dam at the border of Sichuan and Tibet –first envisioned in the 1960s – is nearing completion in 2014 after a construction period of a mere 7 years. An underground laboratory for particle physicists has been added only recently, almost as an afterthought, an opportunity grasped when it turned out that research conditions were ideal at this mountainous site. Clearly here scientific research is informed by a very different approach to planning than Cern where a diverse community of European researchers, physicists and engineers has been probing the fundamental structure of the universe since 1954.

By analysing such divergent approaches to scientific planning, the historians at the MPIWG do not believe in the historical persistence of black and white paradigms such as the Haldane principle which states that "politicians should not interfere in scientific decision-making". Instead, they look at the actors themselves: "When we attempt to find out how engineers, priests, artisans, housewives, scientists and others tried to make things work, we do so to unravel the complex impact of social, political, economic and material conditions. We want to learn how complexity is dealt with and how individual choices and collaborative decision-making were translated into procedural logics or systems of thought or belief", Schäfer says, whether it is eleventh-century Chinese households requiring ancestral shrines, particle studies in modern times or nineteenth-century American children requiring vocational training six days each week, but Sabbath-keeping on the seventh.

Nina Lerman, a historian of industrialization, is researching the training of children in Philadelphia in the 19th century, exploring what children were expected to learn in order to function as industrial workers or housewives, engineers or textile designers. Educational planning was the backbone of both industrialization and democratic beliefs, and researching its history can reveal how the large-scale changes of industrial capitalism were formed by a mosaic of many small-scale decisions about which children would need what knowledge – how to bake bread, how to build a locomotive, how to behave on Sundays – to become "useful citizens" as adults.

Researchers thus take into account that often it is the seeming marginalia that counts. Historian of science and technology, Martina Siebert, is researching how the cultivation of the lotus plant in China evolved into a complex and interlocked system between the 17th and [19th century](#). A map of Beijing from around 1900 shows the water bodies in the so-called "Inner city" which, according to Qing dynasty archival documents, were all used for the cultivation of lotus and thus demanded new expertise and organizational structures. One reason for this, Siebert says, was the Qing court's zeal for efficiency and profit that viewed empty water spaces as wasteful and when looking at lotus, saw not only the beautiful flowers, but also the economic value of the roots buried in the mud.

Yet, particular to the Chinese case is a seeming continuity in big schemes that dynasty after dynasty re-deployed. Changes on this level are often subtle, even if they had dramatic effects. At closer sight, like in many western projects a certain localism prevails. In the East and West projects such as the setting up of an industrial plant, planning a school education, or building a dam followed local traditions and conventions. "Looking at the histories of planning in China and comparing them with historical and recent examples in Europe, South America or the US helps us to better understand how much large-scale projects depended and still

depend on many small-scale decisions and the interests of the people who pursued these projects", Schäfer sums up.

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