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*Impossible Engineering: Technology and Territoriality on the Canal du Midi* by Chandra Mukerji

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*Reviewed by*  
Pamela O. Long  
Independent Scholar  
[pamlong@pamelaolong.com](mailto:pamlong@pamelaolong.com)

The Canal du Midi is a waterway that crosses southwest France north of the Pyrenees and links the Atlantic Ocean to the Mediterranean Sea. It extends for 150 miles (240 kilometers) through a complex and difficult topography and reaches a height of 620 feet (189 meters) crossing the continental divide between the Atlantic and Mediterranean watersheds. Its construction—requiring 100 locks—was completed during the reign of the Sun King, Louis XIV, under the instigation and direction of a tax-farmer named Pierre-Paul Riquet. It represents a heroic accomplishment of French engineering under the aegis of Louis' intrepid minister, Jean-Baptiste Colbert.

Yet Chandra Mukerji's ground-breaking study is a far cry from traditional accounts of heroic engineering. It does provide a detailed, fascinating, and sometimes blow by blow account of the construction history of the canal through all its complicated phases and technical difficulties. But it also represents a fundamental contribution to the study of political power and its relationship to built infrastructures in 17th-century France. Equally important is Mukerji's contribution to methodology as regards the history of early modern engineering.

*Impossible Engineering* is as much a study of the sociology of knowledge relevant to a large-scale engineering project as it is a study of the engineering itself. Mukerji analyzes the ways in which the idea of the canal was 'imagined as an act of state' [15], a necessary beginning, since such a large-scale project could not be accomplished privately; even the very first steps—indemnifying the necessary land and raising adequate funds—required the power and resources of the state. She examines in detail Riquet's strategies for convincing Colbert to undertake the project, and Colbert's strategies for justifying

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it to the king. A crucial issue was the king's desire to dominate the intractable nobles of Languedoc. The idea of royal stewardship over the land (or the *engagement* tradition) became a highly effective rationale for building the canal, and a way to rationalized greater royal control over the region and over the nobles who dominated it.

For France as a whole, Colbert employed a whole string of geographers, engineers, cartographers, and surveyors of various kinds for tasks such as surveying the forests. He also hired military engineers to build fortresses and other specialists to perform geographic functions involving surveying and cartography, essential activities for royal 'stewardship' and control of French territory. In her analysis of these diverse skills, Mukerji takes up a concept that will be central to her account of the Canal du Midi, that of 'distributed cognition'. The knowledge needed for territorial control was not held by one institution or one person but was distributed among diverse individuals from various social classes and included a mix of specific techniques and forms of expertise. These ranged from the mathematical knowledge of academicians to the thorough understanding of local conditions and methods of land and water management that belonged especially to peasants and other local men and women who worked the land.

The numerous decisions that had to be made concerning the Canal du Midi were far from straightforward. For one thing, the project exceeded the formal hydraulic knowledge of the time. Everyone agreed that the waterway needed to connect the Garonne River on the Atlantic watershed to the Aude River on the Mediterranean side. All agreed that the canal would have to cross the continental divide, and that at the high point it had to be fed by water from a higher source that would remain adequate throughout the year even during the summer dry season. If this canal were possible at all, it could be constructed in a number of different ways and along several possible routes. What was certain was that rocks, floods, strong currents, and rapids on one or the other of the two large rivers would present serious problems.

As Mukerji puts it, the project required epistemological work—arguing matters of fact—as well as the labor of construction itself. Ricquet the tax-farmer possessed neither the necessary social standing to legitimate his opinions nor actual engineering expertise. What

he did have was knowledge of the region of Languedoc. And he knew that local peasants and farmers possessed essential knowledge about trees and timber, soils and rocks, streams and small irrigation canals, and how to handle these physical characteristics of the landscape—this through long decades and even centuries of farming and irrigating, constructing water mills, and the like. The tacit expertise of the locals, as well as the knowledge of engineers, surveyors, and others, combined to turn the great experimental project into an actual functional canal.

Mukerji explains that the construction of the canal was divided into two great engineering phases. The first covered the area from the Garonne River at Toulouse and the Aude River near Trèbes, and was the part covered by the contract that Colbert gave to Riquet in 1666. The point of the division was to see if the canal actually could cross the continental divide, using the water supply from the Montagne Noire. If Colbert saw that this project succeeded, he could then undertake the second, from Trèbes to the Mediterranean. Mukerji provides many details of the construction history, including discussions of the techniques used or tried. She also details the shifting authority of Riquet and the supervisors sent by Colbert, and their changing relationships with Colbert and with each other. It becomes clear that the construction of the canal was an experiment that went forward in part by trial and error and included serious failures. Riquet used his own fortune to help finance the project, which suffered constant shortages of money. Colbert relied on him but never fully trusted him.

Perhaps the most intriguing and important part of this study is Mukerji's focus on the hundreds of artisans and laborers who worked on the canal. Mukerji's astute investigation of accounts and records has resulted in an in-depth portrait of ordinary workers and their 'indigenous' expertise. Stone cutters, masons, explosive experts, carpenters, surveyors, and what might be called hydraulic workers, including hundreds of peasant women, worked on the canal.

Mukerji shows that Pyrenees women made up the major part of the work force in key areas, especially in the second phase of the project. They labored as haulers carrying dirt up the mountains to fill dam cavities and they also made changes to the canals to create better water flow. These women were experienced in trapping mountain springs, creating reservoirs, diverting water to make meadows,

and constructing settling ponds and sluice gates. Their knowledge of weather patterns, soils, topography, and watersheds allowed them to bring to the project what Mukerji describes as their tacit knowledge of ancient Roman techniques. These included most importantly contour cutting of the canal through the mountains and the use of hydraulic cement in wet areas, such as in the construction of a sea wall at the difficult site of the harbor of Sète on the Mediterranean. Women from the Pyrenees could be paid less, were accustomed to itinerate work, enjoyed specific traditions of autonomy and power, and possessed hydraulic expertise derived from their local management of streams and hydraulic sites in the difficult mountainous environment of the Pyrenees.

By viewing the construction of the Canal du Midi as a complex process of political and territorial politics, and by taking account of the input of a great variety of skilled workers, Mukerji's book should have a significant influence on the study of pre-modern engineering. No longer can it be taken as a given that such projects were top-down enterprises in which relatively insignificant workers carry out clear directives from above. The complex conditions that Mukerji describes would undoubtedly have prevailed in many pre-modern construction sites, especially those involving difficult technical issues. The knowledge and the skills of local artisans and laborers may have amounted to crucial contributions to both the plan and execution of the work—particularly before the advent of professional engineering. Mukerji's book provides insight into the complicated practices of the pre-modern worksite in terms of both skill and knowledge.

The Canal du Midi pitted 'new Rome', that is, the expanding centralized state, against old Gaul, including the sometimes intransigent nobles and populace of Languedoc who frequently resisted the centralizing, 'modernizing' monarchy. Yet the new Rome that was embodied in the Sun King and Colbert's view of the ideal monarchy were furthered, Mukerji argues, by the local populace of Languedoc or, more specifically, by their knowledge of ancient Roman techniques. Mukerji suggests that ancient Roman ruins in southern 'Gaul' remained to be learned from. The local populace, she suggests, transmitted 'classical' techniques generation after generation as it used Roman ruins as quarries for its own structures and absorbed Roman building techniques in the process.

Mukerji's repeated references to the peasants of Languedoc as 'new Romans' using 'classical' building techniques to bring the Canal du Midi to completion is in my view an oversimplification. For one thing, whatever Roman techniques they were transmitting were hardly unique to them. Ancient Roman building techniques were very widely known by the late 17th century. The *De architectura* of Vitruvius had been a focal point of analysis and discussion for more than two centuries, including a rich tradition of commentary. Ancient Roman buildings and building techniques had been studied extensively in books, but they had also been studied in the actual structures and ruins of structures by humanist antiquarians, artists, engineers, architects, and artisans in Italy and elsewhere at least since the early 15th century. If local peasants, masons, and carpenters in Languedoc knew how to build a wall in the Roman fashion through a centuries-long tradition of handed-down practices, as Mukerji mentions early on [64–66], so also did builders, architects, and antiquarians in Paris, Rome, and elsewhere know how to build such a wall. Roman techniques such as the use of hydraulic cement and the cutting of graded canals for even water flow had been used in the Mediterranean basin by other artisans, for example, in 16th-century Italy. Although some of the techniques used by the Languedoc artisans may have had Roman origins, others may have developed out of their own technological circumstances, and still others may have come from elsewhere—say the Iberian peninsula which possessed centuries-long hydraulic traditions. Mukerji provides few references to medieval and late medieval construction and hydraulic techniques and projects in Languedoc itself, making it uncertain in general how Roman techniques may or may not have been combined with other techniques and practices.

Taking Mukerji's account as a starting point, I would surmise that the unique knowledge that local workers possessed would not have been Roman building techniques *per se*, but rather a close knowledge of local geophysical conditions, including soil, terrain, and hydraulic conditions combined with a rich tool-kit of tried and true methods of working with those conditions, some perhaps derived from the ancient Romans, some from other sources, including their own inventions. It is also possible that Riquet and the other supervisors of the Canal du Midi were already familiar with these techniques both from their knowledge of Languedoc and from practices in other

regions. Although Mukerji's emphasis on the local and tacit knowledge of peasant workers and its importance for the building of the canal is entirely convincing, her repeated description of these workers as the 'new Romans' using 'classical' techniques oversimplifies a more complex reality.

A related issue is that Mukerji pays little attention to hydraulic activities in Italy, the Netherlands, and elsewhere in France that preceded or were concurrent with the work of the Canal du Midi and may have influenced aspects of the canal's design and construction. She does mention that one of Colbert's overseers, an engineer named Pons de La Feuille, visited the Netherlands and recorded Dutch and Flemish sluice-opening mechanisms, locks, and lock walls. Yet there is insufficient follow-up concerning the specific influence of Dutch hydraulics on the Canal du Midi. In Italy, canal building in the Po River valley and elsewhere in northern Italy, and hydraulic engineering activities in other parts of Italy including Rome itself, constituted flourishing enterprises in the two centuries before the construction of the canal in Languedoc. These as well as the numerous hydraulic systems of the Iberian Peninsula are outside the purview of this book—and yet seem to this reviewer to be pertinent to the broader context of the great construction project in Languedoc. Given the relative mobility of engineers and artisans of various skills, it seems likely that these regions contributed hydraulic knowledge to the project, either directly or indirectly.

Throughout and in a final chapter, Mukerji describes Riquet's changing role vis-à-vis Colbert, as well as Riquet's changing self-perception, which ended in his view that he was beholden only to God in his inspiration to undertake and carry out the project. Mukerji's portrait of Riquet is combined with a focus on the difficult steps involved in actually completing the canal. The final chapter summarizes the sociological perspective that frames the book—the pursuit of natural knowledge as impersonal truth, territorial politics involving land management, principles of stewardship and material improvement, and material techniques.

Mukerji's book is beautifully illustrated by a number of photographs of the Canal du Midi at various points, most taken by the author. In sum, this is a masterful analysis that promises to exert an important influence both on historians of science and technology and

on historians of the early modern state. The canal itself is brought to life both as a project in state-building and as an immensely difficult, multi-phased, large-scale engineering project. It was heroic engineering indeed—‘heroic’ now expanded to apply to a multitude of workers, supervisors, experts, administrators, and entrepreneurs, to a Jean-Pierre Riquet who occupies a far more fraught and ambiguous position than before—and to the complex relationships among them all.