Engineering the Neapolitan state

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In 1808 a corps of civil engineers was constituted in the southern Italian Kingdom of Naples to provide it with new infrastructures and to implement a plan of economic and technological renewal. The activity of the corps led to controversy, however. In part the debate concerned their mathematical and scientific knowledge: was it sound? And could it legitimate their reshaping of the Neapolitan landscape? Around this debate, two opposite views of mathematics and of its relationship to engineering practices took shape: that of the engineers and that of their critics. While debates over the legitimacy and scope of mathematical methods in this period were not exclusive to Naples, they were experienced there with unparalleled intensity. The analysis of the production and use of mathematical knowledge in this context can therefore be particularly revealing.

The emergence of modern professions in the pre-unitary Italian states has attracted growing interest, and has proved to be an area where the methodological resources of the history of science and those of social theory can be fruitfully combined (Betri and Pastore 1997; Banti 1993; Malatesta 1995; Santoro 1997). Research has highlighted the relationships between changes in curricula, the redefinition of academic disciplines, the creation of new professions, and the emergence of modern administrative and bureaucratic structures (Brambilla 1997). The connection between professionalization and modernization is most
evident in the case of the ‘modern engineer’ (Castellano 1987; Giuntini 1989; Santoro 1989; Zucconi 1992; Bigatti 1995; Foscari 1996; d’Elia 1996; Blanco 2000; di Biasio 2004). Two main issues have emerged so far from the body of literature on engineering around 1800. First, the institutionalization and legitimization of modern engineering was strictly connected to administrative reform. A second and less straightforward issue has to do with the nature of the engineers’ knowledge, the new analytic rationality that informed their action, and with its relevance as a cause of social change. It is precisely the relationship between the cognitive-technological level and the socio-historical level to which I shall turn my attention here. How did the scientific and mathematical knowledge of engineers relate to their professionalization and to the modernization of the state?

It is generally assumed that the mathematical knowledge of modern engineers, in the Italian states as elsewhere, was the product of a gradual, quantitative increment of previous forms of mathematical and technical knowledge. In this perspective, the novelty of modern engineering training is described as the presence of more and more advanced mathematics. The development of a technoscientific culture, and the improved mathematical training of engineers, would thus be the cause of the shift from the tradition of art to the profession (Foscari 1996, 16). Accordingly, historian Luigi Blanco (2000, 18) has referred to a ‘problematic knot’, a dilemma that characterizes the current historiographical debate: was the professionalization of engineering primarily an intrinsic effect of scientific and technological innovation, or was it shaped by the intervention of the state? In this chapter I shall address this question by exploring aspects of the process of modernization of the kingdom of Naples in the early nineteenth century, and by focusing on the ways that professional civil engineering emerged and was legitimated (Gianetti 1988; de Mattia and de Negri 1988; di Biasio 1993; Foscari 1996; d’Elia 1996, 1997; Foscari 1997, 2000).

**Redistributing power**

The implementation of forms of administration that distinguish a modern state from earlier semi-feudal systems can be seen as a process of redistribution of power. In Naples, this process took the form of a long-lasting struggle against the feudal system and the juridical and cultural institutions that sustained it, a struggle that reached a turning point in 1806, when this independent kingdom was invaded and occupied by the French army. From 1806 to 1815 Naples and southern Italy were an integral part of Napoleon’s imperial system (Davis 2006). The French installed a new government, advised by local reformers and republican sympathizers. The government abolished the feudal system once and for all, and put in place an ambitious project of reform. Essentially, this meant transforming the semi-feudal Neapolitan kingdom into an efficient and centralized administrative monarchy (de Martino 1984; Rao and Villani 1995). The government could count on the collaboration of the reformist intelligentsia and of a significant portion of the local trading and landed middle-classes, to whom the new order could offer unprecedented economic opportunities and new forms of political representation. The new administrative system can be described as vertical, in the sense that it linked each administrative level to the one above and eventually to central government. By contrast, the traditional system can be described as horizontal, because the various administrative and juridical institutions worked almost independently, often following conflicting strategies.

The fate of the entire process of modernization rested upon the successful reshaping of the relation between central government and peripheral administrative institutions. The redistribution of power threatened the interests of elites both in Naples and in the provinces. The traditional semi-feudal system had guaranteed a large degree of autonomy and discretionary power to local elites. It also gave small groups of private investors a monopoly over lucrative financial and commercial enterprises such as public works, the grain trade, and money lending. French reform, by drastically reducing the discretion of provincial institutions, threatened the interests embedded in the administrative status quo (Davis 1981; di Ciommo 1988; Macry 1988). The new centralized and vertical administrative system was designed to allow the government to act quickly and effectively in any portion of the kingdom. Matters that had previously had an exclusively local dimension could now be managed by the central bureaucracy. At the same time, the map of the kingdom was redesigned by dividing it into provinces, districts, and communes, and by ranking towns and ports that hosted public functions according to their newly acquired status. Administrators at all levels acted more and more as civil servants in a hierarchical and meritocratic system, which was a threat to the powerful ancien régime institutions that were still functioning.

Emblematic of the new system of vertical relations was the government representative in each province, the intendente provinciale ‘provincial superintendent’. Also central to the plan of reform was the creation ex nulo of the Ministry of the Interior, which accumulated a large number of functions. All peripheral personnel depended on the Ministry, which was also in charge of controlling the finances of the communes, the administration of prisons, hospitals, hospices, agriculture, trade, manufacture, public education, the production of statistical data and, crucially for our present concerns, public works.

This plan of centralization was by far the most ambitious and radical to be implemented by the French anywhere in the newly occupied territories. As might have been expected, resistance was remarkably strong. Local elites voiced their
concerns primarily through the provincial councils, especially after the 1815 restoration of the Bourbon monarchy, when it became clear that the administrative reform would be continued (Spagnoletti 1988).

The reform aimed to shift the decision-making process from the periphery to the centre of the state. This was not only a physical phenomenon: the very discourse of decision-making was shifted to a new cognitive level. French politicians and the Neapolitan intellectuals who advised them did not have first-hand knowledge of local conditions in the provinces. Instead, the new government legitimated its decisions and long-term plans by referring to a new kind of authority: the technical expertise of civil engineers. With this move, traditional interlocutors of the government such as the landed aristocracy, the church, local communities, and the other relevant local institutions, lost their status as decision-makers. They could not speak the mathematical language of the engineers and they could not understand their technical knowledge. Their opinion on local matters could therefore be reasonably dismissed as irrelevant. Thus the future of reform depended essentially upon the authority of new experts: at the core of the modernization programme were the engineer and his highly specialized mathematical knowledge (for a comparison with the French case, see Porter 1995).

The knowledge of the engineer

The mathematical language of the professional engineer and the supposed neutrality of his scientific judgements embodied the hopes and ambitions of the emerging middle class. In the technical reports of the engineers, as well as in the political and literary discourse, a new bourgeois myth was being forged: that of the engineer's exceptional cognitive, technical, and moral stand. He spoke the 'voice of Reason and fought against the obscure political interests of immoral individuals who threatened the 'common good' and the future of the country.

The Real Corpo degli Ingegneri di Ponti e Strade 'Royal Corps of the Engineers of Bridges and Roads' was established by royal decree in 1808. Never before in Naples had engineers been granted such a high social status, comparable to that of professionals in law and medicine (de Mattia and de Negri 1988). The corps was operative early in 1809, and included twenty-three engineers on four levels: Inspectors, Chief engineers, Ordinary engineers, and Assistant engineers. Each Inspector was responsible for a large territorial unit called a divisione, and was in charge of technical, financial, and administrative matters for all public works in his area. Chief engineers supervised all projects within their own dipartimento, and negotiated with local contractors. Ordinary engineers were responsible for the technical details of specific projects, and were supported by Assistant engineers. A small number of candidate engineers could also be employed as trainees.

On a small scale, the corps was an exemplary model of a vertical, centralized, and well-administered institution, based on a meritocratic system of promotion and alien to the myriad particular interests that had shaped social life under the ancien régime.

The Neapolitan liberal intelligentsia rallied to support the modernizing battle of the engineers. Many believed that, due to the particular features of Neapolitan entrepreneurship, modernization guided from above was the only viable option for reforming both the administration and the economy. As for the engineers, their adherence to the values of a moderate political and economic liberalism was never in question, and culminated in the direct involvement of many members of the corps in the 1848 liberal revolution. The periodical Il progresso delle scienze, delle lettere e delle arti 'The progress of sciences, letters, and arts', a leading voice of Neapolitan and Italian liberalism, provided constant support for the activities of the corps. One contributor referred to engineering practice before the creation of the corps as greatly imperfect, because traditional civil architects had not been trained in the necessary scientific and practical disciplines. Their shortcomings were cognitive as well as moral: unlike the members of the corps, the writer complained, these architects had been chosen only because they were devoted to powerful ministers; as it might be expected, he wrote, their technical errors had been extremely grave (Rossetti 1835).

In straightforward prose, Carlo Affan de Rivera, director of the corps and its school from 1826 to 1852, offered the same fusion of cognitive and moral virtues, not only in the more rhetorical pieces he wrote for the general public, but also in the technical reports he sent to the ministry. Every technical intervention in the territory was an occasion for lauding the exceptional virtues of the members of the corps, and defending their exclusive prerogatives. The works around Lake Salpi, for instance, included land reclamation, the construction of new channels connecting the lake to the sea, and the creation of a modern fishing industry. Rivera reported that the former feudal owner of the lake lacked the relevant scientific knowledge to manage it, and therefore had been unable to make any profit out of it. With engineers now in charge of it things had changed dramatically: they had transformed a malarial area into a profitable investment for the government, a model site for national industry. The technical activities of the engineers always had a clear economic and political dimension. Rivera himself liked to refer to his activity as economia politica, 'political economy': he did not simply design channels and roads but also planned new colonie 'villages' the relocation of the population, and the establishment of factories. Rivera criticized Neapolitan entrepreneurs for their conservative investing strategies, and celebrated the engineers' effort to promote the various branches of political economy and hence the public wealth (Rivera 1842, 4, 6).

The intervention of the corps altered the socioeconomic structure of entire regions. Not surprisingly, Rivera had to fight what he regarded as preoccupations and prejudices, and admitted that the greatest obstacles to his plans were
moral, rather than physical. He lamented that many discredited his work publicly, guided either by their own *illecito guadagno* 'illicit interest', or by the misguided belief of having lost some legitimate right. A typical example was the opposition of sheeple breeders to his project for agricultural exploitation of the Apulian plan. Rivera judged their traditional breeding system to be a heritage of *barbarie de tempi andati* 'barbaric times' and the sign of a *vizioso* 'immoral' system of administration (Rivera 1842, 26).

In Rivera's discourse, the superior morality of the engineer was grounded on his understanding of natural and social reality, which legitimated and guided his transforming action. This was not the knowledge produced and transmitted in universities, where architects and civil engineers had traditionally been trained. Modern engineers were trained in an entirely new institution of higher education, the *Scuola di Applicazione di Ponti e Strade* 'School of bridges and roads', based on the model of the *Ecole des Ponts et Chaussées* in Paris, reformed in 1804 (Blanco 1991; Picon 1992). For the first recruits to the corps, in 1809, entry was by direct nomination by the king on the recommendation of the director of the corps; thereafter, suitable candidates were trained at the highly selective *Scuola* where courses started in the autumn of 1811 (Russo 1967). The course lasted three years (in 1818 it was reduced to two; in 1826 it was extended to four), and at the end the top students could enter the corps of engineers at the lower level (the numbers varied: the 1814 class saw three students entering the corps). The curriculum was radically different from that of the university, and mathematics was a central element. Students were selected through an entrance examination designed to test their mathematical knowledge. It included questions of plane and solid geometry, trigonometry, analytic geometry (curves and second degree surfaces), differential and integral calculus, design, French, and Latin. Successful candidates entered the 'first class', a course in which most of the time was devoted to mathematical disciplines (Rossetti 1835, 330). They studied the basics of mechanics, hydraulics, descriptive geometry, perspective, and geodesy. At the end of this cycle, another examination selected those who would enter the 'second class', mainly devoted to practical applications. Here the students studied subjects such as applied chemistry, agronomy, the application of mechanics to constructions and machines, architectonic structures, architectonic machines, and the features of the various kinds of constructions, primarily walls, roads, roofs, dikes, bridges, and suspended metal bridges. At the end of this second cycle, students went through a final one-week examination, on the basis of which they were ranked (Rossetti 1835, 333–335). The level of the entrance examination, and the career prospects, made the *Scuola* an ideal choice for college-trained men of 18 to 20 years old, mostly from the middle and upper levels of the southern bourgeoisie (Foscari 1997, 286–287). From 1812 a new and multifunctional *Scuola Politecnica e Militare* 'Polytechnic and military school' began to train, among others, candidates for the engineering school. In this way, the curriculum of the engineer became entirely independent from the local colleges and universities.

The life of the corps and the *Scuola* became more difficult under the restored Bourbon regime from 1815 to 1860. A powerful conservative block returned to power, representing the local and monopolistic interests that were most threatened by engineering activities. Reducing the autonomy and prerogatives of engineers became a primary objective of conservative political strategy. At first, in 1817, the corps and the *Scuola* were suppressed. The corps was replaced by a *Direzione generale di ponti e strade*, 'General directorate of bridges and roads', which was closely modelled on an ancien régime institution for the control of roads. Personnel were reduced from sixty-nine to fifteen; inspectors were eliminated; a new figure of contract engineer was created; and the provinces were entitled to supervise some of the works in their own territory. The careers of provincial engineers were influenced by the yearly reports that provincial superintendents sent to the government. The new institution was less structured than the corps, and it was also much less independent of local interests. The juridical status and career prospects of engineers, particularly those on short-term contracts and working under the control of the provincial councils, became uncertain. Even more crucially, public works were now planned on a short-term basis, which made it difficult to modify landscapes (Maiuri 1836).

The aim of these changes was to assimilate engineers under other administrative employees, thus reducing the autonomy and effectiveness of their action in the provinces. The Crown was largely responsible for this weakening of the prerogatives and authority of the corps, and for the closure of its school. Behind these decisions was the political aim of compromising between centralization and the interests of the provincial elites. In the mid 1820s, after the conservative excesses of the early restoration period, the appointment of a new director, Carlo Afan de Rivera, signalled that the balance had again shifted in favour of the centralizing process. Rivera prepared a plan that restored the authority and autonomy of the corps almost to its original form, starting with the name. The plan also included an increase in the number of engineers, limitations on the influence of provincial authorities, and the strengthening of the *Scuola di Applicazione*, which had reopened in 1819. The course was lengthened to four years and the number of teachers was increased. The government accepted the plan almost in its entirety, and it became operative in 1826.

**Conservative utopia versus the ideology of progress**

In the years that followed, as the debate over modernization intensified, the engineering school increasingly became a target for conservative politicians.
Already in the early 1820s, the director Colonel Francesco de Vito Piscitelli had to defend the special nature of the school, remarking that the distinction between civil engineers and other scientific practitioners was a feature of every civilized nation. He also defended the legislation according to which the school was the only entrance to a career of engineering (de Mattia and de Negri 1988, 464). In 1835, Riversi set up a public demonstration of the didactic effectiveness of the school: a one-week exhibition held at the Scuola di Applicazione to celebrate the corps, its many remarkable achievements, and its role in the modernization of the country. The liberal periodical Il progresso reported on it enthusiastically, and asserted that the superiority of modern engineering over previous forms of architecture and engineering derived from its being a coordinated collective activity, in contrast to the traditional image of the isolated genius. Modern engineering was described as the practice of a well-structured group of experts, which acted as if guided by a single mind. The exhibition was a success. Projects exhibited by students included plans of ports, prisons, and bridges. Plans of public works recently completed by the corps were also shown, such as those for the metal suspension bridges over the rivers Garigliano and Calore. Students from the school gave lectures on topics such as mechanics, hydraulics, and descriptive geometry. The author of the report in Il progresso was confident that the future productions of these alert and educated minds (i svegliati e culti ingegni) would benefit the country greatly, and would keep it apace with the wealthiest European countries. The author touched only cursorily upon the reasons for such an unusual exhibition but the relevant passage is revealing. Riversi had to prove that the scientific training of his engineers was sound, and that the school was not a waste of public money (Rossetti 1835, 329–335). Apparently some influential people were convinced of the contrary, and were putting pressure on the ministry of finance to cut its funding. Leading the critics was a first-rank politician, Giuseppe Ceva Grimaldi, president of a major ancien régime institution and future prime minister.

The activity of Ceva Grimaldi is key to understanding conservative cultural and political strategies. In the 1830s, crucial years for Neapolitan modernization, he repeatedly attacked Riversi on the practices of his engineers and the usefulness of the Scuola di Applicazione. He defended the interests of the provincial elites, landowners, and private contractors, and did whatever he could to restrict the autonomy and functioning of the corps. He pressed for a reduction of personnel, for lower wages, and for giving back to the provinces the responsibility for financing and supervising public works (Gianetti 1988, 936–938). By attacking the engineers, conservatives were attacking, although indirectly, the entire centralizing policy of the Crown, and criticizing its absolutist ambitions.

Riversi replied promptly, pointing out the reasons for the socioeconomic developments he considered necessary, and more generally for the need to ‘civilize’ the provinces. But the technical language in which he described the activities of his engineers, and the large amount of technical data with which he presented Ceva Grimaldi, were now being questioned by conservatives. The modern engineer’s ‘analytic reasoning’ was to Ceva Grimaldi an expression of arid and abstract knowledge, which had little to do with the complexity of practical reality and with the art of economic and political decision-making.

The debate generated various publications, which even in their titles showed two opposing perspectives. Thus Riversi published Considerazioni su i mezzi da restituire il valore proprio a’ doni che ha la natura largamente conceduto al Regno delle Due Sicilie, ‘Remarks on the means to value the gifts that nature has lavished upon the Kingdom of the Two Sicilies’ (1832), which emphasized the new possibilities for exploiting the kingdom’s natural resources through the application of modern science. In response, Ceva Grimaldi published Considerazioni sull’opere pubbliche della Sicilia di qua dal faro dai Normanni sino ai giorni nostri, ‘Remarks on public works in continental Sicily from Norman times to the present day’ (1839), an historical essay on the art of administration and the Neapolitan tradition of public works since the Middle Ages. Ceva Grimaldi ridiculed the ‘prejudice’ that civilization in southern Italy had begun with the establishment of the Corps of Bridges and Roads, and called the tendency to attribute all administrative evils to the feudal system ‘a boring commonplace’. In his writings Riversi referred constantly to such well-known myths of modernity as the inexorable path of progress, the rationality of a liberal economy, and the superior moral status of engineers. In response, Ceva Grimaldi seemed to ground his reasoning on an unmistakably conservative utopia. Behind his sceptical remarks on modernity lay references to a mythical description of the kingdom in the pre-French period. In those days, according to Ceva Grimaldi, all channels were navigable, all roads well kept, the administration functioned perfectly, and the skills of Neapolitan master masons were unsurpassed. He asserted that the Neapolitans knew how to build roads even before the French arrived, and that modifying their routes was a sign of little respect for their ancestors. His descriptions are literary reconstructions of a past that never was, where peasants and artisans lived peacefully around the manor and the church, in a kingdom made up of hundreds of small, highly independent patrie, ‘fatherlands’. Behind Ceva Grimaldi’s utopia, and behind each of his arguments, lay the aim of preserving as much as possible of the current territorial and administrative structure of the country. He claimed to be speaking for the many small patrie, which were desperately opposing the ‘tyranny’ of the capital. The enemy was not the king, of course, but whatever was ‘foreign’, ‘abstract’, ‘anti-historical’. The new ‘industrial feudalism’, in Ceva Grimaldi’s view, was no less tyrannous than the old one (Ceva Grimaldi 1839, 149, 172–173). In these same years, the mythical image of a happy and timeless Neapolitan countryside was being diffused all over Europe by the extremely
thinking according to the combinatorial rules of algebra, the study of economic issues on the basis of individual and collective utility, a philosophy of teaching based on sensation and experience, and the corresponding reorganization of scientific disciplines and curricula. It was a set of cultural resources, styles of thinking, skills, mathematical techniques, relevant problems, and possible solutions that informed the activities of the engineers (Picón 1992). The teachers of the Scuola built their experimental and mathematical courses accordingly, so that analytic rationality was incorporated into the training of an engineer from the very beginning.

In its more general sense, analysis was a way of thinking based on the assumption that all complex problems could be broken down into their elementary components, and that these components could be then solved independently thus providing a solution for the original problem. In mathematics, the integration of an equation was taken to be emblematic of this way of proceeding. Mathematical analysis, although a polysemic term, was often used as a general label for the techniques of algebraic analysis and those of calculus, as based on the mechanical manipulation of symbols and in opposition to the intuitive procedures of synthetic geometry. In this sense, analysis was described by its supporters as natural and easy-to-learn. With proper training, any student could master it, because it was simply an extension and formalization of the normal way the human mind works. Once the spirit of the analytic method was grasped, the authors of engineering textbooks claimed, the solution of any relevant mathematical problem would be straightforward, the outcome of a mechanical procedure (Padula 1838, 13). There were no child-prodigies in the engineering school, just enthusiastic students.

It followed that the engineering school taught its students not just more or more advanced mathematics, but a new kind of mathematics altogether. Representative of the analytic approach was a textbook of plane and solid geometry entitled *Raccolta di problemi di geometria risolti con l'analisi algebrica* 'Geometrical problems resolved by algebraic analysis' (1838), by Fortunato Padula, a graduate of the engineering school and one of its future directors. Padula grouped the standard problems of a university course and solved them in a purely analytical way, through the manipulation of general equations that represented the properties of the figures in question. Padula was not simply translating geometrical problems into analytic language in order to make the discovery of the solution easier, and then performing an appropriate final construction, as synthetic mathematicians required. Rather, he did what he had been trained to do: he showed how the solution to each problem could be seen as a particular case of a general structural relationship between families of geometrical entities. The problem-solving process did not begin with inspection of the figure, but with the immediate introduction of the relevant equations, each of them generalized by means of appropriate
parameters and variables, and thereafter manipulated without any reference to the initial figure. The particular origin of the problem thus became irrelevant. The necessity for inspecting the figure was eliminated, as was the entire constructive phase. The paradigmatic work, in this respect, was Joseph Lagrange’s article (1773) on triangular pyramids. In this article Lagrange completely dispensed with the use of figures, and instead provided a description of the general structural properties of the pyramids. These technical developments accompanied a major epistemological shift in mathematics, as the meaning and heuristic power of algebraic algorithms were now conceived as completely detached from geometrical intuition (Fraser 1989). The Lagrangians—the Neapolitan engineers among them—considered analytic reasoning that detached algebraic reasoning from geometric intuition, as a fully legitimate and autonomous heuristic method.

**Standardization**

One of the key issues in the debate over modernization was the standardization of weights and measures. Here all the main social, political, and scientific themes that we have touched upon converged in a single, crucial issue. The engineers, Rivera in the first place, campaigned strongly in favour of standardization (Rivera 1840; 1841). Rivera had his engineers adopt a single and all-purpose decimal system as early as 1830. To him standardization was a necessary if the corps was to take full control of the territory of the kingdom. Once again it was centralization versus local autonomy, uniformity versus variety, rational administration versus a world of autarchic communities.

Traditional Neapolitan measuring systems reflected the complex socio-political structure of the country, and the variety of its traditional occupations. So, for instance, land was often measured in terms of the number of days needed to plough it or the number of men needed to harvest it in a day, or else in terms of its monetary value. This meant that metrological units could not be fixed, because working in the plain was different from working in a mountainous region, and the value of land varied from place to place. Further, products that were manufactured by different processes, like wine and oil, were measured in different units, none of which was decimal. Such variety was of no concern to users, who had developed the necessary translating skills. In the personal negotiations that characterized internal trading, buyers and sellers used their discretion to re-shape the rates of exchange between units. To Rivera and the officials of the corps this was chaos, and a sign of bad administration. A uniform plan of development for the country needed a uniform measuring system.

The heated anti-standardization campaign was guided, as might be expected, by Ceva Grimaldi, and has been described by later commentators as rhetorical and historical, and opposed to the rational, technical arguments of Rivera (Giannetti 1988; d’Elia 1997). The problem with this account of the controversy is that it implies that the contemporary scientific establishment was united in defending Rivera’s arguments when, in fact, it was quite the contrary. In other words, the two fronts did not map onto humanistic and scientific culture, respectively, but rather onto two different kinds of humanistic and scientific culture. Let us consider Ceva Grimaldi’s essay against the reform of weights and measures (1838), one of the most representative texts of the conservative literature. Interestingly enough, this essay contains a long scientific introduction signed by the leading Neapolitan mathematician of the time, Vincenzo Flauti, professor at the University of Naples and secretary of the Royal Academy of Sciences. In opposition to all basic beliefs of the reformist intelligentsia, Flauti noted that mathematical abstractions are beautiful intellectual productions, but they are useless in addressing questions related to public welfare. Flauti openly attacked Rivera and his banda ‘gang’ of engineers for trying to standardize the many systems of weights and measures in the kingdom. The engineers were, he claimed, attempting to provide an abstract solution to a concrete problem, and in so doing they threatened to destroy the inveterate customs of the people. In the past, the people did not need any expert to tell them how to measure and weigh, as they were confident of their own ancient customs. To modify these customs, Flauti concluded, would amount to modifying human nature itself. Flauti agreed that the decimal system was suitable for calculations and for certain scientific purposes, but argued that it was much less so for everyday transactions (Ceva Grimaldi 1838). He believed that decisions regarding weights and measures should be taken by the users themselves, while only economists and historians should advise the government on these matters. This was certainly not the terrain for professional mathematicians, let alone engineer-mathematicians.

Rivera held precisely the opposite view. He thought that a corporation of scientist-artisans should plan and direct public works, and he ridiculed the snobbish behaviour of Neapolitan academic mathematicians, who thought they would degrade themselves if they got close to the factories, and therefore neglected the application of the sciences to the arts (Rivera 1832, II 461). What Rivera aimed for was precisely the application of science to the administration of the state (Rivera 1823, 38).

**Another mathematics**

On what grounds did Flauti criticize the mathematical practice of engineers? Around 1800 Naples had seen the emergence and rapid institutionalization of a mathematical methodology that was different from the analytic approach.
Following the innovative teaching of Nicola Fergola, a group of young and talented mathematicians had developed a lively school of synthetic mathematics (Loria 1892; Amodeo 1905; Mazzotti 1998). This meant that their approach to mathematics was essentially geometrical. Their practice and techniques were constructed around the basic notion of intellectual intuition as the foundation of all mathematics and the source of its certainty. They emphasized the visual dimension of geometrical knowledge—its distinctive perspicuity—against faith in the unlimited power of analysis and the focus on the mechanical manipulation of algorithms, which had characterized late eighteenth-century French mathematics and which was central to early nineteenth-century engineering training in Naples. The Neapolitan synthetic school denied that there could be something like a universal problem-solving method, and insisted on the irreducible specificity of different kinds of mathematical problems and techniques. Crucially, their problem-solving techniques were to be used exclusively in the realm of pure mathematics: they insisted upon the limited scope of mathematical reasoning, which they believed could not guide human action in empirical matters. These beliefs led Fergola and his students to shift their attention from applications to foundational issues, and to prefer the study of classical geometrical problems to that of eighteenth-century analysis.

To solve a geometrical problem elegantly was, according to the synthetics, a matter of long training and exceptional talent. The necessary procedures could not be mechanized in the way the analytics believed and, importantly, they could not be deployed in other disciplines without losing most of their heuristic power. On these grounds, the synthetics asked for a clear-cut demarcation between the speculative pure mathematician and the engineer. The former might lead mathematical research in universities and academies, while the latter would merely use portions of mathematical knowledge for specific practical purposes (Flauti 1820; 1822).

Synthetic teaching was based on discovering and grooming the natural talent of exceptional students through the study of the ancient paradigmatic examples. The best students formed a kind of inner circle that met often at the professor’s house. A typical product of this system was the child prodigy Annibale Giordano who, aged fifteen, had been invited by Fergola to solve a certain geometrical problem, and whose classically elegant solution was published in the journal of the most prestigious Italian scientific society of the time (Giordano 1786). Fergola’s synthetic school was an innovative phenomenon with respect to previous academic traditions. However, Fergola and his students tended to conceal their novel scientific and philosophical interests by presenting their work as essentially derived from an ancient tradition in geometrical problem solving, which stretched from the Classical era through Galileo and the geometers of the seventeenth century. This tradition, with its emphasis on Greek and Latin sources, was intended to give the synthetic school an authoritative position in conservative Neapolitan academic culture. It also reinforced the impression, among later historians, that Neapolitan synthetics were survivors of a past age. On the contrary, Fergola was well versed in algebraic techniques, and in integral and differential calculus (Fergola 1788a; 1788b; undated manuscript). Fergola’s mathematical project was far from being a mere return to the ancients. Rather, this devout professor was clearly concerned by the recent association of certain mathematical techniques—namely analysis—with philosophical and political projects that in his view threatened the stability of traditional society. His scientific work can be seen as a thorough attempt to investigate the foundations of mathematical reasoning, in order to redefine the range of its meaningful applications.

Working along the same lines, Fergola’s former pupil Flauti challenged the engineers in 1839 to solve a number of geometrical problems, with the intention of showing the intrinsic superiority of the synthetic over the analytic method. A reply came from Padula, with an essay significantly dedicated to Rivera Padula stated once again that algebra and calculus should be applied to solve the socioeconomic problems of the country. Anyone who is interested in modern mathematics, Padula argued, should be concerned with its applications to natural philosophy, constructions, and industrial mechanics, and should abandon the sterile and uninteresting exercises favoured by the synthetic school (Padula 1839, 46). He was referring to the concern of the synthetics with pure mathematics, their development of methods of synthetic and projective geometry (Flauti 1807), their study of the history of mathematics, and their attempt to provide a solid logical foundation to the entire edifice of mathematics, including calculus. Indeed, in some respects the synthetics’ programme of research was closer to what we now perceive to be the main European trends of the early nineteenth century rather than the dated Lagrangian programme defended by Padula. The engineers remained ostentatiously uninterested in pure mathematics and synthetic geometry until the mid-century (Besana and Galluzzi 1980).

Having emerged together in years of deep political and cultural struggle, the two Neapolitan schools developed goals and practices that were in most respects opposite. They encouraged different skills and techniques, and were differently receptive to novelties coming from abroad. I would not like to argue here that there was a necessary connection between certain political and religious attitudes and certain problem-solving methods. Rather, my interpretation is historical. In early nineteenth-century Naples different cultural resources, including mathematical knowledge, were being mobilized and reshaped to express and support different socio-political projects for the future of the country. On the one hand, engineers and their supporters among the southern bourgeoise reshaped analysis as an emblem and instrument of modernization. On the other hand, devout and conservative mathematicians like Fergola and Flauti considered the
synthetic approach, and the institutionalization of the new subdiscipline of 'pure mathematics', as the most appropriate response to what they perceived as a broad cultural and moral crisis of European civilization.

The analytic rationality of the engineers, and their mathematical and technical knowledge, were openly challenged by university-trained mathematicians until the late 1830s, when the conservative opposition lost ground in the broader political and social arena. Ultimately, the mathematical knowledge of the engineers became legitimated as enough relevant groups within Neapolitan society began to share the orientation of men like Rivera. The emergence and stabilization of analysis, in other words, should not be seen as a pre-existing historical cause for the process of modernization, but rather as an expression of this process, and the emblem of its success.

Conclusions

In this chapter I have explored some aspects of the relationship between mathematical knowledge and its carriers. The Neapolitan case offers an effective illustration of how mathematical knowledge can be shaped, mobilized, and deployed to support the goals of particular collectives. It therefore provides evidence for the socially constructed nature of mathematical knowledge, and more specifically for the contingent character of the relationship between mathematics and engineering. The boundaries between these two sets of practices and the form of their interaction are the product of socio-historical conditions, and as such are constantly open to negotiation and redefinition.

The chapter has also investigated the way in which the institutionalization of new forms of mathematical reasoning in the first half of the nineteenth century was related to the creation of professional elites and to the formation of the modern state. My reconstruction of the Neapolitan case suggests that these should be understood as different aspects of an essentially unitary process of social and cognitive change. The emergence and stabilization of new forms of mathematical reasoning does not appear to have been the cause of the emergence of new and more effective engineering practices. Rather, the establishment of the new mathematics was a condition for the legitimization of engineering activity—and the socio-political vision that shaped it.

In the light of these considerations, the historiographical dilemma mentioned at the beginning of this chapter should be rejected as misleading. One does not have to choose between two competing historical explanations for the professionalization of engineering—either the appearance of a new body of knowledge or the intervention of the state. My interpretation of the Neapolitan case offers further evidence that science and technology do not evolve by virtue of some inner logic independent from the intentions and purposes of those who learn, teach, use, and change them. In particular, engineering practices seem to be the negotiated outcome of specific cultural, political, and economic interactions rather than the result of a straightforward application of scientific knowledge to the solution of practical problems (Alder 1997; Kranakis 1997). Thus, the analytic rationality and specific mathematical practice of Neapolitan engineers were shaped by, and sustained, their theoretical and practical orientations (for the French case, see Picon 1992; Brian 1994). The institutionalization of what they called ‘analysis’ was part of a broader mobilization and transformation of cognitive resources in support of social reform. In other words, the battle for modernization had to be won not just with but also in the textbooks of mathematics.

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