

**Zeitschrift:** gta papers  
**Herausgeber:** gta Verlag  
**Band:** 1 (2017)

**Artikel:** Water/Space : Ledoux and the disposition of architecture and machines  
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**DOI:** <https://doi.org/10.5169/seals-791257>

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## Water/Space: Ledoux and the Disposition of Architecture and Machines

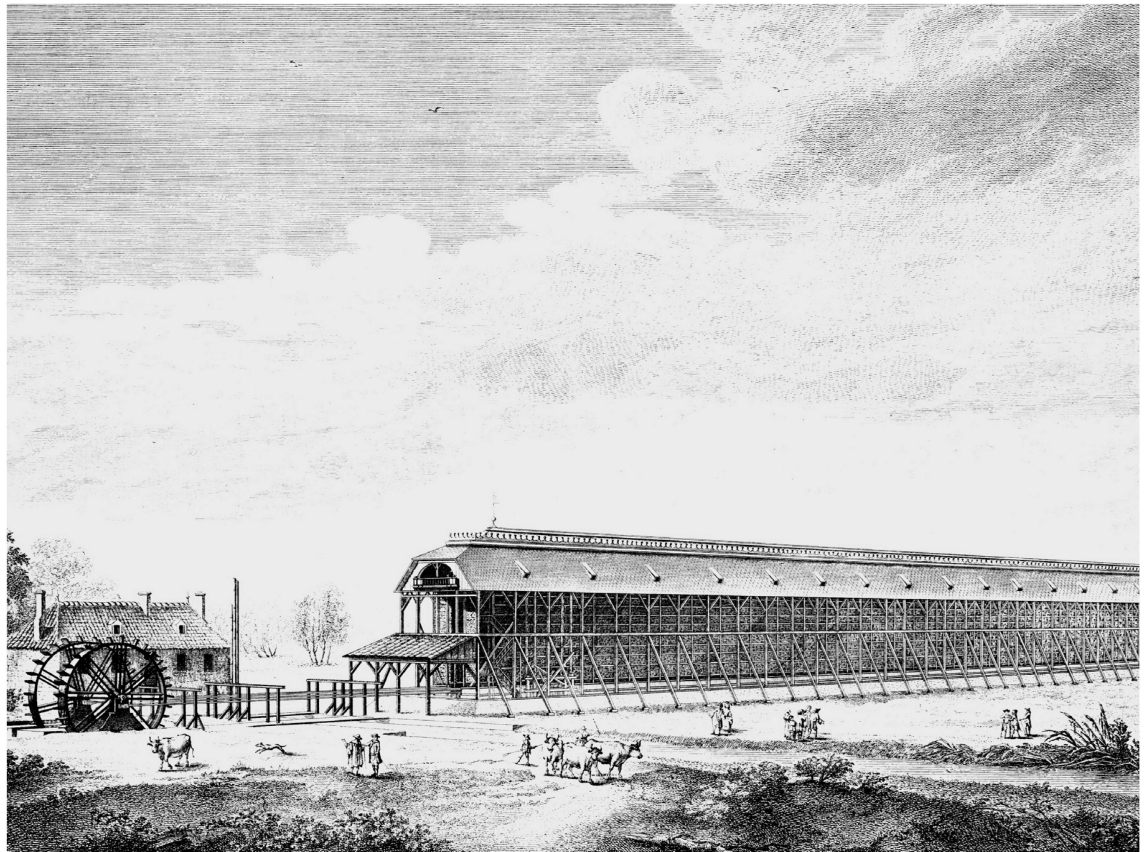
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1 For a bibliography, cf. Julian Jachmann, "Claude-Nicolas Ledoux als Sensualist," *Zeitschrift für Kunstgeschichte*, 75, no. 3 (2012), pp. 351–72. For a helpful overview of recent approaches see Gérard Chouquer and Jean-Claude Daumas (eds.), *Autour de Ledoux: Architecture, ville et utopie* (Paris: Presses universitaires de Franche-Comté, 2008). For important interpretations see Daniel Rabreau, *Claude-Nicolas Ledoux (1736–1806): L'Architecture et les fastes du temps* (Bordeaux: W. Blake & Co., 2000); Anthony Vidler, *Claude-Nicolas Ledoux: Architecture and Social Reform at the End of the Ancien Régime* (Cambridge, MA: MIT Press, 1990). Regarding the systematic organization of production and of social structures, the utopian designs of Ledoux were compared with the works of Sade and Vaucanson in Jacques Perriault, "Le concept de machine et de système chez Ledoux, Sade et Vaucanson," *Culture technique*, 7 (1982), pp. 113–23.

f.1 Graduation building at the Royal Saltworks at Arc-et-Senans, published by Claude-Nicolas Ledoux, 1804.

In its multifaceted diversity, the architectural and literary work of Claude-Nicolas Ledoux (1736–1806) can only be described as dazzling. The manifold topics provoked a plethora of heterogeneous appropriations by architects as well as art historians, who made the architect and pupil of Jacques-François Blondel (1705–1774) successively a revolutionary figure, a proto-modern autonomous architect, and a follower of physiocratic, encyclopedic, sensualistic, and freemasonic thoughts. 1 Apart from the wide scope of his work and his unpredictable fortune, the main reason for the characteristic ambivalence can be found in the only publication of Ledoux, *L'architecture considérée sous le rapport de l'art, des mœurs et de la législation*. The tome of monumental size and broad scope, published in 1804, comprises 125 copper-prints and 240 pages of text. In chapters of varying length, each usually discussing one building, the author oscillates between decade-old and recent projects, between fantastic ideas and realized buildings, between private, public, and technical structures. Moreover, the text is of a poetic, highly metaphorical character, merging several literary genres and styles. This literary "sfumato," as Michel Gallet aptly called it, is at least partly the result of the precarious political situation around 1800 – a time when Ledoux is not at liberty to speak





freely about his success during the last years of the Ancien Régime.<sup>2</sup> Yet on closer examination the volume shows a surprising unity. Ledoux employs his partly realized project of the saltworks at Arc-et-Senans as the focal point of the book, expanding and amplifying this structure at least on paper to create an ideal city called "Chaux." Numerous buildings are integrated into an urban idea that derives from the topographical structure of an English landscape garden and the literary form of utopia. Creating and supporting an ideal community, the benevolent will of the architect replaces the divine creator.<sup>3</sup>

One of the main protagonists in his ideal city is without doubt the element of water.<sup>4</sup> Above all, water is the *raison d'être* of the saltworks at the heart of Chaux. In order to use spare brine from nearby saltworks, aqueducts lead from there to a new, convenient location near a forest, where the abundance of wood facilitates the operation of furnaces for salt production. Ledoux emphasizes the manifold roles of water in his realized buildings as well as in his publication. He presents a fantastic design for a bridge over the River Loue near the saltworks, pointing out its importance as a mode of transport, depicting a towpath and vessels.<sup>5</sup> The saltworks themselves welcome the visitor with an entrance hall designed as a grotto, which alludes to the sources of the saltwater.<sup>6</sup> And even the steam rising from the production buildings should—if we were to believe the architect himself—be employed in a way such as to identify or characterize the building as a location of salt production.<sup>7</sup> The energy of rivers and canals is put to use in mills. Furthermore, by constructing wells, horse ponds, and public baths, the architect makes use of water for public welfare. As Anthony Vidler puts it concisely: Ledoux basically feels "surrounded by water."<sup>8</sup> By controlling the force and employment of the universally important element of water, the architect himself acquires a universal role in the eyes of Ledoux.

Yet the author does not focus on technical buildings alone but presents a variety of private and public building types. And indeed, the responsibility for engineering tasks like the aqueduct, the waterworks, or the salt pans did not lie with him but with specialized engineers and local craftsmen. He even criticizes the form of the graduation building.<sup>9</sup> In his opinion, the wooden supports are "d'une proportion svelte, d'une proportion gothique" and thus lack tectonic plausibility—at least in comparison to the Doric columns he prefers; and according to him the hipped roof violates the laws of art and nature in favor of simple forms.<sup>9</sup>

This criticism points us to a fundamental issue of architecture in the Early Modern period, which came to be more and

<sup>2</sup> Michel Gallet, Claude-Nicolas Ledoux: *Leben und Werk des französischen "Revolutionsarchitekten"* (Stuttgart: Deutsche Verlags-Anstalt, 1983), pp. 7, 126–30.

<sup>3</sup> Ledoux emphasizes repeatedly the universal role of architecture, e.g. Claude-Nicolas Ledoux, *L'Architecture considérée sous le rapport de l'art, des mœurs et de la législation* (Paris: C.N. Ledoux and H.L. Perroneau, 1804), pp. 8, 17, 28–9; at some points the term "machine" is employed, e.g. the "machine ronde" of the universe, pp. 55, 236.

<sup>4</sup> The dominance over nature and especially water was a notion also prevalent in the Ancien Régime, e.g. in Versailles. Katharina Krause, *Die Maison de plaisance: Landhäuser in der Ile-de-France (1660–1730)* (Munich: Deutscher Kunstverlag, 1996), p. 33.

<sup>5</sup> Ledoux himself stresses the importance of canals as a mode of transport, cf. Ledoux, *L'Architecture* (see note 3), p. 74.

<sup>6</sup> Vidler, *Ledoux* (see note 1), p. 114.

<sup>7</sup> Ledoux, *L'Architecture* (see note 3), p. 119.

<sup>8</sup> Vidler, *Ledoux* (see note 1), p. 316.

<sup>9</sup> Ledoux compares the structure to a ship or "ville flottante." See Ledoux, *L'Architecture* (see note 3), p. 57; Vidler, *Ledoux* (see note 1), p. 316.

f.2 Frontispiece of Bernard Forest de Bélidor, *Architecture hydraulique*, vol. 1, 1737.

10 Since the time of Vitruvius, the Doric order is thought to derive historically from wooden structures. In the eighteenth century this concept found an ardent follower in Marc-Antoine Laugier (*Essai sur l'architecture*, 1753). While these theories resulted in important formal experiments, surprisingly they did not help bridge the gap between the system of the column orders and the practice of vernacular or technical wooden buildings.

11 Bernard Forest de Bélidor, *Architecture hydraulique, ou l'art de conduire, d'élever et de ménager les eaux pour les différens besoins de la vie*, part 1, vol. 1 (Paris: Charles-Antoine Jombert, 1737).

more of a predicament in the eighteenth century. Architecture relied mainly on the Vitruvian ideas of stone and column buildings following classical examples. The tectonic principle of massive load-bearing supports, especially columns, is essential to this concept. 10 However, the construction of machines, which were supposed to control and augment movement and force, required a very different approach. Instead of a structure built in stone—or a wooden building painted or plastered to imitate a stone building—a wooden

structure was most common within mechanics; parts that moved, wheels, tubes, ropes, and oblique levers forming complex structures for which weight and stability were just one determining factor among others. Bernard Forest de Bélidor (1698–1761) was one of the leading specialists in the most important fields of engineering—the construction of military and hydraulic machines. In his extensive and popular publication on hydraulics, first published from 1737 to 1753, two illustrations reveal a striking conflict between machines and the prevailing Early Modern concept of Vitruvian architecture. 11 An engraving on the first pages of the treatise shows an example of classical column architecture, encasing a complex apparatus, which is obviously responsible for generating the water pressure for the fountains shown in the background. In this case the machine is limited to an existence in the shadows of architecture. f.2 In another illustration the conflict of different modes of design seems to be more balanced—with an outcome all the more disturbing. f.3 Bélidor shows the pumping machine of La Samaritaine, built after 1712 on the site of an older predecessor in order to supply the royal palaces in Paris with water. In a manner that can only be described as absurd, this seemingly heavy and tectonic example of Vitruvian architecture rests on a much lighter and less solid base that is constructed from wood and conceived more



ARCHITECTURE HYDRAULIQUE

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as a machine than as a building.<sup>12</sup> This obvious discrepancy between achievements in architecture and in engineering posed a problem in the eighteenth century—not least because of the growing professional specialization that manifested itself in successful engineering schools.<sup>13</sup>

<sup>12</sup> The scaffold-like base of the building could hardly be seen while standing on the bridge; its design is therefore focused on this point of view.

<sup>13</sup> The highly complex topic involves the definition of the academic disciplines, the history of institutions and pedagogy in France, and the relationship between art and science. For an introduction to this field of study cf. Antoine Picon, *Architectes et ingénieurs au siècle des lumières* (Marseille: Parenthèses, 1988). Andrew Saint provides a succinct summary: "Architecture, a fellow-traveler clinging to the juggernaut of engineering's onslaught, never quite fell off." Andrew Saint, *Architect and Engineer: A Study in Sibling Rivalry* (New Haven, CT: Yale University Press, 2007), p. 33.

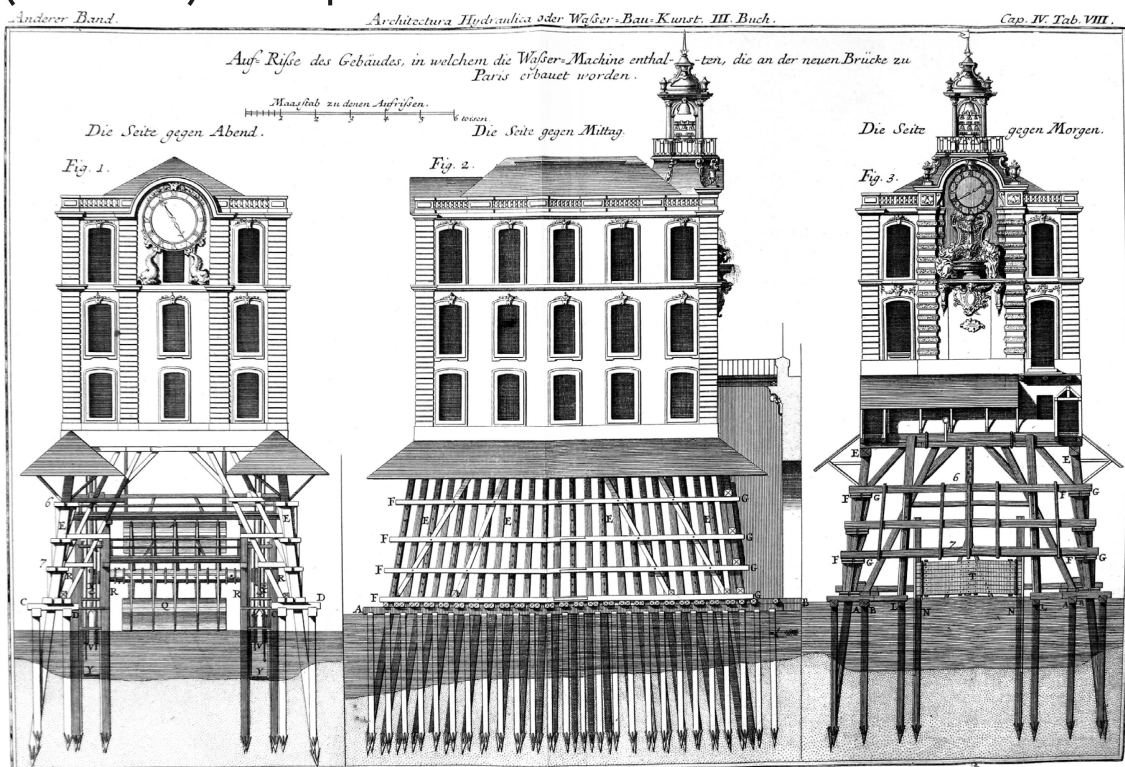
**f.3** La Samaritaine in Paris, built after 1712, published by Bernard Forest de Bélidor, 1743 [1737].

<sup>14</sup> Ledoux, *L'Architecture* (see note 3), p. 45. Boullée's project was aimed at remodeling the Pont Louis XVI (Pont de la Concorde) in Paris, designed by Jean-Rodolphe Perronet; Boullée explicitly criticized the aesthetic aspect of the engineer's concept. See Picon, *Architectes et ingénieurs* (see note 13), pp. 273–4. Boullée's drawing is depicted and described in Jean-Marie Pérouse de Montclos, *Étienne-Louis Boullée (1728–1799)* (Milan: Electa, 1997), pp. 76–8. His design differs significantly from that of Ledoux; Boullée's aims seem to be solely semantic while Ledoux combines semantic and structural ideas as the hulls and masts form the main part of the structure.

**f.4** Bridge design by Claude-Nicolas Ledoux, published 1804. → 42/43

## Bridging structural difficulties with "talking architecture"

If we follow Ledoux's lead in affirming the unifying and universal role of the architect, this problem had to be addressed somehow. Two examples from Ledoux's *L'Architecture*—a bridge and the Maison des Directeurs de la Loue—show how this problem could be dealt with on a conceptual level. The pathway to the ideal city of Chaux, which leads over a bridge across the River Loue, was most likely inspired by a similar project that Étienne-Louis Boullée (1728–1799) developed around 1787.<sup>14/f.4/f.5</sup> Ledoux introduces this



rather fantastic design with two illustrations. A perspective view shows the building in its context: a lavish landscape, interspersed with other imaginary building types, being part of his utopian concept. Furthermore, the function of the structure as junction of transportation routes becomes obvious as a towpath runs below street level. Ground plan and profile of the bridge reveal an implausible construction: the foundations are far too extensive and the form of the bulgy pillars does not follow any conventional reasoning. But even more striking is the outer appearance. The bridge is very low and bare of all ornament, except for the sculptural manifestation of antique ships that seem to carry the road. The piers have the form of hulls while lowered





*Le Douce Architecte du Roi.*

*Bouquet sculpt.*

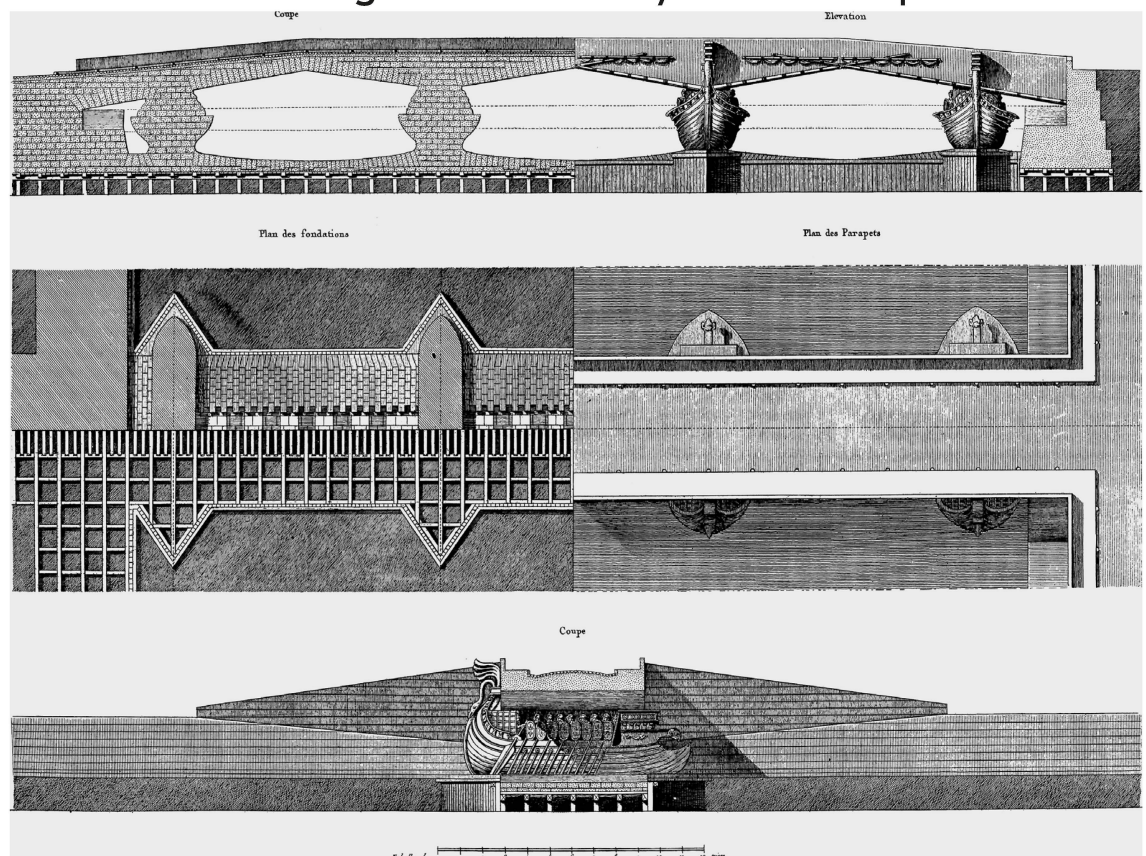
VUE PERSPECTIVE DU PONT DE LA LOÛE.



masts replace the arches. The main argument of a semantically charged building becomes obvious enough in the accompanying text, in which Ledoux mentions the pontoon bridge that Xerxes used to span the Hellespont. This analogy goes as far as to place two of the ship-like pillars next to the shore, thus emphasizing the parallel while impeding the towing of the ships. By drawing on the famous tradition of ephemeral bridges, which have their roots in antiquity, the architect is able to design a structure that draws attention to its function as well as its historical connection to heroic deeds and technical feats.

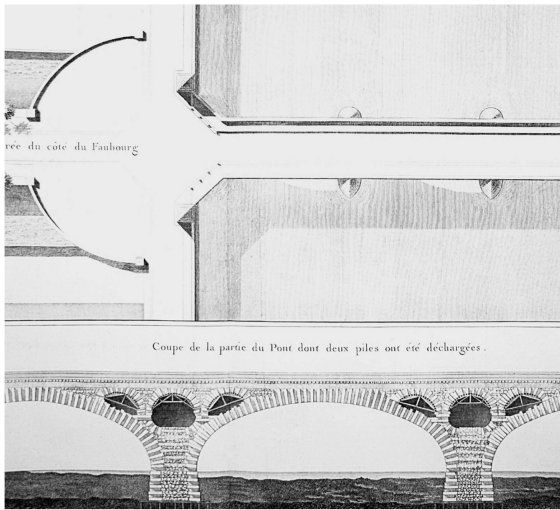
In order to assess the strange morphing of tectonic structures into sculpture in an unbiased manner, we have to consider not only the contemporary tendency towards an *architecture parlante* but also the prevalent issues of bridge construction. In the second half of the eighteenth century Jean-Rodolphe Perronet

**f.5** Bridge design by Claude-Nicolas Ledoux, published 1804.



<sup>15</sup> Not all of the projects included in the *Descriptions* were designed by Perronet himself, e.g. the George V Bridge in Orléans (fig. 6) is a project by Jean Hupeau, in which Perronet was only involved at a very late stage. Cf. Jean-Rodolphe Perronet, *Description des projets et de la construction des ponts de Neuilly, de Mantes, d'Orléans & autres*, 2 vols. (Paris: Imprimerie Royale, 1782–1783).

(1708–1794) was by far the most prominent figure within this field of engineering. Not only did he realize several important and difficult projects, he also made these works accessible in an opulent publication, the *Description des projets*.<sup>15</sup> And what is more, Ledoux worked with him for some time. Among several other topics Perronet addresses the problem of pillars and arches. In order to reduce the contact surface of the bridge, which is subject to the constant attack of water flow and ice, he suggests the construction of smaller pillars of an adapted shape. Engineers of his time experimented with several alternatives,



and sometimes ship-like forms were employed. <sup>f.6</sup> In addition, the whole structure could deviate from classical tectonic ideas. <sup>16</sup> The arch becomes shallow or stretched, constructed following a complex geometry. By chamfering the inner arch, he achieves a streamlined form – the famous “cornes de vache” – which served the purpose of reducing flood dam-

**f.6** George V Bridge in Orléans, designed by Jean Hupeau and built 1751–1763. Perronet published this building in 1783. The ship-like form of the pillars and their curved section are obvious, but Perronet’s “cornes de vache” are still missing.

**16** Perronet was well known for his very light constructions, and even today Picon calls his slender piers “spectaculaire,” Picon, *Architectes et ingénieurs* (see note 13), p. 152. Picon also discusses Perronet and Ledoux. Cf. *ibid.*, pp. 147–50, 273–5.

age. And sometimes even the section through the pillars reveals a curved form that seems more dynamic than tectonic. In addition, the reduced piers as designed by Perronet were no longer able to absorb the extreme horizontal force exerted by the very low arches. The stabilization of the construction became the task of the abutments on the shoreline. <sup>17</sup>

**17** *Ibid.*, pp. 147–51.

Ledoux deals with this problem by disguising the building as a pontoon bridge, thus using shipbuilding and sculpture as a link between Vitruvian architecture and the demands of modern engineering. The thin arches as well as the curved and pointed pillars are thus ascribed to a historical paradigm. By choosing this solution, the author reveals a deeper understanding of the contemporary problems of bridge design. In light of the central issue of reducing the resistance to flow <sup>18</sup> the idea of using the forms already established in shipbuilding to design the pillars seems perfectly consistent. And the form of ships expresses very well the reduced structural role of the piers. Vessels are able to absorb large amounts of vertical forces – i.e. weight – while being horizontally unstable. Another problem is the lack of a universal method for constructing the arch, which Ledoux resolves in a rather bold manner by using straight lines, resembling the masts of ships. Thus he also introduces an element of timber architecture, as wooden bridges show similar V-shaped structures starting from the pillars. <sup>19</sup> This approach has certain implications regarding Ledoux’s view of his profession. The architect is not only responsible for finding and exploiting corresponding traits and intersections between different disciplines but also for designing buildings that are appropriate to their context and communicate their meaning to the beholder.

**18** The engineer Emiland Gauthey (1732–1806) even gives a detailed depiction of resulting wave shapes caused by different pier forms, thus comparing the results in an almost diagrammatic way. See Emiland Gauthey, *Œuvres de M. Gauthey: Traité de la construction des ponts*, vol. 1 (Paris: Firmin Didot, 1809), plate XIII.

**19** *Ibid.*, vol. 2 (1813), plates II, III.



20 Ledoux,  
*L'Architecture* (see  
 note 3), pp. 50–2.

21 Frontinus-Gesell-  
 schaft (ed.), *Wasser-  
 versorgung im antiken  
 Rom* (Munich: R.  
 Oldenbourg, 1982),  
 pp. 88–91. For a  
 contemporary book  
 on the properties of  
 water, cf. Bédidor,  
*Architecture hydraulique*  
 (see note 11).

22 Perronet shows  
 a knife gate with the  
 function of closing a  
 reservoir in the context  
 of a canal project. Cf.  
 Perronet, *Description*,  
 vol. 2 (1783) (see note  
 15), plate XLVIII.

23 Voltaire, "Siècle  
 de Louis XIV," *Œuvres  
 complètes de Voltaire*,  
 vol. 4 (Paris: Furne,  
 1836), pp. 63–309,  
 here p. 222.

f.7 *Maison des  
 Directeurs de La Loue*;  
 design by Claude-  
 Nicolas Ledoux,  
 published 1804.

## Hybrid: *maison—machine*

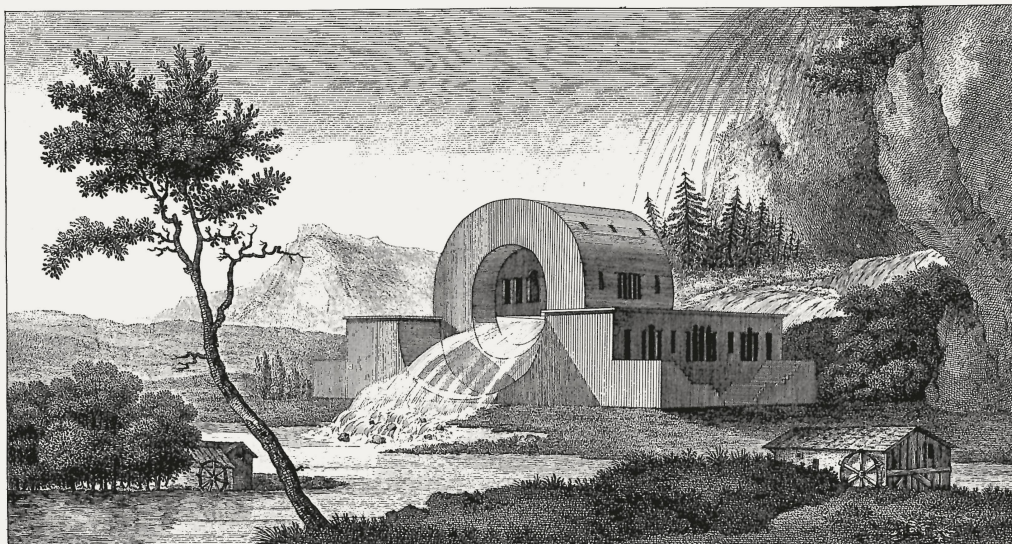
The second important example is the House of the Directors of the River Loue. <sup>20/f.7</sup> This building is also of purely fictional character but holds a crucial position in Ledoux's concept of the ideal city. We see an official's dwelling, which is located near the source of the river. The water passes through the building itself, which can be described as a horizontal cylinder or tube resting on a cubic base. Once again the concept is easily recognizable as *architecture parlante*. As Ledoux elaborates in his text, the inhabitants are responsible for protecting the people against the destructive powers of water. According to him, professionals like engineers, officials, or architects have to transform nature from a force of destruction into a productive power, a hostile wilderness into the cultivated realm of mankind. This is made abundantly clear by the perspective view. The landscape behind the building seems barely inhabitable; a jagged mountain rises abruptly behind a dramatic waterfall; trees are bent crooked by the force of the elements. The scenery in the foreground is completely different. It consists of idyllic meadows, which are pleasing to the eye of the beholder as well as economically productive for the miller, who is using the tamed force of the river. On closer inspection the cylinder itself proves to be a hybrid of two different technical models. In the first place it alludes to a faucet or outlet. Since Roman antiquity, the diameters of outlets have been used to measure the amount of water in order to distribute it evenly or to calculate the fees for the individual consumer. <sup>21</sup> Thus Ledoux highlights the duty and the right of the authorities to control water distribution. However, the cylinder is not completely open. Instead, a protruding room blocks the upper half. A mechanism to control the water flow by inserting a pane of wood or metal is not typical for a valve at this time. Instead, this mechanism belongs to the realm of reservoirs and channels, where it is known as a "knife gate," "sluice gate," or "lock." <sup>22</sup> It becomes clear that the main points of reference are flood control and the intention to produce an even flow of water for shipping.

In the seventeenth century important channels were built in France, and Voltaire would later call the Canal du Languedoc (since 1789: Canal du Midi) "le monument le plus glorieux" for Louis XIV. <sup>23</sup> As with his bridge design, Ledoux not merely chooses a semantically charged form but merges it with a functional structure, in this case the particular distribution of rooms. In the choice of his rooms and the structure of the floor plan he follows a conventional model that he himself varied in dozens of examples. It can be identified as a French *maison de campagne* as described

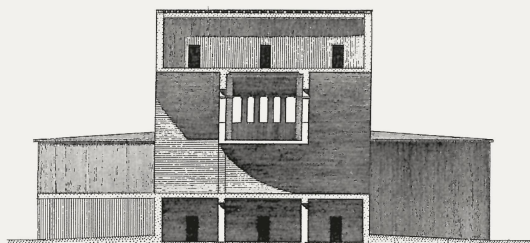


# Maison des Directeurs de la Lotie .

Vue Perspective

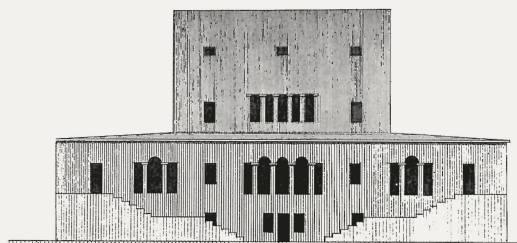


Coupe

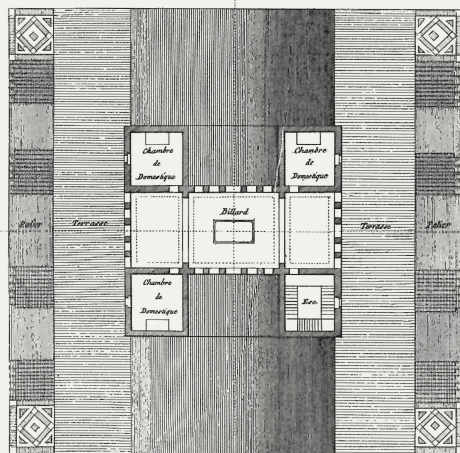


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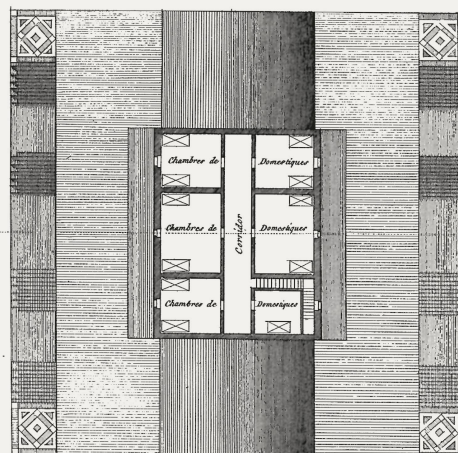
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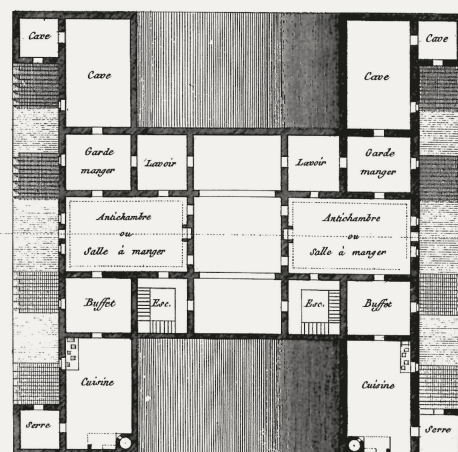
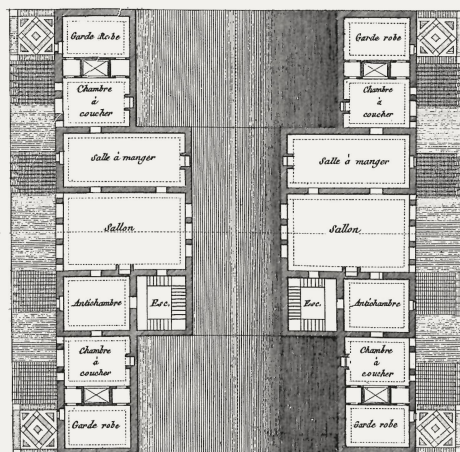
Troisième Etage



Premier Etage



Rez-de-chaussée



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24 Jacques-François Blondel, *De la distribution des maisons de plaisance* (Paris: Charles-Antoine Jombert, 1737–38); Charles Etienne Briseux, *L'Art de bâtir des maisons de campagne* (Paris: Prault, 1743). For the building type and its choice of rooms, see Krause, *Maison de plaisance* (see note 4); for a recent bibliography, cf. Julian Jachmann and Christian Busold, "Typus als Sequenz: Die Maison de campagne bei Charles-Etienne Briseux," *in situ*, 4, no. 1 (2012), pp. 93–102.

25 For other instances in which Ledoux experiments with *appartements*, see Ledoux, *L'Architecture* (see note 3), plates 21, 29. Nicolas Courtin, "L'Ameublement des galeries dans les hôtels parisiens du XVIIIe siècle," *Bulletin monumental*, 166, no. 1 (2008), pp. 63–70.

26 Krause, *Maison de plaisance* (see note 4), p. 33.

by contemporary authors like Charles Etienne Briseux (1680–1754) or the younger Blondel. <sup>24/f.8</sup> The main floor basically consists of an entrance zone – vestibule and stairs – and several *appartements*. The latter are sequences of rooms to accommodate the owner, his wife, and potential visitors, each including *salons* and/or *chambres* as main rooms, and several secondary rooms like *cabinets* and *garderobes*. The main story is organized along two orthogonal axes: the main axis through the entrance and the *enfilade* along the side of the garden, connecting the main rooms through aligned doorways. The upper stories consist of a number of small *appartements* and *chambres* for visitors or servants. This space is a convenient location for a billiard room, from which the owner and his guests can enjoy the view over the landscape. Ledoux followed this conventional model up to a point. <sup>25</sup> On the main floor he duplicates the structure of a *maison de campagne* and rotates it by 90 degrees. Each part of the building has an entrance axis, *salon*, *antichambres*, *chambres*, and secondary rooms, neatly organized along an *enfilade*. But in the upper story the orientation suddenly changes as the view from the billiard room coincides with the direction of the water flow.

On a general level, the idea of transforming a landscape through a building is taken from the very core of French residential architecture. As these structures communicate between a city-side and a garden-side, they have the task of transforming one sphere into the other while the visitor passes through the interior. In most cases, the area of the highest permeability was the main axis in the middle of the building, where the vestibule opened onto the court and the *salon* to the garden. <sup>26/f.8</sup> In a similar way, Ledoux's House of the Directors transforms wilderness into a garden-like landscape through a zone of selective permeability in the center of the building.

On a more detailed level Ledoux uses the structures and ideas of distribution to make his idea plausible. By duplicating and rotating the *enfilade*, he creates a solid base for taming the dangerous wild river. It is now flanked and controlled by a structure that may well be considered the very foundation of French architecture since the sixteenth century. The different dimensions of the society rooms in the middle of the *appartements* and the smaller *chambres* at their end are used to create the valve-like situation in the middle of the building. Yet the most important motif is the use of a billiard room as a symbolic knife gate to control the flow. This type of space can be considered as a descendent of the gallery, which had originally been intended as a means to enjoy the view of the surroundings while taking



a stroll during bad weather. In both cases the line of sight from the interior to the outside was crucial, implying pleasure as much as control.

The players in Ledoux's House of the Directors enjoy a view in four directions, yet the axis of the river takes precedent.<sup>27</sup> In addition, two motifs of the topic of mastery over nature are juxtaposed. In Early Modern times, physical activities such as dancing, fencing, or hunting were considered crucial for the education of princes, as they tied the martial roots of the nobility to more recent concepts of body control and politeness important within the context of the court.<sup>28</sup> This idea is employed again in Ledoux's *Maison des Directeurs*, with the difference that the motif of dominating and cultivating nature—be it the nature of one's own body while playing a game requiring precise movements, or the nature of a torrent—is no longer part of the aristocratic habitus but the self-perception of technocratic professionals. Thus it becomes understandable why Ledoux places a room of seemingly recreational function at this key position. As with his bridge design, Ledoux tries to analyze technical inventions on a structural level, and to include them in the realm of architecture by means of analogy and abstraction. For Ledoux, the central role of water in Chaux, apparent in the *Maison des Directeurs* as well as technical structures, becomes a stimulus to reflection on the relationship of architecture and machines. Both disciplines have to deal with the qualities of a dynamic and changeable medium: it becomes a *tertium comparationis*.

<sup>27</sup> This wish to open up the building towards the stream even leads to a blatant mistake in the pictorial representation of the House of the Directors: the floor plan of the main floor includes three openings of the rooms in the middle axis towards the stream, while the section shows none, thus following the technical possibilities of the time rather than Ledoux's utopian ideas.

<sup>28</sup> It was the sociologist Norbert Elias who placed this control of body and emotions (*Affektkontrolle*) at a central place in the history of the nobility and the "process of civilization"; even phenomena like the baroque garden or the famous Machine de Marly can be connected to this concept. Cf. Norbert Elias, *The Court Society*. Trans. Edmund Jephcott (New York: Pantheon Books, 1983 [1969]), pp. 239–46, 259; Elias, *The Civilizing Process: Sociogenetic and Psychogenetic Investigations*. Trans. Edmund Jephcott (Malden, MA: Blackwell Publishing, 2003 [1976]), pp. 60–1. For the position of his theories in recent historical models, cf. Ronald G. Asch, *Europäischer Adel in der frühen Neuzeit: Eine Einführung* (Cologne: Böhlau, 2008), pp. 143–8, 218.

## Architecture and machines in the eighteenth century

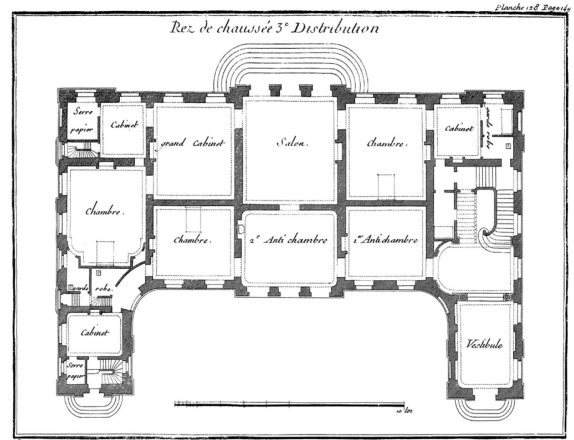
Even if Ledoux's efforts to address formal problems emerging within the rift between architectural and technical design are undoubtedly as singular as they are curious in outcome, they point to an underlying issue of more universal importance. A central aspect of this topic is a conspicuous convergence of terminology within the fields of engineering and architecture, especially in the central category of *disposition*. In the famous *Encyclopédie* (1751–1772) of Denis Diderot and Jean-Baptiste le Rond d'Alembert several types of machines are mentioned, but the most significant definition is to be found in the article on hydraulic machines by d'Alembert himself. He starts by specifying the general tasks of machines—"à augmenter & à régler les forces mouvantes"<sup>29</sup>—a definition that could directly be applied to Ledoux's faucet-like house. More importantly, a few paragraphs later he emphasizes the Greek etymology of the word "machine," meaning "invention" and "art" rather than "a material object of any kind." This abstract notion of a machine as an ingenious invention

<sup>29</sup> Jean-Baptiste le Rond d'Alembert, "Machine," in d'Alembert and Denis Diderot (eds.), *Encyclopédie ou dictionnaire raisonné des sciences, des arts et des métiers*, vol. 9 (Paris: Briasson, 1765), pp. 794–800.

allows the utilization of this word in various heterogeneous fields, such as engineering, painting, and theater.

Returning to the engineer Bélidor, we find the following definition in his *Dictionnaire portatif de l'ingénieur et de l'artilleur* from 1768: "MACHINE. On donne ce nom en général à l'assemblage de plusieurs pieces jointes ensemble, & tellement disposées qu'elles peuvent servir à augmenter ou à régler les forces mouvantes selon les différens usages auxquels on les applique, soit dans la guerre, dans l'architecture, ou dans les autres arts. Il y a des machines simples, & d'autres composées, dont la construction & les usages peuvent se varier presque à l'infini." <sup>30</sup> Again, the regulation of forces,

and the need for infinite variation and thus invention are central ideas. But more importantly, they are specified in a way that connects engineering and architecture. <sup>31</sup> The key terms are *disposition* (*disposer*) and *distribution* — both very close in meaning and often used as synonyms. <sup>32</sup> Within architecture these phrases serve to address the spatial structure of a building or ensemble, i.e. the location and position of the buildings and their parts, such as the layout of the ground plan and the structure of the interior space. During the eighteenth century the perfection of these aspects was considered to be a genuine French achievement. Consequently, the terms are ubiquitous in French publications on architecture of this time. <sup>33</sup> Briseux and Blondel call *distribution* a most important art, the latter also a "science inépuisable." <sup>34</sup> Art and science have to meet in the spatial concept, as rooms have to be not only beautiful but also socially appropriate and commodious. <sup>35</sup> Ledoux follows this established line of thought and observes — not unlike Blondel — even a progress in the "science de la distribution." <sup>36</sup>



30 Bernard Forest de Bélidor and Charles-Antoine Jombert, *Dictionnaire portatif de l'ingénieur et de l'artilleur* (Paris: Charles-Antoine Jombert, 1768), p. 410.

f.8 In this maison de campagne the middle axis is made permeable, even though the entrance to the building is located in the right-hand wing; design by Charles-Etienne Briseux, published 1743.

31 Another noteworthy correspondence is the term "pièce," which can refer to a single room in architecture as well as to a machine part.

32 There are two antique sources of these terms: one is Vitruvius, the other the theory of rhetoric. Cf. Bettina Köhler, *Die Stadt Paris und das Wohnhaus: Zum "Bâtiment Particulier" in der französischen Architekturtheorie von 1600–1750* (Alfter: VDG, 1994), pp. 207–37; Peter-Eckhard Knabe, *Schlüsselbegriffe des kunsttheoretischen Denkens in Frankreich: Von der Spätklassik bis zum Ende der Aufklärung* (Düsseldorf: L. Schwann, 1972), pp. 123–8. *Distribution* and *disposition* are usually mentioned in encyclopedias and dictionaries, where the huge scope of their application becomes apparent, cf. d'Alembert and Diderot, *Encyclopédie*, vol. 4 (1754) (see note 29), pp. 1062–6; Académie française (ed.), *Dictionnaire de l'Académie française*, vol. 1 (Paris: Smits et Co., 1798), pp. 430, 433 (the definitions in the earlier editions of this work are very similar). Bélidor and Jombert use both words in regard to architecture and engineering. Cf. Bélidor and Jombert, *Dictionnaire* (see note 30), p. 227.

33 Köhler, *Stadt Paris* (see note 32), p. 207.

34 Briseux, *L'Art de bâtir*, vol. 1 (see note 24), p. 27; Jacques-François Blondel, *Cours d'architecture ou traité de la décoration, distribution & construction des bâtimens*, vol. 4 (Paris: Desaint, 1773), p. 189.

35 "La Commodité & la Beauté consistent en la disposition des Pièces," Briseux, *L'Art de bâtir*, vol. 1 (see note 24), p. 18. Cf. Köhler, *Stadt Paris* (see note 32), p. 179.

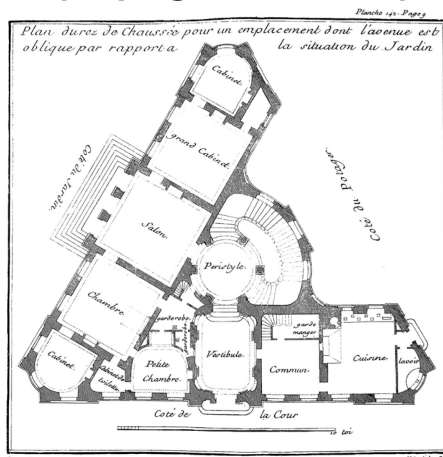
36 Ledoux, *L'Architecture* (see note 3), pp. 11–12.



The identical terminology made it clear in the eighteenth century that if architecture is mainly seen as an ingenious disposition of elements in space, its design process has to be very similar to that of machines. With this approach the main elements of Vitruvian architecture, such as column orders, decorum, and the triad of *firmitas*, *utilitas*, *venustas* are upheld, yet they are subjected to new and dynamic design processes. And vice versa, the organization of machines is sometimes measured by aesthetic standards. In the *Encyclopédie* we find the following remark concerning a machine for the processing of silk: "Le corps de cette machine est simple; c'est aussi sa simplicité qui en fait la beauté." <sup>37</sup>

It could prove an interesting line of inquiry to ask if these terminological convergences explain the sometimes machine-like quality of spatial distribution. <sup>39</sup> Apart from the plethora of designs for regular *maisons de campagne* in his publication of 1743, the aforementioned Briseux suggested some unique solutions for difficult sites. One example shows the need of an oblique angle in the middle axis, and the author suggests employing the ordinary layout of two parallel series of rooms but

<sup>37</sup> D'Alembert, "Machine" (see note 29), p. 798. The central role of "disposition" in the concept of Ledoux is emphasized in Perriault, "Le concept de machine" (see note 1), pp. 115–16.



separating them to form a shape like the letter V, with the staircase as the connecting element. The challenging task of bringing the orthogonal structure of rooms and the irregular angle into accord sheds light on the highly flexible and elegant methods used to intertwine spaces of different sizes and layouts, which were established in eighteenth-century domestic architecture. Instead of ideal proportions

<sup>39</sup> Triangular maison de campagne; design by Charles-Etienne Briseux, published 1743.

as defined by Pythagoras and Vitruvius, or a rigid typology, the structure of the building follows the functional concerns of *commodité*. <sup>38</sup> This category must not be confused with modern concepts of functionality, as it describes material functions as well as representative features. The different routes and access points of owners, visitors, and servants within an *appartement* required interwoven sequences of rooms, with secondary rooms like *garderobes* fitted in the remaining spaces. The relationship of the parts of a whole is now to be defined through their importance and functional interdependence. This relationship was necessarily a highly flexible one as rooms in a *maison* or *château* had functions that varied over time, depending on the changing seasons, events, and visitors. This applies in particular to the smaller *maisons de plaisance*, which were not infrequently sold. In order to

<sup>38</sup> Köhler, *Stadt Paris* (see note 32).



accommodate not only the different functions of each room but also the changing sequences of ceremonial spaces, a dynamic understanding of the design of floor plans seems to be a commendable strategy, not unlike the approach of machine design, where the alteration of any part influences the whole while the structure in its entirety has to be able to work under different conditions and with potentially varying objectives.

If we ask in this context for possible relationships between architecture and machines, I would like to suggest a different approach than the reduction of architectural thinking to concepts of optimization and the economy of means as employed by Liane Lefaivre and Alexander Tzonis in the 1980s.<sup>39</sup> At least in the eighteenth century, other parallels seem to be far more conspicuous. The central role of *disposition* in the design both of machines and architecture points to an emphasis on a process of invention that is understood as a dynamic one, i.e. as an interrelation of potentially changing parts. Within the field of architecture, this approach manifested itself in the predominant category of *commodité*, which is the complex result of a multitude of material, social, psychological, and semantic constraints, requirements, and ideals—architecturally realized in diverse and highly adaptable floor plans consisting of sequences of intertwined spaces. This rational yet not transparent system is not only employed but also staged. While Ledoux converts in his *Maison des Directeurs* the middle axis of a typical residential building to transform the torrent and landscape instead of the usual views and functions, Briseux was successful in bringing the main axes and spatial sequences into accord with the oblique angle of the site. And in a completely rational way the building serves to connect and organize three outside areas: court, garden, and kitchen garden. To emphasize the hinge-like structure of the floor plan, Briseux employs the round *peristyle* in the center of the building. He thus not only makes his idea of rotating one of the two room sequences visible, but also adds a dynamic characteristic, underlining the diverse possibilities and changing directions of design processes.

39 Liane Lefaivre and Alexander Tzonis, "Die Maschine im architektonischen Denken / The Machine in Architectural Thinking," *Daidalos*, 18 (1985), pp. 16–26; Lefaivre and Tzonis, "The Mechanization of Architecture and the Birth of Functionalism," *Via*, 7 (1984), pp. 121–43.