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Politics on the Topographer's Table: The Helvetic Triangulation of Cartography, Politics, and Representation

1. Introduction

Maps are crucial elements in the construction of states. They are essential, of course, in delimiting the physical site, the territorial boundaries, the natural resources and even political constituencies that make up the state. But maps are also representations saturated with national ideologies. Maps are mythopoetic structures, formative iconographical elements in the physical embodiment of the myth of the nation, and as such participate in constructing and stabilizing the state's defining powers.[2] Maps are made to appear as disinterested scale models, inert records providing a transparent window on the world analogous to the photographic image – a message without a code.[3] Yet maps, Bruno Latour reminds us, should be understood as "immutable and combinable mobiles" constructed from networks which accelerate the passage and control of information from periphery to centers of control and calculation through the establishment of obligatory points of passage. Mapmakers achieve their purposes by subjecting the networks of information gathering to a metrology, a grid, systems of measurement and accounting; and at the same time the map's ability to carry out the purposes of those centers of calculation depends upon inscribing the system of signs constituting the map onto the outside world. "The outside world is fit for an application of the map only when all its relevant features have themselves been written and marked by beacons, landmarks, boards, arrows, street names, and so on."[4] This feature of mapmaking alerts us that maps are interested, and that in order for their interests to be achieved the system of signs must be accepted as a basis for interpretation.[5] Accepting the map as a natural description of the world is acknowledging the sovereignty asserted by the state or center of calculation in whose name the map is produced as its instrument. When we consider that maps are part of a semiological system, a system of values and signs constituting and sustaining the myth of the state, then it makes sense to consider that achieving consensus on the formal properties of representation embodied in the map should be taken as crucial step in nation building.

The central thesis of this paper is that mapmaking played a central role in the principal stages of state-building usually identified by political historians as crucial to the formation of modern Switzerland, from the first stirring of efforts to conceptualize a Helvetic Republic in the 1750s through the intensive period of state-building between 1830 and 1874. Producing a map of the Swiss Federal State entailed more than providing a reliable system of cartography. Agreements on the map were intimately bound up with ideological debates at the heart of the emerging new nation. To accept the map of the Federal State as a legitimate description of the geographical region between the Lake of Constance and Geneva was to accept the defining power of the Swiss State. In section 2 I will discuss the "patriotic dreams" of the proponents of the Enlightenment for the transparency of spaces, whether cartographical, literary, or political, which formed the point of departure for both mapmakers and statebuilders in Switzerland. These early enlightened efforts in cartography were, however, without issue until the 1830s when the political mood shifted suddenly in favor of liberalism and the accompanying intensification of the national cartography project in Switzerland. For this renewal of state crafting, science as I will argue in section 3,

proved to be both instrumental as well as politically expedient. The following two sections concentrate on the technical cartographic aspects of the national topography project led by Guillaume-Henri Dufour. In sections 4 and 5, while showing that the path from landscape to map is a sequence of transpositions of the organization and labor involved in the processes of recording,[6] I examine the legitimizing function that came to be attributed to precision survey techniques, which served the purpose of both increased domination over nature and the construction of the bourgeois state as the nation. In the final concluding remarks I discuss how "cartography," a system of recording that appeared to subject nature to the rule of measure, reached its full incarnation in photogrametry, a supposedly uncoded, objective mechanical reproduction of the landscape. This extremely popular system of recording promoted the "assemblage" of Switzerland, but it did so only by eliminating certain images of nature through rigorously disciplining the senses.

2. The transparency of spaces

Designed in accordance with the scientific methods of the French cartographic school around Jacques and César-François Cassini[7] and geared toward the creation of a central "bureau" for topographical surveying, the first plan for a national survey that was to cover Switzerland with a trigonometric net originated in 1754 in the prison of Aarburg. Jacques Barthélemi Micheli du Crest (1690-1766), the author of the project, had been at Aarburg as a state prisoner of the Canton of Bern since 1749.[8] The cartographer an enemy of the state? The case is much more complicated. Micheli du Crest belonged to the family of Geneva magistrates, became captain of a regiment in the French service in 1713, was elected to the Great Council of Geneva in 1721, and maintained contacts with renowned scientists of his day both at home and abroad.[9] Published in 1730, his "Carte des environs de Genève" garnered him international respect as a cartographer, just as his other publications did in the areas of astronomy and experimental physics.[10] An additional field of scientific engagement, devising plans for the construction of fortresses, brought him less success. On account of the criticism of a government project to restore the city's fortifications,[11] which he published in 1728, Micheli du Crest was expelled from the Council in 1730, and his property was confiscated; a defense written in Paris[12] led to his decapitation "in effigie" in 1735. Micheli du Crest's political activity in Paris brought him just as little fortune, and for that reason he also had to leave Paris in 1742, traveling to further stations of exile in Zurich, Bern, and Neuchâtel. This, at least in the eyes of the Bern magistrates, must have brought him close to the Henzi Conspiracy,[13] the only serious attempt to depose the patrician Ancien Régime in Bern through violence. On August 18, 1749, he was sentenced to life in prison.[14]

Although it was thus not his scientific work that put Micheli du Crest behind bars, it would nevertheless be naive to assume that his political struggle against the aristocratic, exclusionary tendencies of the Bern patriciate had nothing to do with the *scholar* Micheli du Crest at the ripe age of 59. The question is, however, What constitutes the political dimension of a thermometer or a topographical map? An answer can be reconstructed from a letter to Albrecht von Haller of May 1755, in which Micheli du Crest informed the doyen of the Swiss Enlightenment about his previous cartographic work in Geneva[15]:

> "Je levais sur le terrain la carte détailé des environs de Genève, où toutes les maisons, toutes les haies, tous les chemins, toutes les différentes natures de plantation, tous les ruisseaux, tous les escarpemens, pentes et monticules *devaient être exactement mesurés*. Je l'avais fait avec la chaîne sur le territoire de France, et cela m'occasionna une assez grande difficulté; je la prévis plus grande en Savoie, où j'avais le double de terrain à lever. J'avais dans ma chambre une table de 7 pieds de roi de longueur et 5 pieds de large, sur laquelle je traçai mon brouillard de plan bien exactement et je vis conséquemment *le vide que j'avais à remplir* en Savoie. Je tirai dans tout ce quartier à *divers points de marque*, tels que des arbres, des maisons, des tours, des rochers, des croix, des amas de bois, en un mot à tout ce qui put me sevir de signal dans les lieux élevés des alignemens sur de grands cartons, d'abord du clocher de St. Pierre, ensuite de quantité de ces points du pays, de sorte que je pris bien *une douzaine de stations d'alignemens en tout sens sur différens cartons*. Ensuite avec ces cartons *je croisai et recroisai* les objets alignés tracés sur ma table de toutes ces différentes stations, et *lorsque je voyais que me alignemens se croisaient tous au même point, j'étais assuré de la justesse parfaite de sa position*."[16]

Micheli du Crest's method of work was precise, unerring, self-critical, and did not stop short of even the smallest topographical details. There was practically nothing, his letter to Haller stated, that had escaped his view. And this view was of a new quality, since, unlike the absolutist view – a view predicated on a centralized perspective – it did not proceed from a particular point in a prescribed direction, but instead allowed a change in perspective as often as one wished. In a manner similar to the school of Dutch painters, which as early as the 17th century had begun to replace the (Italian) central perspective with a perspective of several vanishing points, the enlightened cartography of the 18th century introduced a recording technique that no longer permitted a single, exclusively valid standpoint of the observer. The depicted space was transformed into a "sequence of rooms or vistas successively viewed" – "additive works that could not be taken in from a single viewing point."[17] In Micheli du Crest's terrain recording, the observer can direct his view from different stations "en tout sens" onto the landscape, until he is sure of having correctly recognized its form. In doing this, he makes use of a technical system of recording that allows him to verify the surveyed lines and points of intersection on the survey table from virtually any other position, "de façon que divisant l'ouvrage par planchette, chaque planchette avait ainsi sept ou huit points de marque désignés par des petits ronds rouges et des chiffres, qui sur mes tablettes marquaient le lieu et qui me servaient de point de visée sur ma planchette."[18] In this way, the topographer could emancipate himself from the constraints that the landscape imposed on him and move freely within it, or rather within its depiction.[19] The statement is clear: Once a perspective that is quasi-independent from the observer is introduced, anyone in the possession of his rational faculties can be an observer, re-enact and verify the work of the cartographer. Cartography was to cease to be an opaque science of decree.[20]

Haller, the founder of experimental physiology, will have understood very precisely what was at issue in Micheli du Crest's letter. Experimentation and empirical knowledge were the only reliable foundations of scientific research for him as well. Moreover, Haller had himself taken a first step toward the "emancipation of perspective" in his poem "The Alps," a paradigm of Enlightenment. The poem presents the reader with a breathtaking motion by describing from an elevated position – perhaps the Chasseral – [21] the alps, the midlands, the lakes of the countryside surrounding Bern, the mountains of Freiburg and – *turned around backwards* – the hilly outlines of the Jura as a "streak of green valleys which, twisted here and there, vanishes in the distance."[22]

Micheli du Crest had taken the emancipation of perspective pre-figured by Haller a step further when he consistently applied vertical projection in his Geneva map.[23] He did this, perhaps at the cost of relinquishing the "ever novel delight" of which Haller had spoken, but certainly out of obligation to the utilitarian primacy of measurability – "[toutes les choses] devaient être exactement mesurées." The landscape was no longer simply represented as a panorama by Michel du Crest, but rather described according to a perspective that was only conceivable in exclusively geometrical terms. Unfortunately, Micheli du Crest the political prisoner had to be satisfied himself with panoramas;[24] but as a free cartographer he wanted to use "vertical projection from beginning to end."[25] In order to do this, of course, he needed to emancipte himself from the hands of the state. In Aarburg, however, his view was held captive – "un homme renfermé dans une bastion et qui ne pouvait travailler que d'un seul point"[26] – and his topographical work remained to the end of his life a "patriotic dream."[27]

Michel du Crest's enlightened intention to represent space in a geometrically transparent, or critically rational manner, and thus to configure it appropriately for the emerging bourgeois public sphere, becomes apparent the moment one takes a closer look at the "Nova Helvetiae Tabula Geographica." Johann Jakob Scheuchzer (1672-1733), a doctor of medicine and professor of mathematics, presented it to the Zurich government in 1713, after 18 years of work. The "Scheuchzer Map" appealed to a large market, both domestic and foreign, was reprinted in Amsterdam and Paris as early as 1715, and attained an extraordinary degree of popularity in Switzerland in numerous reprints and copies.[28] It was not merely Scheuchzer's submissive cover letter to the authorities that made his map a map of the ancien régime, but precisely his understanding of nature, which differed completely from that of Micheli du Crest and Haller. Rivers and lake shores were rendered in a thoroughly schematic fashion, mountains "stylized in a formal wavy line and placed somewhat closer together for high mountains, without any characteristic stamp."[29] The bourgeois criticism of the 19th century would accuse Scheuchzer of having had no "sense for true natural forms."[30] His map was not – through change of perspective and of the observer – intersubjectively verifiable ("true"), but instead, despite barometric elevation measurements, resembled a magisterial decree: officially decreed perception of natural space. Even the villages, towns, and cities were distinguished as Catholic or Protestant according to the pre-eminent political-confessional criteria, recently reaffirmed by the Second Villmerger War of 1712.[31]

The difference from Enlightenment topography emerges particularly clearly in the decorative border of the Scheuchzer Map. The border contains, in addition to the allegorical representation of the most important Swiss rivers, a frightening depiction of the Devil's Bridge, and beyond this the "Climb up to Gemmi," engraved by Melchior Füssli, including waterfall and rainbow. Mountain falls, avalanches, the Lucerne Dragon, and ball lightening keep them company. While Haller emphatically called for "Reason's light [to] brighten the vault of the Earth,"[32] Scheuchzer drew threatening natural phenomena and forced them to the margins of his map, but even so he did not achieve the radical new dimension of the "Carte des environs de Genève" by Micheli du Crest.[33]

Micheli du Crest's (too) early attempt to apply the principle of measurability and of empirically precise depiction[34] of topographical conditions consistently to Swiss cartography, his clear renunciation of dragons, fossils, and ball lightening, remained as suspect in the ancien régime as the demographic-statistical works of Jean-Louis Muret or Johann Heinrich Waser. They had either to be forbidden or neutralized in some other way, no matter how.[35] It was probably also for this reason that Micheli du Crest's proposal to begin a trigonometric survey of Switzerland, which he handed over to two members of the federal Diet in 1754.[36] "C'est une chose très utile et très commode pour le gouvernement des Etats, que celle d'y avoir des cartes exactes, bien détaillées et bien dessinées de tout le Pays, puisqu'on juge infiniment mieux sur un plan que sur les lieux mêmes, car le plan représente à l'oeil non selement les terres, mais encore tous leurs environs plus qu'à perte de vue", Micheli du Crest wrote in his memorandum. The proposal, however, never received a deemed attention.[37] The transparency of geographical spaces advocated by proponents of the Enlightenment – where "the sun's light streams through fleeing mists"[38] – was threatening to the ancien régime, because it implied transparency of political space as well. At stake was the construction of a bourgeois public sphere, which already existed in practice in the scientific, economic, and patriotic societies of the 18th century, and which finally began to demand recognition in the political sphere as well.[39]

3. Political Constellation and Federal Cartography

The example of Micheli du Crest demonstrates not only the political dimension of the cartographic enterprize, it also makes clear that the 18th century was not lacking in conceptions for founding a national cartography.[40] Models and instruments for this enterprize were available. Theodolites, surveying poles, barometers, survey tables, thermometers, hygrometers, and telescopes of sufficient perfection were also to hand. Even the problem of projection, or of the curvature of the earth, had been sufficiently solved, thanks to the French survey work in Peru and Lappland.[41] In the ancien régime, at least in Switzerland, the missing element was a national authority interested in creating political instruments to empower the surveyors' tools. A political authority was still lacking that could have identified with a national cartography project strongly enough to provide the financial resources necessary for its realization.

With the downfall of the Helvetic Republic of 1804, that kind of political authority receded far into the distance. The Confederation was nothing more than a loose coalition of states.[42] The resolutions of the Diet had *de facto* no instrumental force; their realization depended largely upon the cooperation of the individual cantons. Solutions achieved at the federal level came about for the most part under the political and military pressure of Napoleon Bonaparte.[43] With Napoleon's fall, the centrifugal forces already manifest were strengthened even further. The federal treaty of August 7, 1815 was not even an actual constitution, but rather an "agreement that combined the cantons in a league of sovereign states."[44] The reaction led by Karl Ludwig von Haller (the grandson of the Enlightenment figure), wanted to return to the pre-Napoleonic conditions. Everything that could have supported national unity, was abruptly abrogated. Each canton had its own currency, its own postal service, and insisted upon the sovereignty of its military and foreign policy affairs. More than four hundred customs barriers prevented free commerce; different measures of distance, weight, liquids, and grain applied in almost every canton.[45] Only in the area of military organization were higher, confederal authorities formed.[46]

In these circumstances a unified federal cartography was unrealizable. Until the early 1830s, the budget for confederal surveying remained at an extremely low level. The Diet listened patiently to the reports of Quartermaster Colonel Hans Konrad Finsler (1765-1841), it is true, and repeatedly vouched for

petty credits from the confederal military fund, but a substantial contribution to a national project was out of the question.[47] A combination of completely different factors eventually made it possible to secure regular federal outlays for surveying around 1833.[48] First, the Swiss Naturalist Society, an organization dating from the 18th century, began to make promote a national mapping project. On the occasion of an annual convention at the Great St. Bernhard, the Society commissioned a committee to work out the details of a program and an appeal for subscriptions of a Swiss map.[49] In this "Appel au zèle scientifique," the confederal authorities were above all criticized for having in the past years proven themselves incapable of at least canvassing the entire country with a trigonometric net. The Society resolved to take up the cause energetically and to exert cooperative pressure on the confederal military authorities.

Second, opinion within the army itself changed with regard to the work that had thus far been accomplished.[50] In 1832, Quartermaster Colonel Ludwig Wurstemberger (1783-1862), who had been chosen as Finsler's successor, invited all persons involved in survey work to a conference in Bern, which was to last for several days and to assist in the reorientation of Swiss triangulation.[51] In fact, a fundamental consensus emerged as a result of this conference concerning the current poor state of domestic topography as well as the steps necessary for an improvement of the situation. The protocol ascertained that after 23 years of work there was still no certainty about the longitude and position of the two ground-lines near Zurich and Aarberg, and that confederal triangulation did not in any way agree with the triangulation projects of the individual cantons. Finally, one had to admit that it had not yet been possible to complete the triangulation net. What made the conference "one of the most important moments in the history of Swiss surveying"[52] was an agreement on the mapping scale to be used in the future, the selection of a method of projection, and the decision to use the meridian and the parallel latitude through Bern as orientation for the net.[53]

Third, the intensive promotion of national cartography should be seen in the context of a far-reaching transformation of the political system. Encouraged by the Paris July Revolution of 1830, liberal politicians stepped forward in many cantons, demanding the recognition of the principle of national sovereignty, the elimination of suffrage limitations, the separation of powers in the state, as well as the creation of a more transparent administration. Eleven cantons, in which all together more than two thirds of the entire Swiss population lived, gave themselves liberal constitutions in the short span of less than a year and guaranteed the political equality of their citizens, the separation of powers, the right to petition, freedom of the press, and freedom of trade and commerce.[54] The creation of media for expressing popular opinion, led by the *Neue Zürcher Zeitung* and the liberal opposition's *Appenzeller Zeitung*, the revitalization of the Helvetic Society, the founding of the Confederal Rifle Club (1824), the Swiss Gymnastics Club (1832) and the Officers' Society (1833) created the forums of a bourgeois-liberal public sphere in Switzerland that looked far beyond the boundaries of the individual cantons and were generally receptive to "national" issues. At the same time, liberal politicians energetically set themselves to the task of revising the Federal Treaty of 1815. At the end of 1832, the Diet was presented with a moderate liberal "Federal Charter of the Swiss Confederation," which was to realize at the federal level the liberal constitutional changes achieved in the cantons[55] One year later, the Diet increased federal outlays for cartography, tripling the sum of the previous annual budget[56] and continued this policy of boosted support for topographic-scientific projects in the following years as well (*Figure 1*).

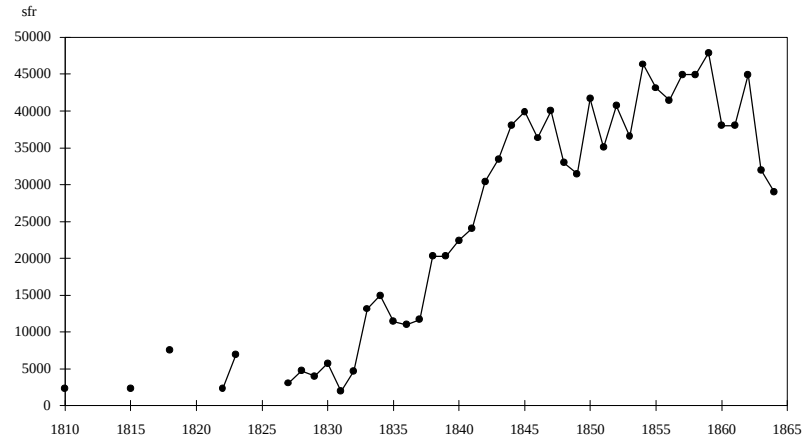

Figure 1: Federal Expenditures for Domestic Surveying 1810-1865 (Swiss Francs)[57]

The political transformations between 1830 and 1832 resulted in a significant shift in the social composition of the army leadership which was also beneficial to the national cartography project. The patrician-minded Quartermaster Wurstemberger, a member of the Grand Council of the canton of Bern, refused to take an oath to Bern's new liberal constitution and withdrew from all of his offices. That the choice of his successor went to Guillaume-Henri Dufour (1787-1875) was a indication of the military technical reorientation of the 1830s; as "the leadership of the military became more scientific" and "much that earlier had been left up to the heavens was now included in the calculations, the awareness, and the plans of the generals,"[58] the demands on the General Staff, and the Quartermaster Staff officers as well, began to change. Neither Finsler nor Wurstemberger had had the benefit of professional military or technical training.[59] Dufour on the other hand was a graduate of the Ecole Polytechnique in Paris[60] and the Ecole du Génie in Metz. From 1810 until 1813 he had fortified Corfu and led the fortification works in Lyon in the service of the French military. After his return to Geneva, he was named canton engineer in 1817[61] and instruction officer at the newly founded confederal military school in Thun in 1819. There he had already been working on problems of the cartography of the region.[62]

For a variety of reasons, the liberal reform movement of the 1830s remained, until the Sonderbund War of 1847/1848, ineffectual at the federal level. For my purposes here, a significant development of this period was a clear division of the members of the Diet into a "progressive-liberal" and a "catholic-conservative" camp. In the common language of the time national "progressive-liberal" projects could be assured of gaining an (extremely narrow) majority in the Diet, thanks to the formation of this split.[63] A national mapping project now suddenly gained political opportunity by complementing the ideological goals of this fragile liberal majority. Their goal of establishing a unified Swiss economic space was assisted by a unified cartographical representation; and the borders of a Switzerland conceived as a nation were to be precisely defined not only in military, political, and economic terms, but topographically as well.[64]

Although "bourgeois" projects with an apparent Enlightenment orientation resurfaced during the 1830s – some with significant political effects[65] – this did not mean that the Swiss map now being undertaken had the same political content as Micheli du Crest's project. The political circumstances of 1832, and with them the political function of a map of Switzerland, were not comparable with those of 1754. Dufour's mission was to demonstrate through the transparency of a scientific cartographic representation the political-economic unity of the "Swiss Confederation." Dufour's modern military-technical training and his political stance "entre libéralisme prudent et conservatisme conciliateur"[66] were the best guarantees that this goal could be achieved.

4. Precision for the Record and Legitimated Surveying Techniques

A discussion that took place between Dufour and his new colleagues in March 1833 made it clear that one practically had to start over from scratch: "[On] se vit dans l'obligation de tout reprendre à nouveau et de conduire l'operation, comme si rien n'avait été fait avante cette époque depuis la mesure d'une base jusqu'au dernier triangle, pour ne laisser planer sur l'ensemble des résultats aucun sujet légitime de doute ou de méfiance."[67] The old measurements carried out under Finsler could neither be verified, nor were they internally consistent. Dufour, however, deemed it essential that the new map of Switzerland should be established on precise measurements beyond all scientific doubt. It was therefore decided to take new measurements for the two ground-lines near Aarberg and Zurich that had been used for triangulation until then.[68]

The first of the two new surveys at Zurich's Sihlfeld in the summer of 1834 already demonstrated that the break with earlier projects was a fundamental one. Dufour not only used them for a systematic training of his colleagues in the use of surveying instruments, he also had the instruments and methods carefully standardized and demanded that the measurements be accurately recorded according to an exacting protocol.

Using three examples, I will demonstrate briefly the meaning precision assumed in the field laboratory at Sihlfeld and later near Aarberg. Of particular interest is how the data received by the

engineers was not only recorded but transformed by them in the process, and how both the survey records and the instruments utilized were subsequently subjected to verification in order to insure the foundations for the topographical designation "Switzerland", but also to guarantee that the measurements would be internationally compatible, a key element in legitimating the state.[69]

The laths used for establishing the ground-line were 18 Paris feet or 3 tois long (5.848m). On one end there was a spherical segment made of steel, at the other a cylinder also of steel, but with a flat transverse section. During the measurements, the rods were situated in a channel and could be moved vertically and horizontally using screws. In order that no collisions could occur when two rods were placed together rendering the measurements imprecise a small space was left open between the rounded end of one rod and the flat end of the next, into which a wedge of tempered steel was inserted (*Figure 2*).[70] The space between the measuring rods then had to be determined by calculation.

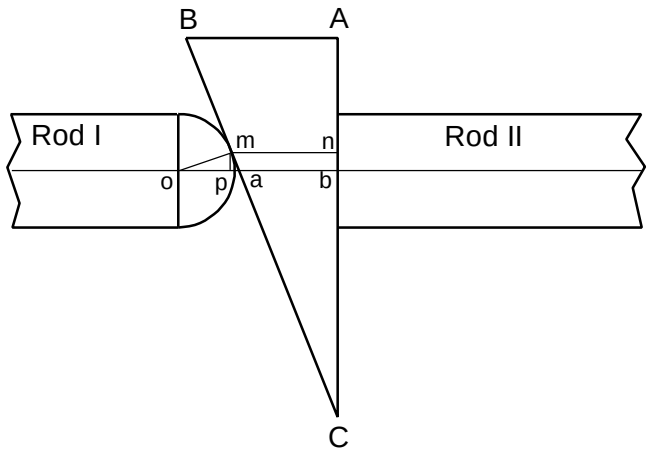

Figure 2: Measurement of the Space between Measuring Rods[71]

Since the wedge *ABC* determines the interval *mn* instead of *ab*, the distance *ap* had to be subtracted in order to gain *ab*. If *r* is the radius of the zone of contact, then the formula applies for the correction:

$$\overline{pa} = r(1-\cos\alpha) \text{ or, in Dufour's expression:}$$

$$\overline{pa} = 2r\sin^2\frac{\alpha}{2}$$

If an extremely tapered wedge was used, as was done during the verification of the measuring rods (a =2°30'), a correction of .014277mm per rod resulted at a radius of 15mm for the spherical segment. The device was so precise that even small vibrations or slight changes in temperature made it impossible to ascertain the same length twice in a row. A somewhat blunter wedge therefore had to be selected and provided with a vernier, so that in the field measurements could nevertheless be taken to within 1/500 of a rule, or 15/10000mm[72]. Measurement results were checked by the engineers several times,[73] then sent immediately to Dufour, who usually checked the correct calculation of the measurements again; he was also the one who instructed the engineers as to the formulas to be used – nothing was to be left to chance.

The unconditional pre-requisite for such a multi-stage verification of the results was the development of a systematic and reliably-kept measurement protocol. *Figure 3* reproduces an excerpt from the protocol of the Aarberg survey at measuring rod no. 571. The sequence of measuring rods, in this case II, III, and I, was given in Roman numerals. The next measurement had followed the sequence III, I and II. The temperature reading was also noted three times, from which the mean was taken each time. In the same way, the distance of the measuring wedge was noted, as determined and corrected by the method described above, and reduced to a theoretical length at a temperature of 10° Réaumur. The fourth column was reserved for measurement with the 'T' utilized with differences of elevation.

571st Measuring Rod

II			III			I			
Thermometer		Wedge	Thermometer		Wedge	Thermometer		Wedge	Th.
15,5	16,9	37,7	16,7	17,0	41,7	16,1	16,6		
Mean		Reduction to 10° R	Mean		Reduction to 10° R.	Mean			
16,2		1,89	16,8		1,97	16,3			

Figure 3: Example of a Survey Protocol of the Base-Line Measurement in Aarberg

The protocol itself is to be seen as the first step in a routine, complex system of record-keeping, at the end of which a printed map was to stand. In this regard, it is striking that here already transformations were made with regularity (mean and reduction) that obstructed any direct translation back into the original. Survey protocols did not record any landscape, their numbers did not convey any mountains, which skilled map readers could then visualize as natural spaces.[74] The deadly boredom, from which the survey engineers must have suffered in the face of the profusion of measurements that were made just for the two base-line determinations points in the same direction. In Zurich and Aarberg, a total of 2810 survey rods were placed together. Even at this lowest level of the cartographic recording, the reward of delight for the "ever-seeking eye," of which for example Haller had still dreamed, was hardly conceivable. And even when this "delight" made itself known – as for example in the sight of a "true gathering of the perpetual snows of Helvetia, who allow nothing foreign in their lap" – an engineer was called back to his charts by his superior: "Immersed in contemplation, I sat in wonder until Mr. Eschmann called for me to write down and reduce his observations."[75]

Transposed data recorded in a protocol had to exhibit regularities validated by other protocols, and not necessarily those of the Swiss engineers. An example is provided by the revision of the distances found at Aarberg and Zurich, the primary reason being a discrepancy discovered in comparison with French measurements of a ground-line at Ensisheim. Bringing their measurements into line with French results ultimately required a revision of the temperature tables used for the reduction to 10° R. It is interesting to observe the meticulousness with which the Swiss engineers tried to find an explanation for the difference between their measurements and those of the French; and it is also interesting to see how they revised their protocols in order to mesh with those of the French cartographers. Already during the verification of the rods, it was discovered that their elongation did not change in proportion to the temperature, something that had to do with the sluggishness of the thermometer. The measuring rods expanded more quickly than the thermometer was able to indicate. This problem, which threatened the goal of perfect precision, was tackled with a degree of exactitude that emerges from the report of Johann Eschmanns, Dufour's closest colleague:

> A trough in the form of a channel closed at both ends was taken and filled with warm water. The measuring rod was placed into it and given time to match the temperature of the water, the thermometers were checked, then the rod was taken out to be placed on the comparator. Here one had to wait for the measuring rod to match the temperature of the surrounding air. Now the comparison was made all over again and the contraction divided by the difference in the temperatures of the warm water and the air. Then the temperature of the water was varied and one proceeded in the same way in order to find out whether high temperatures produced the same elongation as low ones. Since it was impossible to make the comparisons of length at the moment of removal from the water, the first comparison was taken precisely 30 seconds afterwards; then it was checked from 30 seconds to 30 seconds, so that a series was gained that articulated the law of cooling. Then the value at the moment of removal itself was determined by means of interpolation.[76]

The result of these trials was a correction to all measurements of the Aarberg base-line by .03647 Paris measures per 1° R difference in temperature. In total 26.919 rules, or .187 Paris foot had to be added. Afterwards, Eschmann reduced this standard to 13° R, the temperature of the Toise of Peru, which meant a total correction of the distance measured at Aarberg (40189.691 feet) of only 4.484 feet, or .01%.

Now, it would be completely wrong to assume that Dufour's enterprise would have been satisfied by determining a single ground-line as precisely as possible and thus providing the basis for the triangulation net.[77] As the revision of the temperature tables suggests, it was equally important to make the Swiss survey internationally compatible. The triangulation work recorded in terms of the ground-line measurement had precisely the purpose of guaranteeing connections to other national boundaries. This

was also the reason for Eschmann's weeks of work at calculating. While the differences from an older ground-line determination at Sihlfeld, taken by Johannes Feer in 1794/1797 on behalf of the mathematical-military society in Zurich, seem not to have disturbed him, Eschmann struggled with every imaginable computational art to make the connection with the French network possible.[78] Even given the primacy of measurement, the data remained a construct. In July 1836, Eschmann wrote about this to Dufour:

> The doubts concerning the additive correction of the Aarberg base-line have in no way surprised me, since I reviewed the matter several times without being able to explain it to myself. Finally I noticed that the ground-line must have experienced an increase at 10° R, since the new elongation coefficient was much larger than the old one, and the average temperature was 12° R, while its reduction at 13° R is even more significant than before; because France's topographical bureau made use of our old warmth table, which is somewhere around 10° R at its minimum, whereas it is now proportional to the number of degrees everywhere and much larger.

Eschmann then made up a table of the expansion coefficients for iron determined by various physicists and used it to calculate the mean (.00001491 rules per 1° R). His own determination would have given .0000141 rules. With the new coefficients, the rods measured up to 10° R (a total of 831) had to be shortened, while those with a temperature over 10° R – all 1400 of them – had to be lengthened:

> *There is thus no mistake, neither on the part of the French nor on mine* ... and the results, which I have the honor of sending to you as definitive, hopefully will be so forever.[79]

The connection with the French network was achieved trigonometrically across two different triangulation nets. While the length measured in Aarberg came to 13053.740m, using the French ground-line at Ensisheim resulted in an additional .035m. The same method applied to a second triangulation net resulted in a length .020 m shorter. With this level of accuracy, the foundation of the Swiss survey project was secured and internationally confirmed.[80]

5. Transpositions: From Landscape to Map of a Nation

In 1835, the military surveillance authorities reported to the Diet that the protocols, "some from the late Mr. Quartermaster General Finsler, who continued to be entrusted with the verification and calculation of the triangles," were being kept in the best order and contained "154 triangles of the first class, 894 of the second, and 1446 of the third; all together thus 2494 *observed, calculated, verified, and recorded triangles*"[81]: The gigantic machinery of a new "national" recording system for the landscape of Switzerland had come to fruition (*Figure 4*). "Nous voilà enfin maîtres de nos éléments," Dufour commented on December 9, 1836,[82] when the connection with the Lombard triangulation network was reported to him. "Maîtres de nos éléments" – the expression implied mastery of natural spaces through the means of their representation in a cartographical recording system, in which the third stage had only just been reached.[83] The extremely complex process of transformation from landscape to the finished "Topographical Map of Switzerland" cannot be described in all of its details here. Now that I have discussed the problems of the instrumental measuring of the ground-line and its entry into the protocols, the following pages will examine in closer detail only two of the partial transpositions indicated in *Figure 4* : The regulations for recording and the technical production of the map at the press. In them, the political dimensions of cartography are probably expressed most clearly. They also illustrate the filters translating between "landscape" on the one side and "map" on the other.

LANDSCAPE

Process	Instruments/Techniques
Ground-line measurement	Rods, thermometers, wedges
Correction/Compatibilization	Survey protocol; calculations
Triangulation	Signals; theodolite: survey markers
Projection	Analytical geometry/projection theory
Division of the folios	Determination of standard measure
Regulations for recording	Ccategorization of landscape elements
Defining the nomenclature	Interviews/archives
Recording of terrain	Ordinance survey maps, coordination network
Determination of elevation	Telescope; theodolite
Standard reduction	Compass; calculation
Engravement	Copper plates
Printing	Press
Assemblage/control	Paper

MAP

Figure 4: Stages of Transposition in the Cartographic Recording System

Dufour's "Instruction for Recording in 1/25000" contains the most important rules of transposition for standardized terrain recordings. "In the areas, in which assessor surveys exist, the engineer will reduce these plans in order to use the same as a first draft. While he ranges through the villages, he will take note of the changes that have become necessary and newly added objects. For this rectification, he makes use of the survey table or the swivel rule. If no assessor plans exist, the engineer will make a triangulation of the third order by using the trigonometric points assigned to him. Then he records the details, fixing the position with cross-bearings, or if that is not possible by making an outline with the help of a magnetic compass. It is also permissible to make use of stadia for detail operations." We might summarize these as follows: Transposition rule 1: Reduction of the assessor survey or a triangulation of the third order as functional equivalent. Transposition rule 2: assessment of changes through inspection of the terrain (field observation). Transposition rule 3: Use of the survey table or the swivel rule, the compass, or the stadia. The work instructions are reminiscent of Micheli du Crest: reification and retention of the present image of the landscape by means of technical instruments, according to which the remaining landscape elements are to be oriented. This fundamental catalogue of rules was followed by a categorization of landscape elements, a definition of what is "of interest." This included "watercourses of the valleys and ravines, the ridges of the mountains, the tops of the hills, as well as the watersheds," transportation routes, lakes, ponds and swamps, peat moors, mines, quarries, rock formations, slopes, moraines, abysses, canyons, scablands, faults, "in a word, all characteristic features of the land." These were, however, "to be expressed according to their real forms, as they would present themselves to an observer situated directly above them, and not with conventional symbols." Pictograms were, however, allowed for castles, factories, chalets or isolated farms, ruins, and in general all edifices." Observing the interests of the map's military sponsor, everything that created "a serious obstacle for a movement of troops" was to be included. The same went for the exact depiction of roads, which were divided into five categories, in which trade political interests played a role: Postal roads with four parallel lines, "other good major roads with two lines, one heavy and the other fine, side roads in good condition, where a wagon can pass through easily, with two fine lines, lanes that are only passable for oxen carts with

one fine and one dotted line, mule tracks or foot paths with solid or dotted lines." Colors, stroke types, and symbols each received a definite meaning assigned to them: watercourses blue, buildings red, vermilion or crimson. Stone bridges were drawn with red, wooden bridges with black lines. The anchor points of the map received special attention: "The numbers of the most important [canton] border markers ... are written in red and in Roman numerals ... the trigonometric signal points are indicated with a small triangle, the church towers with a small black circle, the inside of which remains white." Even the form of the captions was specified: "The handwriting of the original recordings is executed with the usual roundness, but carefully executed, and the size [is chosen] in the correct relationship to the importance of the object. It is even better, when the engineer adheres to the pattern supplied to him by the confederal topographical bureau. With the exception of print that refers to rivers, streams, valleys and mountain chains, the same is always made parallel to the long side of the page, that is, from west to east."

Dufour repeatedly specified which instruments were to be used for transcription of the landscape onto the ordinance survey map. For example the entry of the "stadia gradations," were defined for the most important points with the "known geodesic methods." "For points of less major importance, as for example those that only serve to determine horizontal contours ..., differences of elevation can be calculated with an elevation diagram or the logarithmic slide rule."[84] The terrain is expressed as precisely as possible with horizontal contours that represent the intersecting lines of the ground surface with level planes vertically separated by 10m. ... The contours are rendered by unbroken lines in brown (burnt sienna)." In every instance, the engineer was to be wary "of every affectation." The provisions written by Dufour[85] are a comprehensive set of transposition rules for a precise cartographic depiction of natural objects and landscape elements. The need for centralized oversight of the terrain recordings – which recall Latour's "centres of calculation"[86] – was of crucial importance because the recording had for the most part to be delegated to the cantons. Federal projects had to perform a delicate balancing act to survive financially while ensuring the cooperation of the cantons. The active participation of the canton under the more or less gentle central supervision of the federal state was an integral component of the political culture of Switzerland in all other areas of federal policy (with the exception of foreign policy).

Like the specifications for surveying the ground-lines at Aarberg and Zurich, the derivation of correctional formulas and projection methods, and the above-mentioned specifications for original recordings, the rules for the reduction to the selected map scale of 1:100000 also had to be established and monitored, as did the protocols for transferring the map onto copper printing plates. Lacking proper experience, Dufour turned to the Depôt de la Guerre de France for guidance. It can be assumed that the projects in Dufour's topographical bureau took a form similar to that described by the first draftsman of the Depôt de la Guerre in his response to Dufour.[87] The instructions provided by the Depôt illustrate the number of complex tasks involved in translating field data to a standard map. According to this, the survey maps of the original recordings, which were colored at the bureau (in the field, a pencil was used exclusively)[88], were transferred onto tracing paper and reduced to the scale map by a draftsman, who worked primarily from the geodesic points provided on the survey maps for orientation. This draft went to the engraver of the "trait," who transferred it onto the copper printing plate. "From the engraving, 2 proofs are taken on white paper; the text draftsman next enters the inscription in the prescribed manner and afterwards it is engraved by the text engravers. A new proof thus now contains the trait and the inscription. The plate next reaches the terrain engraver, who works from a pattern that has been produced by a draftsman from the second of the two aforesaid proofs by means of quill and who also has construed the contours. The terrain engraver works from these two drafts. The hatching of water is finally entered by an engraver who does nothing other than this."[89]

The production of the engraving is thus a process involving extreme specialization, in which every functional stage follows its own transposition rules. One of these numerous transposition rules concerned the nomenclature of the map – a diplomatic matter of the highest order.[90] The confederal military commission had decided that the titles and commentaries on the folios were to be in German, while the town names would be given in the language spoken by the majority of the local population. This was, especially in the border area between Bern, Fribourg, Neuchâtel, and the Waadt or in the Bern Jura, politically a very delicate and risky venture. Local opposition to the state's unifying power of definition was practically pre-ordained. The declared policy of the military authorities was to reduce multi-lingual nomenclature to a single language. "If a mountain or a river has several names, only a single one is to be written, namely the most well known or the one that is accepted by the local authorities. *Through this the name becomes to a certain degree official*."[91] Translation protocols were thus required in order to even read the map. Folio V of the "Topographical Map of Switzerland" contains a translation catalog of approximately

450 important or controversial place names in four languages.[92] In it, the map reader was instructed to think of Gebsdorf as Courchapoix, Ueberstein as Surpierre, to translate Marmels as Marmorèra, Tinzen with Tinzogn, or Treiten as Treiteron. Thus, prior to the founding of the federal state in 1848, the multi-lingualism of Switzerland, according to the slogan "national unity – cultural diversity," had already become an integral component of the future state ideology.[93] In order to ensure that "diversity" did not assume a threatening nature, however, "official" nomenclatures were used wherever at all possible. The engineers involved in terrain recording asked the local authorities, the village teacher if need be, what a village, hamlet, valley, or hill was "correctly" called. This practice allowed the producers of the map to reduce topographical complexity considerably; and in the process any influences of dialect were ridded of local varnish through transcription into written language, while traditional and locally-rooted names of town and country were almost entirely ignored.[94]

The state's topographical monopoly on definition was not easy to establish. The publication of the first folios of the map project launched a furious debate which led Dufour to resign temporarily. The primary complaints made against Dufour in the *Schweizerischer Beobachter*[95] were directed against his system of depiction, secondly against the determination of place names, thirdly against the elevation readings, in short: against the very cornerstones of his cartographic recording system. But most importantly, the complaints came from the most diverse camps at the same time: a former collaborator of Dufour's claimed that the map had been carelessly and quickly produced: "Je suis étrangement étonné que l'autorité fédérale ait pu permettre la publication de cette carte avec de pareilles lacunes."[96] Colonel Maillardoz, the president of the confederal military council, had already accused Dufour beforehand of insufficient precision in the specification of national boundaries.[97] The article in the *Schweizerischer Beobachter* made it clear that the nomenclature chosen would inevitably meet with the immediate opposition of local residents. Interestingly, in his response, Dufour frequently referred to the names ascertained in the original recording maps; he thus used one stage of the recording system in order to deflect criticism from the final map.[98] In other cases he depended upon local informants; but he tended to rely on persons, such as school teachers, who opposed traditional geographical knowledge.[99] While Dufour dismissed problems of nomenclature with counter-attacks such as "cavils" or "chicanery for our bi-lingual country," in the area of elevation statistics he defended himself exclusively with scientific-methodological arguments. Thus Johann Eschmann wrote as justification to Dufour that "the same instruments and the same methods" has been consistently applied and all accepted elevation readings and calculations had been verified – "those are the fruits of 1000 combinations." Furthermore, the best instruments had been used in constructing the new map.[100] The recording system itself attained legitimate character.

6. "Assembling Switzerland", Map Popularity, and the Loss of Images

What about "nature," the physical spaces captured within the network of national triangulation? At the beginning of 1838, the folio "Triangulation primordiale de la Suisse" appeared as the first publicized result of the topographical survey. The lithograph contained nothing but the bare net, with indications of the names of the intersections, the lengths of the individual segments of the triangulation "exprimés en mètres et réduit au niveau de la mer." Neither rivers nor lakes, valleys nor villages nor canton boundaries were indicated – pure abstraction in trigonometrical terms, with the clear message: The natural alpine expanses and deep valleys were to be transformed into the uniform geographical space of Switzerland *(Figure 5)*.

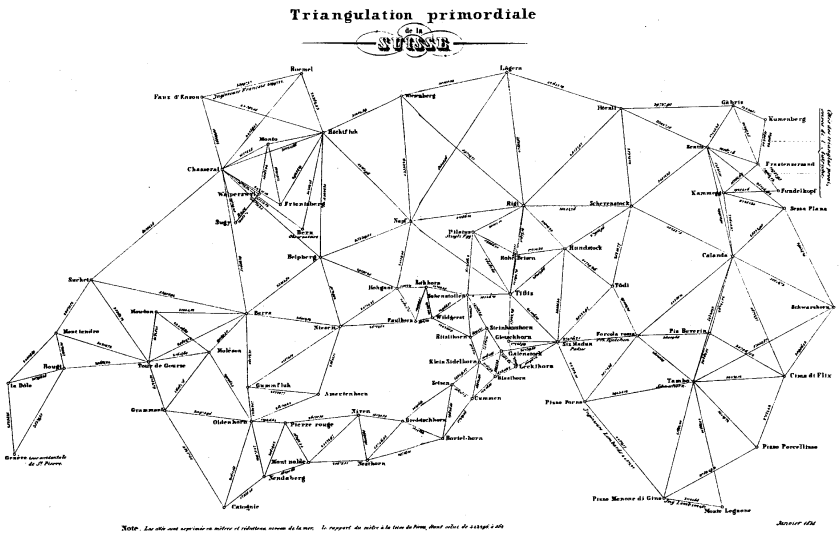

Figure 5: Triangulation primordiale de la Suisse[101]

One then set out to fill in this network, right down to the survey map of the engineer involved in the original recording, to translate it to map scale according to the rules, and in highly specialized and equally regimented sequential processes to produce a total of twenty-five copper plates that were supposed to represent the country beyond all scientific doubt – the precision of the ground-line measurement and its record in the protocol were to vouch for that. There had been a few minor problems during the terrain recording, such as opposition of the population or lack of cooperation from the local authorities. The storm of protest only broke when the concrete results were made public.

But once again political events came to the aid of the project. In 1847, Dufour was elected as commander-in-chief of the army against the Separatist League created by the Catholic-conservative cantons. The clear victory of his troops and the foundation of the federal state with a liberal-republican constitution realized political conditions at the national level, the precursors of which had already enabled the "take-off" in "confederal topography" in 1833. After 1848, Switzerland was identified with an institutional political stability that promoted modern economic growth, the creation of a domestic market with a uniform system of measures and currency, and the unhindered boom in the export economy during the second half of the 19th century. The "Dufour map's" bid for identification as a national accomplishment increased under these new political conditions – the map itself became the cornerstone of the federal state's self-representation. It was not without reason that the single folio published in 1848 comprised an "overview," in French "assemblage" – instructions, therefore, on how "Switzerland" was to be pieced together. From then on the printing press ran ever faster until all twenty-five folios were be pieced together in 1864 (*Figure 6*).

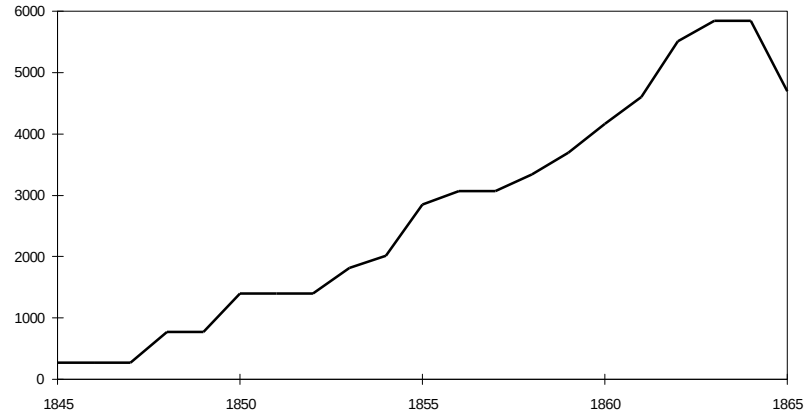

Figure 6: Annually Printed Folios of the Dufour Map 1845-1865[102]

While the main topographical work on the Dufour map falls within the phase of the structural formation of Swiss liberalism,[103] the actual technical production and diffusion of the map took place in a period of political stability and ideological hegemony of the "liberal" party. I have attempted to explain the effort by Swiss liberals to revitalize the Enlightenment-motivated cartography project of the 18th century in terms of the instrumental role played by a "national" cartography in constructing the economically, politically, and ideologically unified space "Switzerland."[104] What became of the map of 1848 appears to confirm this thesis. At first, no opportunity was neglected to present the "Dufour Map" at international exhibitions. The representation of the natural space of Switzerland also contributed to the representation of Switzerland as a politically unified nation. In 1855, the "Topographical Map of Switzerland" won a gold medal of honor on the occasion of the Paris World Exhibition, in 1873 a certificate of honor in Vienna, in 1876 a certificate of award in Philadelphia, in 1878 a certificate of honor once again in Paris, in 1889 a grand prize in Paris. The map was awarded many other distinctions on other occasions as well.[105]

Parallel to this, a cult of personality developed around Dufour as "father of the nation," which was closely related to the cartographical undertaking he had led. In recognition of his leadership of the map project, the state government presented Dufour with a "silver centerpiece, consisting of two fruit bowls, one above the other. ... Towering above the upper fruit bowl is Helvetia bestowing a wreath, the rim of the fruit bowl being designated for inscriptions. At the base, the corners of the pedestal are occupied by three figures of solid silver, which with their emblems represent topographical surveying, copperplate printing, and technical military work."[106] That a victorious Helvetia and her bountiful fruit is supported by these three figures suggests that together with political and military means Dufour's cartographical work was to be viewed as one of the founding pillars of the federal state.[107]

Nearly three years before the presentation of the centerpiece, the cult of Dufour had been inscribed on the landscape itself: in 1863, the highest Swiss mountain peak in the Monte Rosa group received the name Dufour Peak by a resolution of parliament. A popular biography of Dufour – "compiled with special consideration of the service he rendered for the political independence and unity of Switzerland, as well as for scholarship, art, and humanity" – that appeared in 1878 and went through many editions traces a direct line from Dufour Peak across the immense masses of the nation of summits to the precise measurement, in certain respects the graphic representation, of Switzerland. "Dufour Peak that majestic summit of rock is called, which, adorned with everlasting snow, sits upon its throne as lord amid an entire, gigantic army of alpine princes of nearly the same high birth, princes of the Land of the Swiss, who lift up the silver tresses of their heads, in rings closer and wider about him, from out of the immense masses of the lower people of summits and daily receive the first hail and the last kiss of the sun god. It does not carry this name without reason: the representatives of the Swiss nation have named it thus in honor of General Dufour, and indeed with the special purpose of erecting a monument to the priceless accomplishments of this man in the service of the precise measurement and graphic representation, as correct as it is effective and expedient, of the Land of the Swiss."[108] Senn uses here a metaphor as forced as it is revealing. The senate of these divinely inspired sages, whose "primus inter pares" and at the same time "lord" is said to be Dufour, is surrounded by the immense masses of the lower people, whose – assumedly democratically elected – representatives erect for the precisely measuring cartographer a monument to his "correct," "effective," "expedient" representation of the "Land of the Swiss;" Helvetic triangulation of cartography, politics, and representation – the geographical space of Switzerland has become transparent and uniform, the mists have finally dissipated.

The "correct measurement" was in fact soon corrected,[109] but the map remained "effective" and "expedient" nevertheless – as a planning aid for the construction of railroad lines and streets, for the development of telegraph networks and for the postal administration, for tourism and for military home defense.[110] The Swiss map was substantially more important, however, as an instrument of national politics. "The popularization of cartography, its application to all branches of public life, is an achievement of the past few decades."[111] It was supplied to cantonal administrations and schools at subsidized prices, and as early as 1853 the state had a compact edition on a scale of 1:250000.[112] Into the middle of the grand century-project of bringing literacy to the entire Swiss population, initiated by enlightened pastors of the 18th century and institutionalized by the bourgeois-revolutionary Helvetic, fell a successful project that attempted to teach the "Swiss people" the official, federal manner of reading geographical space. "We can achieve great things when we have learned to use this rich source!"[113] Reified, this claim appeared at the Swiss National Exhibition of 1883 in Zurich. In the exhibit of "Modern Art," one found "in the branch of sculpture the glorification of today's cartography, the best illustration of its contemporary popularity. It is the shepherd lad who studies the map."[114] For Haller, this shepherd lad was still a "student of nature,"

whose "reason [was bound] to no school law;" in his Alps "rules reason, led by nature."[115] After Dufour and after 1848, one wanted to hear no more of this. The shepherd lad, in 1883 as in the 18th century, indeed still stood *pars pro toto* for Switzerland, but this personified Switzerland now grasped the rarified condition of its landscape from a folio of federal cartography. "It is certainly no mere coincidence that led the artist to chose precisely this motif and inspired him to express the far-reaching influence of cartography in such perfect form. It is the ethical influence of cartography which speaks to us out of the marble, that eminent significance of the map as a means always ready to serve the elevation of the spiritual and economic prosperity of solitary individuals as well as the entire society."[116] The transformation of Haller's "He knows his fatherland and with its treasures / Can deify his ever-seeking eye"[117] into the map-reading shepherd lad of marble as he was presented at the National Exhibition of 1883 is itself a breathtaking work in the semiology of mapmaking. "The majority of our readers have probably already seen the Dufour Map pulled out into a single piece," Senn had written in his biography of Dufour only a few years before, pointing on that occasion as well to "our people's developed sense for maps."[118] "It is a mighty work, this map, – the fruit of Dufour's thirty-three year effort and his exceptional field surveyors, geometers, engineers, draftsmen, engravers, copperplate printers, in short all of those men of science and art whose precise collaboration such a work demanded ... *All Switzerland* may thus place its just pride in Dufour's map work." Yet, although Senn here evokes the specialized transposition process of landscape to map once again, he seemed to wish to ascertain the illusory legibility of the map by claiming "that there is no foot path, no bridge, no house, no brook in the entire land from the plains to the highest alps that is not depicted in the right place and in the correct form, not to mention the graphic representation of the lay of the land, which is carried out here in all details so precisely and with such plastic effect that it seems as if one could soar like an eagle high above the land and looking down upon it study with a sharp eye cliff and crevice, hill and slope, ridge and valley floor in reality." Only those who read Senn's hagiographical text closely will discover that the cartographic transposition of the Swiss landscape must have transformed not only the reader, but also the landscape itself according to the principle of measurability. What topographers still found was a "fantastic confusion of ice banks, of precarious glacial towers, of sheer cliffs and yawning crevasses, ...days away from every human habitation," a world characterized by "snow storms, lightening and thunder." Not even the most skillful map reader have come to such visions from the "Topographical Map." The cartographic principle of measurability was an "effective" vehicle of the bourgeois mastery over nature in the 19th century.[119]

The same principle of measurability, however, also resulted in the subsequent suppression of the world of images. Ulrich Meister, colonel in the General Staff, national president of the left-liberal party, forestry superintendent of the city of Zurich, and author of a work on the national fortification of Switzerland, formulated this loss of images in a short essay on the "current standpoint of Swiss cartography" and the "legibility of our maps:" "Under the influence of the state's leadership and guidance of cartography, there has developed a noticeable preponderance of measurable factors or of the mathematical element as opposed to the simply depictive element in the recording as well as in the execution."[120] Little could be done to prevent this. The perspectivist representation, which Meister proposed at least for the smaller cities[121] so that one could recognize them on sight, belonged to the past. Meister was actually aware of the impossibility of his demand: "We miss the *picturesque element* greatly in the current production of cartography, or better said the use of *perspective* . This demand must seem somewhat awkward, when it is otherwise demanded of maps that they should only contain material that is *measurable* either directly or by conveyance. Originally, the map was a painting, a pictorial tablet; the cartographer drew or painted the terrain objects on the map in the form in which they appeared to him, and he integrated them into their linear relation as far as this was known to him. In the period of more precise geodesic foundation, mathematical precision was established in the foreground as the most important priority."[122] The "Dufour Map" had closed off the avenue of perspectivist representation once and for all, reserving it for panoramas and reliefs.[123] "It is not easy, forcing this ponderous, imposing mountainous land into a suitable likeness and at the same time still preserving the legibility of the map."[124]

Meister was right about the demands on the senses imposed by the requirements of abstraction, precision, and the new technical media. The end point in the development of the cartography of the "long 19th century" is formed by a machine that in its functional method resembled the phonograph to an astonishing degree: Von Orel combined the stereocomparator constructed by Pulfrich with a pantographically functioning lever system that was able to transfer all side and depth movements of the comparator onto a firmly attached drafting carriage.[125] "Machines take over the functions of the central nervous system"[126] – before the First World War in the area of cartography as well. Long before this,

however, bourgeois-liberal cartography had begun to translate cartographical substitute sensualities into the abstract measurability of the topographical map.

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[1]I am deeply indebted to Beat Glaus, Felix Gugerli, Rudolf Jaun, Heinz Lippuner, J. Rafael Martinez, Ulrich Pfister, and of course to Timothy Lenoir for their critical suggestions and logistical support.

[2]See John Brian Harley, "Maps, Knowledge, and Power," in Denis Cosgrove and Stephen Daniels, eds., *The Iconography of Landscapes: Essays on the Symbolic Representation, Design and Use of Past Environments* (Cambridge: Cambridge University Press, 1988), pp. 277-312; especially pp. 278-280; pp. 283-284. See also David Buisseret, ed., *Monarches, Ministers, and Maps. The Emergence of Cartography as a Tools of Government in Early Modern Europe* (Chicago and London: University of Chicago Press, 1992), and Christian Jacob, *L'empire des cartes. Approche théorique de la cartographie à travers l'histoire* (Paris: Albin Michel, 1992).

[3]Denis Wood, *The Power of Maps* (New York: Gilford Press, 1992), especially p. 51.

[4]Bruno Latour, *Science in Action. How to Follow Scientists and Engineers Through Society* (Cambridge, Mass; Harvard University Press, 1987), p. 254.

[5]John Brian Harley, "Deconstructing the map" in *Cartographica* (26) 2 1989:1–20. Denis Wood Denis and John Fels, "Designs on Signs / Myth and Meaning in Maps" in *Cartographica* (23) 3 1986:54–103.

[6]Cf. Friedrich A. Kittler, *Aufschreibesysteme 1800 / 1900* (Munich: Wilhelm Fink Verlag, 1987).

[7]The Cassinis' "Carte topographique de la France" was based on the first trigonometric survey of an entire country. It utilized vertical projection. See Monique Pelletier, *La carte de Cassini* (Paris: Press de l'Ecole nationale des ponts et chaussées, 1990) and Josef Konvitz, *Cartography in France, 1660–1848. Science, Engineering, and Statecraft* (Chicago and London: University of Chicago Press, 1987).

[8]Mémoire expliquant sommairement la proposition de faire lever géométriquement les cartes générales et détaillées de toute la suisse cmposé par le Sr. Micheli du Crest, fait au Château d'Arbourg, le 26 juin 1754, quoted in Johann Heinrich Graf, *Das Leben und Wirken des Physikers und Geodäten Jacques-Barthélémi Micheli-du-Crest aus Genf, Staatsgefangener des alten Bern von 1746–1766* (Bern: K. J. Wyss, 1890), pp. 97-101.

[9]Among these contacts were René Anoine-Réaumur, Pierre Louis Moreau de Maupertuis, Albrecht von Haller, and Daniel Bernoulli; see Eduard Fueter, *Grosse Schweizer Forscher* (Zurich: Atlantis-Verlag, 1941), p. 120. Micheli du Crest was a corresponding member of numerous learned societies.

[10]See Gardy Fréd, "La carte des environs de Genève, dessinée par J.-B. Micheli du Crest (1730)", in: *Geneva, Bulletin du Musée d'Art et d'Histoire de Genève* 2 (1924), pp. 187-192; Jacques Barthélemi Micheli du Crest, *Description du thermomètre universel* (Paris, 1741); *Recueil des diverses pièces sur le themomètre* (The Hague, 1756); *Mémoire sur la sphéricitè de la terre* (Berne, 1760); *Recueil physique sur le tempère du globe de la terre* (Bern, 1760). For biographical information, see Rudolf Wolf, *Biographien zur Kulturgeschichte der Schweiz* (Zurich: Orell, Füssli und Cie., 1858), pp. 229-60 and Graf (1890).

[11]Jacques Barthélemi Micheli du Crest, *Mémoire sur ce qui s'est passé au sujet des fortifications de Genéve* (Geneva, 1728). On the political and cartographical history of fortifications see Martha D. Pollack, *Military Architecture, Cartography, and the Representation of the Early Modern European City* (Chicago: The Newberry Library, 1991), and Henning Eichberg, *Festung, Zentralmacht und Sozialgeometrie. Kriegsingenieurwesen des 17. Jahrhunderts in den Herzogtümern Bremen und Verden* (Köln: Böhlau 1989).

[12]Jacques Barthélemi Micheli du Crest, *Requetes, Avertissement placet, Mémoire du Sieur Micheli du Crest, au sujet des sentences rendues contre lui tant au Grand qu'en petit Conseil de Genève, avec les moyens de nullité et recours au Conseil général contre les dites sentences* (Sion, 1735).

[13]On the conspiracy led by Samuel Henzi (1701-1749) against the Bern patriciate, see Graf (1890) and Rudolf Braun, *Das ausgehende Ancien Régime in der Schweiz. Aufriss einer Sozial- und Wirtschaftsgeschichte des 18. Jahrhunderts* (Göttingen and Zürich: Vandenhoeck and Ruprecht, 1984), pp. 270-71.

[14]Wolf (1858), pp. 229-37.

[15]On the relationship between Enlightenment and geographical studies, see Hermann Alfred Schmid, *Die Entzauberung der Welt in der Schweizer Landeskunde. Ein Beitrag zur Geschichte der Aufklärung in der Schweiz* (Basel: Helbing und Lichtenhahn, 1942).

[16]Letter of May 15, 1755 to Albrecht von Haller. Quoted in Wolf (1858), pp. 253-54. Emphasis mine.

[17]Svetlana Alpers, *The Art of Describing, Dutch art in the Seventeenth Century* (Chicago: Chicago University Press, 1983), pp. 62, 122.

[18]Letter of May 15, 1755 to Albrecht von Haller. Quoted in Wolf (1858), p. 254.

[19]Cf. on the other hand the conception of view in Pascal: "Il faut tout d'un coup voir la chose d'un seul regard, et non pas par progrès de raisonnement." Blaise Pascal, *Pensées suivies des écrits sur la grace*, ed. by Jacques Chevalier (Paris, 1937), p. 21. On the absolutist view, see Rudolf Braun and David Gugerli, *Macht des Tanzes — Tanz der Mächtigen. Hoffeste und Herrschaftszeremoniell 1550–1914* (Munich: C.H. Beck, 1993), chapter 2.3.

[20]Maps in the Ancien Régime often had the status of military secrets and, like archival materials, were kept under restriction by the authorities. See Rudolf Wolf, *Geschichte der Vermessungen in der Schweiz* (Zurich: S. Höhr, 1879), p. 71.

[21]"So wird, was die Natur am prächtigsten gebildet / Mit immer neuer Lust von einem Berg erblickt." Albrecht von Haller, "Die Alpen (1729) (Stuttgart: Philipp Reclam Jun., 1978), pp. 15, 323-24. The Chasseral was surveyed by French engineers and later served as the point of departure for designated elevations on Dufour's map. See Puissant, *"Nouvelle description géometrique de la France* (Paris, 1832), pp. 407, 527; see also Wolf (1879), pp. 175-85.

[22]Haller (1729/1978), pp. 15, 339-40.

[23]At the same time, Jean-Henri Lambert attempted theoretically to introduce into painting an artificial observational position— still from a central perspective, it is true— which was no longer tied to the constraints of the ground level. "Or, qui veut se porter garant que le point que devrait occuper l'oeil ne se trouve en l'air?" Jean-Henri Lambert, "Essai sur la perspective," (Paris: Roger Laurent, 1752).

[24]Jacques Barthélemi Micheli du Crest, *Prospect géometrique des Montagnes neigées, dittes Gletscher, telles qu'on les découvre en tems favorable, depuis le château d'Aarbourg dans les territoires des Grisons, du Canton d'Ury, et de l'Oberland du Canton Berne* (Augsburg, 1755); Micheli du Crest, *Mémoire pour l'explication du Prospect des Montagnes neigées que l'on voit du chateau d'Aarbourg* (1755).

[25]As in his suggestion for a uniform map of Switzerland; see Richard Grob, *Geschichte der schweizerischen Kartographie* (Bern: Kümmerly und Frey, 1941), p. 73.

[26]F.L. von Pfyffer, quoted in Wolf (1879), p. 108.

[27]In 1755, Isaak Iselin published his book *Philosophische und patriotische Träume eines Menschenfreundes*, which was re-issued in 1758 and 1762. Franz Urs Balthasar's piece "Patiotische Träume eines Eydgenossen von einem Mittel, die veraltete Eidgenossenschaft zu verjüngern" appeared in 1758. Micheli du Crest's topographical project (see Grob (1941), p. 73) also belonged in the end to this category of "helvetic dreams" that emerged around the middle of the 18th century and strove for a rejuvenation of "Helvetia" from the space of the bourgeois public sphere. See Ulrich Im Hof, *Die Entstehung einer politischen Öffentlichkeit in der Schweiz. Struktur und Tätigkeit der Helvetischen Gesellschaft* (Frauenfeld: Huber, 1983), pp. 25-26.

[28]In 1765 the map was still going into a new edition; it was used for the most diverse illustration purposes, even in popular calendars. Grob (1941), pp. 49-51.

[29]Grob (1941), p. 50.

[30]Wolf (1858)

[31]On the Scheuchzer Map, see Wolf (1879), pp. 47-56; see also Arthur Dürst, *Johann Jakob Scheuchzer: Nova Helvetiae tabula geographica. Erläutendes Begleitwerk zur Faksimileausgabe der Nova Heveltiae tabula geographica von Johann Jakob Scheuchzer* (Tiguri, 1971).

[32]According to the first, more radical version of Haller's poem; in the definitive version the line is softened to "Macht durch der Weisheit Licht die Gruft der Erde heiter." Haller (1729/1978), pp. 17, 365, and 105 (Preface by Adalbert Elschenbroich).

[33]On Scheuchzer's biography, see Fueter (1941), pp. 111-12, *Historisch Biographisches Lexikon der Schweiz*, vol. 6 (Neuenburg, 1931; R. Steiger, *Johann Jakob Scheucher* (Zurich, 1927); Wolf (1858).

[34]On his theory of the absolute zero point, Micheli du Crest remarked self-critically: "jusqu'à ce qu'on ait justifié par un certain nombre d'expériences ... on ne peut pas conclure qu'il soit universel." Cf. Jacques Barthélemi Micheli du Crest, *Description de la méthode d'un thermomètre universel* (Paris, 1741). The quotation is found in Wolf (1858), pp. 240-41.

[35]"Etude de la population du Pays de Vaud," the study produced by Pastor Jean-Louis Muret (1715-1896), a statitician and member of the Bern Economic Society, led the Bern Grand Council to ban all publications containing population statistics; Braun (1984), pp. 55-56. On the statistical and political activities (and on the execution) of Johann Heinrich Waser (1742-1780), see Rolf Graber, 'Der Waser-Handel. Analyse eines sozio-politischen Konflikts in der Alten Eidgenossenschaft," *Schweizerische Zeitschrift für Geschichte* 30 (1980), pp. 321-56. See also Christian Simon, "Hintergründe bevölkerungsstatistischer Erhebungen in Schweizer Städteorten des 18. Jahrhunderts. Zur Geschichte des demographischen Interesses," *Schweizerische Zeitschrift für Geschichte* 2 (1984), pp. 186-205.

[36]"J'ai de plus remis à Mr. le Banneret Imhoff un mémoire qui renferme et explique sommairement la proposition pour lever géométriquement la carte générale et les cartes detaillées de toute la Suisse." Letter to Albrecht Haller, September 5, 1754. Quoted in Wolf (1879), p. 108 and Graf (1890), p. 101.

[37]In 1762 Micheli du Crest sent a new version of his memorandum to the Government of Bern, and did'nt succeed either. Graf (1890), p. 109; Grob (1941), p. 73.

[38]Haller (1729/1978), pp. 17, 361-72.

[39]Reinhart Koselleck, *Kritik und Krise. Eine Studie zur Pathogenese der bürgerlichen Welt* (Frankfurt on Main: Suhrkamp 1959/1973), p. 41. See also Jürgen Habermas, *Strukturwandel der Öffentlichkeit. Untersuchungen zu einer Kategorie der bürgerlichen Gesellschaft* (Neuwied, Berlin: Luchterhand, 1962). See also Im Hof (1983).

[40]See J. L. Hogreve, *Praktische Anweisung zur topographischen Vermessung eines ganzen Landes* (Leipzig, 1773).

[41]Antonio Lafuente and Antonio Mazuecos, *Los caballeros del punto fijo. Ciencia, politica y aventura en la expedición geodésica hispanofrancesa al virreinato del Perú en el siglo XVIII* (Madrid, 1987).

[42]Daniel Frei, "Mediation," in *Handbuch der Schweizer Geschichte*, vol. 2 (Zurich: Berichthaus, 1980), p. 844.

[43]As for example the border problems of the cantons, Frei (1980), p. 849.

[44]Jean-Jacques Biaudet, "Der modernen Schweitz entgegen," in *Handbuch der Schweizer Geschichte*, vol. 2 (Zurich: Berichthaus, 1980), p. 892.

[45]Biaudet (1980), pp. 904, 910.

[46]See the Confederal Military Order of 1817. In 1819 a Central School for Officers and Non-Commissioned Offierces of the Artillery and Corps of Engineers was set up in Thun, in 1829 a Central School for Infantry and Cavalry Officers. Biaudet (1980), p. 915. For general background, see Georges Rapp, *L'Etat-major général suisse. Des origines à la Guerre du Sonderbund (1798-1847)* (Basel and Frankfurt on Main: Helbing und Lichtenhahn, 1983).

[47]Wilhelm Fetscherin, ed., *Repertorium der Abschiede der eidgenössischen Tagsatzungen aus den Jahren 1814-1848*, vol. 2 (Bern: K. J. Wyss, 1876), pp. 551-564 (§135: Trigonometrische Vermessungen; topographische Arbeiten).
[48]On the importance of alliance for the promotion of scientific-technical projects, see Latour (1987), pp. 103-44.
[49]*Appel au zèle scientifique tendant à obtenir des souscripteurs pour la confection d'une carte topographique détaillée des Alpes de la Suisse* (Lausanne, 1829). On the role of the Naturalist Society in domestic topography, see Wolf (1879), pp. 238-40.
[50]A resolution of the Diet of August 1, 1822 firmly maintained that all national topographical projects fell within the jurisdiction of the army and were to be concentrated within the army in the confederal General Quartermaster Staff. Cf. Fetscherin, p. 552. See also Hans Rapold, *Strategische Probleme der schwiezerischen Landesverteidigung im 19. Jahrhundert* (Frauenfeld: Huber, 1951), pp. 35-42.
[51]Johann Heinrich Graf, *Die schweizerische Landesvermessung 1832-1864. Geschichte der Dufourkarte*, (Bern: Eidgenössisches topographisches Bureau, 1896), pp. 19-26.
[52]Wolf (1879), pp. 240-41.
[53]It was decided to use the scales of 1:25000 and 1:50000 for surveys of flat land and mountans respectively. Engravings were to be done on a scale of 1:100000, and this was to be projected according to the modified Flamsteed method. See Graf (1896), pp. 26, 76-82.
[54]Biaudet (1980), pp. 918-19.
[55]The "Federal Charter" proposed by Diet commission at first foundered, was strongly revised and presented to the cantons on May 17, 1833, where even this version found no mercy. Biaudet (1980), pp. 923-27.
[56]See *Abschied der ordentlichen eidgenössischen Tagsatzung des Jahres 1833* §IX, pp. 8-9. The sum appropriated for domestic topography came to 10% of the entire military budget. Ibid., pp. 23-25.
[57]Including allocations to the cantons. Source: Graf (1896), pp. 241-42.
[58]Bruno Uebel, "Was sind die unerlässlichen Erfordernisse zu einem eidgenössischen Generalquartiermeisterstabs-Offizier?," *Helvetische Militär-Zeitschrift* (1834). Quoted in Rudolf Jaun, *Das eidgenössische Generalstabskorps 1804-1874. Eine kollektiv-biographische Studie* (Basel: Helbing und Lichtenhahn, 1983), pp. 206-07.
[59]Finsler was a businessman and a banker by trade, Wurstemberger had acquired autodidactic knowledge of surveying technology. See Jaun (1983), pp. 59, 198.
[60]On his topographical training at the Ecole Polytechnique, see Raymond D'Hollander, "Influence de la cartographie française sur Dufour, in Roger Durand and Daniel Aquillon, ed., *Guillaume-Henri Dufour dans son temps. 1787-1875. Actes du colloque Dufour* (Geneva: Société d'histoire et d'archéologie, 1991), pp. 135-51.
[61]See also Tom F. Peters, *Transitions in Engineering. Guillaume Henri Dufour and the Early 19th Century Cable Suspension Bridges* (Basel and Boston: Birkhäuser Verlag, 1987).
[62]For biographical information, see Roger Durand and Daniel Aquillon, ed., *Guillaume-Henri Dufour dans son temps. 1787-1875. Actes du colloque Dufour* (Geneva: Société d'histoire et d'archéologie, , 1991). See also Guillaume-Henri Dufour, *Instruction sur le dessin des reconnaissances militaires* (Geneva and Paris: Barbezat et Delarue, 1828).
[63]The act increasing federal allocations for trigonometric surveying was pushed through in the absence of the delegates of Uri, Unterwalden, Neuenburg, Schwyz, and the City of Basel. Fetscherin (1876), p. 557.
[64]The military authorities, who wanted to control weapons smuggling by occupying the border during the Tirol revolt of 1809, were not only confronted by the fact that most of the cantons mobilized incomplete and poorly-equipt operative personnel, but discovered that they did not have a clear enough picture of the boundary lines in the East of Switzerland; entire villages were missing on the existing maps and the shape of Canton Thurgau was completely displaced. The triangulation ordered by Quartermaster Colonel Finsler in order to determine the course of the boundaries could only assume a temporary and improvised nature. Frei (1980), p. 849; Graf (1896), pp. 5-6.
[65]Support for a national cartography project may well have sent out signals similarly with regard to Pope Gregor XVI's Encyclica "Mirari vos" of August 15, 1832 opposing the modern political doctrines of the freedom of conscience and "impudent science."
[66]On Dufour's political stance, see Marco Marcacci, "Le député Dufour et l'avènement de la démocratie moderne à Genève," in Durand and Aquillon (1991), pp. 87-98.
[67]Guillaume-Henri Dufour, *Notice sur la carte de la Suisse dressé par l'état-major fédéral* (Geneva: J. G. Fick, 1861), p. 6. This polemical pronouncement did not in fact correspond to the established facts, but it more than likely formed an important part of the finance strategy that Dufour pursued vis-a-vis the federal authorities. The prelimary works were already blotted out of memory in the concluding report. Henri Dufour, *Schlussbericht über die topographische Karte der Schweiz* (Bern: Topographisches Bureau, 1864). See also Wolf (1879), p. 245.
[68]Micheli du Cresti had already proposed establishing a ground-line in Aarberg .
[69]Cf. Bruno Latour, "Give Me a Laboratory and I Will Raise the World," in Karin Knorr-Cetina and Michael Mulkay, eds., *Science Observed: Perspectives on the Social Study of Science* (London: Sage Publications, 1983), pp. 141-70.
[70]For the purposes of depiction, the angle a of the wedge in figure 2 is significantly larger than in reality.
[71]See Graf (1896), pp. 46-48.
[72]Ibid., p. 48. For more details on the surveying procedure, which has been simplified here, see Wolf (1879), pp. 247-50.
[73]"Da ich ganz gut weiss, wie leicht es ist, sich zu irren, mache ich jede Rechnung zwei- oder dreimal ...," Eschmann to Dufour, July 14, 1836; in Graf (1896), p. 57.

[74]"Schreibmaschinen speichern kein Individuum, ihre Buchstaben übermitteln kein Jenseits, das perfekte Alphabeten dann als Bedeutung halluzinieren können." Friedrich A. Kittler, *Grammophon Film Typewriter* (Berlin: Brinkmann und Bose, 1986), p. 27.
[75]Diary entry of Rudolf Wolf, September 20, 1835, in Johann Jakob Burckhardt, "Eine Alpenreise von Rudolf Wolf im Jahre 1835", *Die Alpen* (2) 1989, p. 98.
[76]Johannes Eschmann, *Rapport sur les bases d'Aarberg et celle de Zurich corrigées par de nouvelles experiences*. Quoted in Graf (1896), p. 58. See also Johannes Eschmann, *Ergebnisse der trigonometrischen Vermessungen in der Schweiz* (Zurich: Orell, Füssli und Cie., 1840).
[77]For reasons of space, I forego a description of the measurements of elevation, which were taken with just as much exactitude. See Graf (1896), pp. 82-85.
[78]On the measurements of the mathematic-military society in Zurich, see Wolf (1879), pp. 163-68.
[79]Eschmann to Dufour, June 14, 1836; in Graf (1896), pp. 56-57. Emphasis mine.
[80]Graf (1896), p. 61.
[81]"Bericht der eidgenössischen Militäraufsichtsbehörde an die H. Tagsatzung über den Zustand der trigonometrischen Arbeiten auf Mitte des Jahres 1835," in *Abschiede der eidgenössischen Tagsatzung des Jahres 1835*, supplement Litt. E, p. 6. Emphasis mine.
[82]Correspondence notebook of Dufour, no. 3 (July 9, 1836). Quoted in Graf (1896), p. 91.
[83]Latour (1987), pp. 223-32. On 19th century attempts at disciplining nature by technical and scientific means see David Gugerli, Redeströme und Elektrifizierung. Zur diskursiven Gestaltung einer modernen Technik in der Schweiz 1880–1914 (Zurich: Chronos, 1996), chapter 4.
[84]On the utilized instruments, see Graf (1896), p. 143.
[85]Parallel to the described catalog, a catalog for the original recording on the scale of 1:50000 existed, which was used in the mountains. Printed as Supplement II in Graf (1896).
[86]Latour (1987), pp. 215-57.
[87]Cited in Graf (1896), pp. 141-42.
[88]Ibid., p. 144.
[89]Ibid., p. 142.
[90]It is not astonishing that in the late 1930s a return to names of towns in dialect was demanded. "Mit der Angleichung an die neuhohcdeutsche Schriftsprache verfielen die Väter dieser Vorschriften der in weitesten Kreisen des Volkes herrschenden Geringschätzung der Mundart und der irrtümlichen Meinung, dass so frisierte Namen vornehmer und schöner aussähen." B. Cueni, "Die Nomenklatur der Landeskarten," in *100 Jahre eidgenössische Landestopographie 1838-1938* (Bern: Landestopographie, 1983), p. 1.
[91]Graf (1986), pp. 142-43. Emphasis mine.
[92]The translation catalog of Folio 5 (1850) contains translations from German to French, French to German, Italian to German and German to Rhaeto-Romanic.
[93]See Privy Councillor Zollinger's "toast to the fatherland" on the occasion of the Confederal Choral Festival in Zurich, *Neue Zürcher Zeitung* no. 194 (July 12, 1880).
[94]For a linguistic perspective, see Paul Zinsli, *Südwalser Namengut. Die deutschen Orts- und Flurnamen der ennetbirgischen Walsersiedlungen in Bosco-Gurin und im Piemont* (Bern: Stämpfli und Cie., 1984).
[95]G. Studer and K. J. Durheim, "Unmassgebliche Bermerkungen über die eidgenössische trigonometrische Militärkarte Nr. XVII," *Schweizerischer Beobachter* 41-43 (April 4, 7, and 9, 1846). The article was also reprinted separately and sent to all canton offices. See also K. J. Durheim and G. Studer, *Erwiderung auf den von Herrn Oberst Dufour an den Eidgenössischen Kriegsrath gerichteten Rapport über die Bemerkungen gegen die neue Schweizerkarte* (Bern, 1847).
[96]A. J. Buchwalder, "Observations sur la Carte fédérale," *Journal bernois* 83 and 84 (1846). Quoted in Graf (1896), p. 154.
[97]The complaines concerned Lake Constance and Lake Geneva, on which no national boundaries were marked. Maillardoz to Dufour, October 25, 1845, Graf (1896), p. 158.
[98]Guillaume-Henri Dufour, *Rapport sur les observations anonymes* (1846).
[99]Dufour countered the complaint that "Beistandhorn" should instead be called "Wystätthorn" by noting that his engineer had been thus instructed by a schoolmaster of Turbach, who served as a guide; his engineers had always asked the most education people of the area. Graf (1896), p. 160.
[100]Eschmann to Dufour, March 14, 1847. Quoted in Graf (1896), p. 156.
[101]Graf (1896), plate between pp. 96-97.
[102]Calculated according to Graf (1896), p. 237.
[103]Eisner Manuel, *Politische Sprache und sozialer Wandel. Eine quantitative und semantische Analyse von Neujahrsleitartikeln in der Schweiz von 1840 bis 1987* (Zurich: Seismo, 1991), p. 92.
[104]"Die Kartographie ist und bleibt immer ein getreues Spiegelbild des in einer gewissen Zeitperiode zur Geltung gelangten Standes von Wissenschaft und Kunst, belebt durch den Pulsschlag des wirtschaftlichen Lebens der betreffenden Zeit. Ihre Art des Auftretens ist daher heute anders gestaltet als ehedem ..." Ulrich Meister, *Der heutige Standpunkt der schweizerischen Kartographie und die Lesbarkeit unserer Karten* (Zurich, 1883). The essay appeared, as is apparent from the text, in the broader context of the Swiss National Exhibition in Zurich in 1883.
[105]A list of distinctions in Graf (1896), p. 249.

[106]Graf (1896), p. 247.
[107]See also Georg Kreis, *Helvetia – im Wandel der Zeiten. Die Geschichte einer nationalen Repräsentationsfigur* (Zurich: Verlag Neue Zürcher Zeitung, 1991); Guy P. Marchal und Aram Mattioli (eds.), *Erfundene Schweiz. Konstruktionen nationaler Identität* (Zurich: Chronos, 1992).
[108]Walter Senn-Barbieux, *Das Buch vom General Dufour. Sein Leben und Wirken, mit besonderer Berücksichtigung seiner Verdieste um die politische Selbständigkeit der Schweiz, sowie um Wissenschaft, Kunst und Humanität, unter Benutzung der besten Quellen für das Volk bearbeitet* (Glarus und Leipzig: Carl Ziegenhirt, 1878), p. 84.
[109]On the Topographical Atlas of Switzerland begun under Hermann Siegfried (1819-1879), see Grob (1941), pp. 126-35.
[110]"... alle diese Reise-, Post- und Eisenbahnkarten, diese Bilder des wirtschaftlichen Lebens der Staaten, in messbaren Linien auf die Karte eingetragen, diese statistischen ethnographischen und historischen Karten sind der sprechendste Beweis dafür, welch verschiedenen Gebieten die Kartographie dient, wie die Kartographie ein unentbehrliches Hülfsmittel der modernen Welt geworden ist." Meister (1883), p. 2. Special maps were usually produced through a superimposed printing process.
[111]Meister (1883), p. 2.
[112]Parliamentary Resolution of December 14, 1853. Published 1873.
[113]Meister (1883), p. 12. On the literacy project and the transmission of values since the ancien régime, see Marie Louise von Wartburg, *Alphabetisierung und Lekrüre. Untersuchungen am Beispiel einer ländlichen Region im 17. und 18. Jahrhundert* (Bern: Peter Lang, 1981); Rudolf Schenda, *Volk ohne Buch. Studien zur Sozialgeschichte der populären Lesestoffe 1770 bis 1910* (Frankfurt on Main: V. Klostermann, 1970); David Gugerli, *Zwischen Pfrund und Predigt. Die protestantische Pfarrfamilie auf der Zürcher Landschaft im ausgehenden 18. Jahrhundert* (Zurich: Chronos, 1988).
[114]Meister (1883), p. 2.
[115]Haller (1729/1978), pp. 4, 31; ibid., pp. 6, 67, 83.
[116]Meister (1883), p. 2.
[117]Haller (1729/1978), pp. 15, 310.
[118]Meister (1883), p. 12.
[119]Senn (1878), pp. 84-86. Emphasis mine. On mastery of nature and political aesthetics, see Ulrich JOST, "Guillaume-Henri Dufour. L'esthétique politique et l'appropriation de l'espace," in Durand and Aquillon (1991), pp. 111-21.
[120]Meister (1883), p. 3. On Ulrich Meister, see Hans Schmid, *Ulrich Meister. Ein Zürcher Politiker* (Zurich: Verlag der Neuen Zürcher Zeitung, 1925) and Rudolf Jaun, *Das Schweizerische Generalstabskorps 1875-1945. Eine kollektiv-biographische Studie* (Basel and Frankfurt: Helbing und Lichtenhahn, 1991), p. 229.
[121]Meister (1883), p. 11.
[122]Ibid., p. 10. Emphasis in the original.
[123]Stephan Oettermann, Das Panorama. Die Geschichte eines Massenmediums (Frankfurt on Main: Syndikat, 1980).
[124]Meister (1883), p. 6.
[125]Eduard von Orel, "Der Stereoautograph als Mittel zur automatischen Verwertung der Komparatordaten," *Mitteilungen des k.k. milit. geogr. Institutes* 30 (Vienna, 1911), p. 62; Max Weiss, *Die geschichtliche Entwicklung der Photogrammetrie und die Begründung ihrer Verwendbarkeit für Mess- und Konstruktionszwecke* (Stuttgart: Strecker und Schröder, 1913). For Switzerland, see R. Helbling, "Die Stereoautogrammetrische Geländevermessung," *Schweizerische Bauzeitung* 76 (1921). Grob (1941), p. 148.
[126]Kittler (1986), p. 29.