David Gugerli: Mapping. A communicative strategy. In: J.P. Gaudilliere, H.J. Rheinberger (Hg.): From molecular genetics to genomics : The mapping cultures of twentieth-century genetics. Abingdon: Routledge 2004, p. 210 – 218.

11 Mapping

A communicative strategy

David Gugerli

Mapping is an authoritative tool for the production and exploration of relatedness, and it provides its users with a highly efficient analytical instrument for specific problems or questions. Wherever mapping is successfully employed, it allows for the visual aggregation, combination, and interpretation of selected *and* large amounts of data. Hence, mapping is both a compelling visualization technique and a powerful graphical means of orientation within an information domain.

Most communities of scientific practice have been developing or using some sort of maps for some time. That is why Donna Haraway asserts, "Cartography is perhaps the chief tool-metaphor of technoscience." (Haraway 1997: 163). Haraway's phrase has been widely quoted—apparently nobody, however, has dared to ask why cartography or mapping should be called a metaphor. What is so metaphorical about mapping?

Of course, there are many different things that can be mapped, and many different mapping endeavors. There is, for instance, topographic mapping, genetic mapping, cognitive mapping, mapping literature and art, and even the mapping of maps (Harley and Woodward 1987). While some research communities map countries, others map cultures. The only thing that is missing in this abundance of mapping endeavors is the mapping of all forms of mapping.

The proliferation of mapping leaves us, on an analytical level, with two immediate options. We could refrain from using the notion of mapping altogether—where almost everything in scientific practice seems to be related to mapping, the very notion of mapping simply looses its specificity. Alternatively, we might want to introduce an artificial difference between real mapping and metaphorical mapping.

Neither of these is very attractive. While the former is obviously not productive at all, the latter is rather thorny, for the following reason: if we think about topographical mapping as the relevant, the actual, the real, or the original form of mapping, then most of the maps dealt with in this volume are not maps at all. Without noticing, Scott F. Gilbert stumbles over this problem in his provocative statement: "...there *really* are no gene mapping communities in *the actual sense of mapping*. (...) These aren't maps. These are addresses" (Gilbert 2001).[1]

Gilbert's reference to "the actual sense of mapping" is no more helpful than a general assumption of a proliferation of metaphorical cartography in technoscience. One claim is the other's immediate and unavoidable consequence. While the abundance of the metaphorical discourse produces a counter-discourse of the actual, the distinction between real and metaphoric delegitimizes most of the mapping activities that are indeed crucial to many forms of knowledge production.

There is one way out of this vicious circle: the delicate search for functional equivalents in different realms of scientific practice. After all, I still believe that it is useful to conceive of any kind of mapping activity as a part of a generalized form of scientific practice and communication. Of course, we have to be careful not to suggest that problems are identical when they are not comparable. And we have to describe and understand problems in more abstract, fairly general terms, in order to spot the crucial historical similarities and/or differences between various kinds of mapping. Then, and only then, we won't have to talk about mapping in metaphorical terms, or define or construct the "real" or the "actual" form of mapping as a chief-reference point.

The proposed solution to the dilemma has consequences both for the history of genetic mapping and for the history of topographical mapping. The activities involved in mapping landscapes or countries and mapping genes or flies do not fundamentally differ, and they become comparable. The study of one scientific practice illuminates the understanding of the other.[2]

My entry point for the following short and preliminary remarks is Robert Kohler's assertion that "genetic mapping is in principle rather like the triangulation method of topographical mapping." In his noteworthy book *Lords of the Fly*, Kohler writes: "The first step is to establish a baseline by choosing two genes and measuring the distance between them very accurately, by counting large numbers of recombinants. This baseline then serves as a reference to which all other points are related." (Kohler 1994: 65). I would argue that this observation could be radically extended to insights from the history of nineteenth-century topographical mapping.[3] It is my hope that this might also inform specialists in the history of genetic mapping, at least those historians of science who are dealing with Morgan's *Drosophila* group at Columbia University. I have, however, the impression that we will eventually obtain some elements for those mapping practices which have been used throughout the twentieth century in its secular and on-going "hunt for the gene."[4]

Hence, I will expand Kohler's description by shedding light on a few general characteristics of topographical mapping, which can easily be retranslated into the realm of the twentieth-century mapping culture of genetics. Subsequently, I will deal with the following two questions. What are scientists doing when they are mapping? And what effects do maps have on their readers? Answering these questions should enable me to clarify the machinery of a map's visual impact. After all, this evidence is one of the crucial ways that a map accomplishes its communicative tasks.

Goals of the mapping exercise

Which are the most important goals of a nineteenth-century topographical map? In general terms, a topographical map—as a *completed product*—was intended to materialize in a single piece of printed matter the instantaneous visual aggregation of its contents. For special occasions—such as a national exhibition—all parts (or individual sheets) were firmly glued together, put into one frame and presented as one *tableau* to the sponsoring public (Gugerli and Speich 2002).

In order to reach this goal, cartographers maintained that any decent mapping project—in the sense of a surveying *process*—had to start with big entities (the base line and the first-order triangulation), in order to move progressively into ever-smaller units of a country's landscape. In this sequential process of measuring, annotating and (re-)calculating angles or relative distances, on the one hand, and drawing, counting and registering topographical details, on the other hand, an all-encompassing relatedness was produced. Thus, as an *inscription*, the map had to be fine-tuned in every single part of its countless corresponding components. Then, and only then, could maps be judged as "elaborated according to the strong scientific principles that had been observed from the very beginning of a mapping project right up to its accomplishment" (Dufour 1865: 204–9).[5]

With regard to a topographical mapping project's visualizing goals, we can observe how cartographers tried to conventionalize space and landscape. Natural, social, and political entities were systematically subjected to the rules of conventional graphic forms of expression and scanned according to these specifications. At the same time, however, the transformation had to acquire a natural resemblance to the physical world. A map should express, by means of artificial conventions, the highest possible degree of natural similitude. Simple and standardized graphic strokes or minimal pictorial elements should combine into a pictorial effect of a plastically formed landscape seen from an imagined, infinite vertical perspective.

Such an artificial nature or natural artifice had to be achieved in order to guarantee several communicative advantages of the map. The most important advantage was certainly that the apparent scientific, procedural neutrality and abstraction of the map served to mediate interpretative conflicts about a country's or a nation's "nature."

Take as an example nineteenth-century Switzerland: the differences between the dynamically changing urban centers and the increasingly marginalized countryside, the lingering conflicts between Catholic and Protestant regions, the clash between agricultural fears and industrial hopes, the struggle for political participation and representation in an emerging political system called "the nation," not to speak of the huge disparities between languages, cultures, traditions, and social classes. All these and many other tensions were completely ignored by the national survey. The Topographical Atlas did not distinguish the key features of these conflicts; it did not tell its readers about the very distinctive alternatives shaping their future. It rather created a graphically consistent, uniform, and conventionalized landscape, suggesting a homogeneous space of action. When confronted with the Atlas at the 1883 national exhibition, one commentator claimed that everybody involuntarily felt national pride in the defence-worthy glory of the nation as represented by the map. "This object," he continued, "is the pearl of the whole exhibition, and it represents, in a most dignified form, the political unity of Switzerland" (J.v.S. 1883: 269). The map substituted most political differences with topographical subtleties.

Moreover, by means of naturalizing its conventions, a map was also able to hide most of its own constituent predispositions. Thus, a map was not only the astonishingly coherent end-product of a scientific procedure; it was even a quasi-natural picture, which could not be contested on the grounds of individual preferences or political priorities. Wherever possible, "modern" topographical maps successfully refrained from any explicit reference to personal opinions and individual preferences, since they were the product of a collective scientific practice. Due to these moves towards professionalization, many craftsmen in the field of cartography lost their standing in the course of the nineteenth century. Authors like Friedrich Wilhelm Delkeskamp may still have sought to provide their clients with an array of esthetic images of highly individual character for a time; very soon, however, they had to abandon their projects (Delkeskamp 1830–35). The professional community of cooperatively acting topographical engineers successfully absorbed any individual artistry. This aspect of collective authorship strengthened the illusion of cartographic neutrality, and thereby to a large extent augmented a map's legitimation.

Hence, the map of a national survey could stand and mediate the deictic gesture both of an individual and a collective readership. Pointing to the map simultaneously produced indicated presence and absence, difference and identity, specificity and relatedness. Thus, the map reassured individual and collective origins, it showed present positions, and it declared the range of possible future movements.

Cartographic production abounds

What are scientists or engineers doing when they are mapping? Of course, they pursue all—or at least some—of the previously mentioned goals. At the same time, however, they generate preliminary results and side-products as part of their mapping activities. Sometimes they need to change their methods and are forced to adjust the work they have already done. They need to keep records of their measurements and alterations; without an archive for their field notes and previous calculation sheets, they would have to start from scratch when changing the method. In other words, archives help to temporalize the production of a map, to divide it into a series of distinctive processes, which can be—if necessary—regrouped, synthesized and reprocessed (Luhmann 1980). Even if it is true that "gene maps are . . . built up gradually of interconnecting segments from a baseline, just as a topographical map is built up from a baseline in a network of connected triangles" (Kohler 1994: 65), the mapping project has to take into account that the baseline might change its actual (or precisely estimated) length due to a remeasuring of the base or due to the recalculation of the raw-data (Gugerli 1999).

While such adjustments frequently change the expected outcome of a mapping project, preliminary results are also likely to change the assumptions about the object that is being mapped. The genetic landscape of *Drosophila* gradually changed as the Morgan group made progress on its mapping project around the time of the First World War. "Mappers had to create standard *Drosophila* stocks specifically adapted to the peculiar requirements of quantitative measurement. Genetic maps are the blueprints of the standard fly…" (Kohler 1994: 54). Between 1832 and 1865, the same happened to cartographers' assumptions about the form, extension, height, and relative position of the Swiss alpine mountain peaks. Sure enough, Dufour's engineers did not produce standardized mountains, but they labored on the fixation of standard reference points on the top of these mountains. Subsequently, these points could be related to other points for triangulation and projection purposes. Usually, putting something on a map is a long and iterative process, during which this entity gradually gains both specificity and relatedness. Mountains, for instance, become normal, well-defined cartographic entities: they are gradually immersed in a uniform graphical space, which contains numerous other mountains.

Finally, topographic and genetic mapping rearrange their mappers—their position in the project, their influence on the outcome, their organizational relevance, their power of definition, and their body of knowledge. Further, mapping procedures rearrange a whole array of things—nucleotides and rocks, genes and rivers, crossing-overs and triangulation points, theodolites and incubators. While one mapping endeavor gradually stabilized and therefore changed the fly, the other stabilized and reshaped the nation (Gugerli 1998; Gugerli and Speich 2002).

Of course, these similarities could easily be overshadowed by pointing out the differences between the two mapping projects. Nobody would honestly claim that topographical mapping in the era of European nation-building was exactly the same endeavor as genetic mapping during the North-American dawn of the Fordist mass-production era.[6] Nobody would go so far as to ignore the difference between a geneticist's microsope and a topographer's telescope. Quite obviously, no landscape will ever turn into a chromosome. And yet, the problems that have arisen and the strategies that have been developed for genetic and topographic mapping closely resemble each other, at least on an abstract level. Both mapping endeavors produce a similar communication tool by means of observing, measuring, registering, negotiating, recalculating, standardizing, drawing and redrawing, and finally printing, quoting and reprinting. The analytical approach, which looks for functional equivalents, makes genetic mapping at least as real a procedure as topographic mapping. And the same analytical approach shows that cartographers produce as many metaphorical claims for their work as any cultural study on the Morgan group could possibly invent. To put it bluntly: cartographic mapping can also be viewed as a metaphor.

The performance of maps

What are maps doing when they are finished, what is their performance and communicative power? First of all, they serve as filters. They reduce complexity by eliminating differences and evidencing a few selected features. As we have seen, some topographic maps eliminated religious or economic differences between regions. National topographic surveys of the nineteenth century invited their readers to identify unifying aspects—which were to be found in the so-called natural conditions of their country and its landscapes—rather than debate on the spatial expression of highly controversial social differences. The optical homogeneity of a cartographic space, its procedural consistency, and its graphic uniformity stands for the country's political and cultural unity. The genetic distance map of the Morgan group statistically eliminated morphological or phenotypic differences and filtered those genetic elements that were relevant for the genetic description of the ideal type of fly—the standard *Drosophila*.

Second, maps change collective patterns of seeing, collectively shared and standardized ways of perception, and the culturally shaped interpretations, which prevail among their readers. The members of the Fly Room at Columbia University gradually got acquainted with the graphic representation of *Drosophila*'s genetic conditions. They learned how to read and see the genetics of "The Fly"—as well as how to manipulate it—by studying such an abstract graphical tool as a chromosome map. Similarly, readers of a national topographical survey in the nineteenth century learned how to read, how to see, and how to manipulate or act within the natural, the institutional, and the ideological framework of the nation.

Third, maps always serve as tranquilizers against the *horror vacui*, the fear of the void, by suggesting that they provide an optically consistent space, a graphically uniform representation. This is what I would call the fiction of completeness of cartography. Wherever the (unfinished) map contains a white spot or an obvious gap between two addresses, the mapping practitioners have to fill it with some information. Maps ask to be completed. It is noteworthy that the Human Genome Project successfully turned this imperative into a strong argument for obtaining the necessary financial resources and the required institutional support: "Starting maps and sequences is relatively simple; finishing them will require new strategies or a combination of existing methods. After a sequence is determined . . . the task remains to fill in the many large gaps left by current mapping methods."[7] No matter what purpose completing the human genome map should serve—a decent map is simply not allowed to have unknown regions.

Following this, mapping projects integrate different levels of precision into one representational space. They distribute, as it were, accuracy and precision over their entire graphematic space. Their highly celebrated sequences of data transpositions, which eliminate individual authorship and create newly imagined communities or identities, unify both their objects and their readers. This is probably the most important aspect of a politics of truth provided and performed by any kind of scientific mapping.

Generating social and technical evidence

Finally, we have to consider the sociotechnical evidence a map is able to generate, since it is the collective evidentiary value of a map that enhances its communicative functions. Much more than procedural consistency alone has to be accomplished in order to cartographically produce the visualization of a nation's collective space of action, of cultural reproduction, of political planning, public administration, or civil engineering. Curiously enough, the conditions of cartographic evidence can be found both in a map's making (through the production and expression of relatedness) and in its final appearance (through the power of visual aggregation).

There is a whole array of conditions that produce and eventually stabilize a map's evidentiary value in its final expression. Since maps have to be produced following the most exact scientific methods, it is necessary to make public the standards, procedures, and the level of precision of a mapping project. The exponents of nineteenth-century national surveys became eager to publish some of their data in an internationally standardized form, since this allowed for their scientific validation. This was especially true for data concerning base measurements and first-order triangulations as all the other data were much too clumsy and could not be presented to anybody outside the cartographers' study. Publishing preliminary results, which provided evidence of the scientifically consistent progress of the genetic mapping of *Drosophila* or the human genome, was probably as important as the publication of any kind of final map or final text.[8]

Nevertheless, mapping projects always have to acquire a huge amount of cultural sanctioning through the presentation of their final product at national and international exhibitions, or through the publication of popular accounts and biographies, and it is absolutely crucial for a map to achieve a cartographical conditioning of its readers. In other words, scientific and cultural approval co-produced a map's visual power.

Part of such approval is the seminal accounts of the very conditions of the mapping practice. These remain decisive for the production of a map's evidentiary value even after the map is finished. The forms of collaboration between political entities as well as the division of labor among the many participants of a project have to be carefully organized *and* discursively connected with a mapping project's product. Thus, it becomes important for the value of a map as a piece of evidence to declare the participation of molecular biologists or astronomers, venture capitalists, universities, governments, or national scientific foundations, software engineers or engravers, laboratory assistants or topographers. Seemingly, the linking of the spatial visualization with further scientific, administrative, and technological practice usually enhances a map's value as a means of communication and a piece of evidence.

Focusing on different mapping projects in terms of functional equivalents sheds light on the fact that the negotiation of representational means and formats, the fine-tuning of a map's conditions of production, the history of its development, and even the self-representation of the mapping endeavor are of great importance when it comes to understanding a map's persuasiveness. Without agreement and final decision on these issues, a map will never acquire a collectively sanctioned visual power value and it will never be able to serve its communicative functions, either among its producers or its readers. This self-reinforcing tendency of a mapping project might even go so far as to put into oblivion some of the practical communicative purposes that initiated the project. The production of relatedness and visual aggregation that serves the ends of governments and the goals of scientific communities develops a dynamic, which goes far beyond any explicit instrumental utility. Thus, a map mediates communicative processes, which were never planned, and sometimes not even imagined, by its own, particular mapping community.

Notes

1 My emphasis.
2 "Il n'y a pas de phénomènes fondamentaux. Il n'y a que des relations réciproques et des décalages perpétuels entre elles" (Foucault 1994: 277).
3 I am drawing upon research carried out over the last few years together with Daniel Speich. I thank him for invaluable discussion time. Claims, errors, omissions, and shortcomings are my responsibility. See Gugerli and Speich (1999, 2002).
4 See "Human Genome Project Information, Mapping and Sequencing the Human Genome" on <http://www.ornl.gov/hgmis/publicat/primer/prim2.html> for its astonishing, late-twentieth-century parallels to what the following remarks try to describe with reference to two older mapping endeavors. For an overview on the hunt for the gene see Keller (2001); Kay (1999); Nelkin and Lindee (1995).
5 My translation.
6 "The standard maps of 1919–1923 represented data from some ten million flies, and altogether about thirteen to twenty million flies were etherized, examined, sorted, and processed!" (Kohler 1994: 67).
7 Human Genome Project Information, Mapping and Sequencing the Human Genome, <http://www.ornl.gov/hgmis/publicat/primer/prim2.html>.
8 See "Human Genome Project Information" <http://www.ornl.gov/hgmis/project/progress.html>. Several other websites continuously monitored the Human Genome Project's sequencing output.

Bibliography

Delkeskamp, F.W. (1830–35) *Malerisches Relief des klassischen Bodens der Schweiz. Die Delkeskamp-Karte; topographisch-künstlerisches Bild der Urschweiz aus den Jahren 1830–1835. Nach der Natur gezeichnet und radiert von Friedrich Wilhelm Delkeskamp*; kommentiert von E. Imhof (1978), Dietikon, Zürich: Stocker.

Dufour, G.-H. (1865) "Schlussbericht des Herrn General Dufour über die topographische Karte der Schweiz vom 31. Dezember 1864," *Bundesblatt der schweizerischen Eidgenossenschaft*, 17: 203–14.

Foucault, M. (1994) *Dits et écrits 1954–1988 par Michel Foucault, Tome IV. 1980–1988*, in D. Defert and F. Ewald (eds), Paris: Gallimard, 270–85.

Gilbert, S.F. (2001) "Fate Maps, Gene Expression Maps, and the Evidentiary Structure of Evolutionary Developmental Biology" paper presented at the conference *The Mapping Cultures of Twentieth Century Genetics*, Berlin, Germany, March 1–4, 2001.

Gugerli, D. (1998) "Politics on the Topographer's Table: The Helvetic Triangulation of Cartography, Politics, and Representation," in T. Lenoir (ed.) *Inscribing Science: Scientific Texts and the Materiality of Communication*, Stanford: Stanford University Press, 91–118.

—— (1999) "Präzisionsmessungen am geodätischen Fundament der Nation. Zum historischen Anforderungsreichtum einer vermessenen Landschaft," in D. Gugerli (ed.) *Vermessene Landschaften. Kulturgeschichte und technische Praxis im 19. und 20. Jahrhundert*, Zürich: Chronos, 11–36.

Gugerli, D. and Speich, D. (1999) "Der Hirtenknabe, der General und die Karte. Nationale Repräsentationsräume in der Schweiz des 19. Jahrhunderts," *WerkstattGeschichte*, 23: 61–82.

Gugerli, D. and Speich, D. (2002) *Topografien der Nation. Politik, kartografische Ordnung und Landschaft im 19. Jahrhundert*, Zürich: Chronos.

Haraway, D.J. (1997) *Modest_Witness@Second_Millenium. FemaleMan©_Meets_Oncomouse™*, New York: Routledge.

Harley, J.B. and Woodward, D. (eds) (1987) *The History of Cartography*, Chicago, IL: University of Chicago Press.

Human Genome Project Information. Available at <http://www.ornl.gov/hgmis/project/progress.html> (accessed February 27, 2002)

Human Genome Project Information, Mapping and Sequencing the Human Genome. Available at <http://www.ornl.gov/hgmis/publicat/primer/prim2.html> (accessed February 27, 2002)

J.v.S. (1883) "Die Landesausstellung in militärischer Beziehung," *Allgemeine Schweizerische Militär-Zeitung. Organ der schweizerischen Armee*, 29: 269–329.

Kay, L.E. (1999) "In the Beginning Was the Word?" in M. Biagioli (ed.) *The Science Studies Reader*, London, New York: Routledge, 224–33.

Keller, E. Fox (2001) *Das Jahrhundert des Gens*, Frankfurt a. M., New York: Campus.

Kohler, R.E. (1994) *Lords of the Fly. Drosophila Genetics and the Experimental Life*, Chicago, IL: University of Chicago Press.

Luhmann, N. (1980) "Temporalisierung von Komplexität. Zur Semantik neuzeitlicher Zeitbegriffe" in N. Luhmann (ed.) *Gesellschaftsstruktur und Semantik*, vol. 1 Frankfurt a. M.: Suhrkamp, 235–300.

Nelkin, D. and Lindee, M.S. (1995) *The DNA Mystique. The Gene As a Cultural Icon*, New York: Freeman.

From Molecular Genetics to Genomics

The mapping cultures of twentieth-century genetics

Edited by
Jean-Paul Gaudillière and Hans-Jörg Rheinberger

Routledge
Taylor & Francis Group
LONDON AND NEW YORK

First published 2004
by Routledge
2 Park Square, Milton Park, Abingdon, Oxfordshire, OX14 4RN

Simultaneously published in the USA and Canada
by Routledge
29 West 35th Street, New York, NY 10001

Routledge is an imprint of the Taylor & Francis Group

Typeset in Baskerville MT by
Newgen Imaging Systems (P) Ltd, Chennai, India
Printed and bound in Great Britain by

E: Please
rovide printer
etails

British Library Cataloguing in Publication Data
A catalogue record for this book is available
from the British Library

Library of Congress Cataloging in Publication Data

ISBN 0–415–32850–0

This book is dedicated to the memory of Frederic L. Holmes