Jacques Bertin

Jacques Bertin (1918-2010) was a French cartographer whose main contribution was his theoretical and practical reflection on the use of graphic material (diagrams, Â«mapsÂ» and graphs). This was the subject of a ground-breaking treatise that was published in 1967: '*La sÃ©miologie graphique*' (Graphic Semiology). Bertin's influence has not only been strong in modern cartography studies at university level, it has also influenced statisticians and data visualization specialists.

Jacques Bertin was born in 1918 in Maisons-Lafitte and died in Paris in 2010. In 1934, after his secondary school studies, he was accepted at the Ecole de Cartographie, which had only just been opened by Â«Emmanuel de MartonneÂ» in the university in Paris. There he was taught mathematical geography (geodesy, projection systems), map drawing and also general geography, as Martonne wanted to make cartographers/geographers out of his students and have them "develop technical skills together alongside a geographical education."

After he graduated, Bertin worked in publishing for a while, and at the end of WW II, he took up a post in the Centre National de Recherche Scientifique (CNRS). He took part in a project on the Paris social space led by the sociologist Paul-Henry Chombart de Lauwe (1913-1998). This study resulted in the publication in two volumes of ‘Paris et l’agglomÃ©ration parisienne’ (Paris and its Urban Area) (1952). In the first volume – *‘L’espace social d’une grande citÃ©’* (The Social Space of a Large City) – Bertin wrote a chapter entitled: ‘Recherche graphique’ (Graphic Research) in which he set out his first theoretical reflection on the language of cartography. In particular he outlined the notion of visual variables and the properties of these variables. He thought that a mapmaker should work towards ‘visual unity’, i.e. an image that is efficient and that can be apprehended globally. For this book he created innovative diagrams, resorting to a thematic, univariate system of cartography. This choice was completely at odds with traditional mapmaking in French geography, especially with the croquis de synthÃ¨se rÃ©gionale (regional synthesis sketch-map), in fashion right up to the seventies, which was overloaded with data and often unreadable.

In 1954, at the instigation of two historians, Lucien Febvre and Charles MorazÃ©, Jacques Bertin began to work at the Ecole Pratique des Hautes Etudes, in the social science research centre created after the war with the help of the Rockefeller Foundation, which became L'Ecole des Hautes Etudes en Sciences Sociales in 1975. There he opened a cartography laboratory which was renamed Laboratoire de Graphique in 1974. He headed this laboratory until his retirement in 1985. This period saw the crystallization of his ideas. The laboratory was used to prepare maps and diagrams on demand from researchers from different backgrounds. Confronted with these diverse requirements in terms of both data and types of illustration, Bertin and his collaborators progressively went on to develop the general principles to guide graphic representation, at the same time maintaining fruitful links between mapmaking and the different disciplines of the social sciences. This work led to the publication of his book '*SÃ©miologie graphique. Les diagrammes, les cartes, les rÃ©seaux*' (Graphic Semiology: Diagrams, Maps and Networks) in 1967. This book was a major milestone in contemporary cartography. It discusses all the different forms of graphic expression, assimilating them to a language: graphics, or the graphics system. For Bertin this language represents the 'rational side' of images. Bertin first explains the principles of information analysis prerequisite to the representation stage. He demonstrates that notwithstanding the multiplicity of the data, what is important was the way they relate to each other: differential/qualitative, ordered or quantitative. He then goes on to describe the graphics system, developing the notion of the visual variable, i.e. a perceptible variation affecting a visible dot or mark. Eight variables are listed: shape, orientation, grain, colour, value and size, to which are added the two dimensions of the map, i.e. the position of the dot or mark on the map (figure 1). For each he details perceptive characteristics: selectivity, associativity, order and quantity. One of the key elements in the efficiency of the image is its selectivity, i.e. the possibility for the reader to quickly identify families of similar symbols. Bertin then provides a "graphics grammar" in the form of a set of rules for design and readability that enable the production of suitably eloquent representations. In the second half of his book, he explains the concrete applications of this "grammar", classified according to the types of information to be represented.

In this book, graphics are not only treated as a data presentation tool, but also as a potential processing tool. In order to simplify sets of data, in his laboratory Bertin developed various tools that can be assimilated to "mobile" graphics: ordered displays (known as Bertin matrix) and image-files. By way of manual interventions – permutations and reclassifications - categories of objects or spaces with similar characteristics can be identified. Bertin considered the discovery of the mobility of images as a founding element of his thought. He developed these methods of visual processing more specifically in his book ‘*La graphique et le traitement graphique de l’information’* (Graphics and graphic processing of information) in 1977.

Bertin’s treatise was written in the particular intellectual context of the sixties and seventies. It was the symptom of a general movement in semiotic image analysis, also extending to photography, art images, advertising images, comic strips and cinema. It can also be interpreted in the context of structuralism, which influenced all the social sciences of the time. Through the notion of the variable, Bertin put the emphasis on the different relationships between graphic symbols. He thus suggested a kind of framework or organisational plan for graphic language. His system has in fact often been compared to linguistics. Graphic semiology also has similarities with Claude Shannon’s communication model (1948), even if it does not make any reference to it. With Bertin, as with the map-design movement in the United Sates, the reader is integrated into the cartographic communication process. The visual message takes readers' perceptive abilities into account and the map is to be designed "for the least mental cost" to users. This approach nevertheless has its limits. Bertin regarded the reading of a map as a perception, and therefore concluded that the rules of his graphics system were universal. He took no account of the cognitive aspects involved in the reading process – nor of the cultural biases. Reading a cartographic image can depend on the reader’s experience, or on culturally acquired reflexes, for example the interpretation of colours. Bertin's graphic symbols denote rather than connote. Yet far from giving neutral and objective information possessing the same meaning for everyone, a symbol conveys meanings that vary precisely because they are subjective.

Bertin made concrete contributions to cartography: he elaborated several projection methods in the fifties, he illustrated numerous publications, research studies and school textbooks, and he designed wall maps and several historical atlases. In the sixties he was the first person in France to carry out automatic cartography experiments. His theoretical contribution, however, overshadows all this work. His two books (1967 and 1977) have been translated into several languages. ‘Graphic Semiology’ has been re-printed several times (in 1973 in revised version, 1999, 2005, 2013). Bertin’s ideas have been circulated through teaching channels in Paris to both French and foreign students. His ideas have thus made a mark on several generations of cartographers and can still be found in today’s basic cartography course books. In English-speaking countries his book, ‘Graphic Semiology’, was translated fairly late (1983) in the context of digital map-making. Even if the treatise comes under criticism for its rather old-fashioned, mainly manual methods, its position as a ‘classic’ in the field is assured through its originality and, for that reason, it was reprinted in 2011.

The visual data processing methods were used up to the start of the seventies among French mapmakers. They then fell into disuse because they were less easy to implement than multivariate statistical analysis. However this aspect of Bertin’s work is now recognized as a pioneering element by statisticians and visual data analysis specialists (Visual Data Analysis or Visual Analytics). The manual reordering procedures that he conceived have been converted several times into digital formats, as shown in the 2014 Bertifier web application (Charles Perin, Pierre Dragicevic and Jean-Daniel Fekete), enabling visual tables to be generated from calculated data and then processed automatically.

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