Computerised Methods for Palaeolithic Art Studies

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Abstract

Since the discovery of portable and cave Palaeolithic art in the second middle of XIX° century, the research methods have made major progress, mainly since the seventies. The purpose of this paper is to show the role of computerized methods for the study of Palaeolithic art, focusing particularly on:
- Recording techniques (various photography, photogramme try, laser 3D) and image processing,
- Style analysis of paintings and sculptures,
- Spatial structuring of cave art figures,
- Chronological and regional studies by data analysis.
It is then possible to discuss the reasons of both the potentialities and the limits of cave art studies in the purpose of explaining the meaning of Palaeolithic art, and to propose new developments to achieve it.

Introduction

Palaeolithic art research is based upon numerous methods and techniques, come from other scientific fields like first Archaeology, but also other Human Sciences (Ethnography, History of Art and History of Religions), from Exact Sciences: (Physics and Chemistry) and from Engineering Sciences (Semiotics, Computer Sciences, Statistics and image processing). In this paper, I would rapidly recall the different methods, with several case examples: firstly, acquisition methods beginning with recording techniques, intrinsic and extrinsic characterization and determination of art objects, secondly with structuring methods like sequential analysis, chronological analysis, stylistic analysis, intrasite and intersite spatial analysis, and finally the methods for the reconstitution of the symbolic art system in its global context (Iakovleva 2002).

First Phase: Acquisition

[1] Acquisition by recording techniques

The records of a cave art painting or a portable art sculpture are the result of an interaction between the art object to be recorded and the specialist who has to record it.

Recording is not else than an interactive and retroactive training process between the art object and the specialist. He is of course helped by appropriate optical, photographical and computerized systems, in order to improve it. But digital recording needs always a visual control nearby the wall or the support of the art objects. The recording method is starting with a recording convention which is a formalized descriptive syntax, like for a key of a map or the colour matrix of a satellite image. Such an example of a recording convention designed for the study of the magdalenian engraved and sculptured frieze of the "Roc-aux-Sorciers" rock-shelter at Angles-sur-l'Anglin (Vienne, France) is given in (Iakovleva and Pinçon 1997).

The 2D recording for cave art is using various and well adapted techniques :

- Freehand drawing on a plastic film, at a very short distance of the wall,
- Drawing directly on a photograph printing (scale 1/1),
- Photography, enhanced by more or less sophisticated techniques like special films, digital records, image processing and photographic fit.

Going back to the wall, with a microscope and macro-photographs, it is then possible to record the details which cannot be visible with long-distance records, needed to limit the negative effects of image distortion. Such techniques allow making conventional records. An example of conventional recording is given in a study of the magdalenian engraved and sculptured frieze of the "Roc-Aux-Sorciers" rock-shelter in Angles-sur-l'Anglin (Vienne, France): the panel of Venus and the panel of Ibex. The conventional records, after validation, may be then transformed into realistic records (Iakovleva and Pinçon 1997).

The analysis using high (binocular) or very high (ESM) magnification on the portable objects, or when it is not possible due to their volume on replicas obtained by casting, are allowing to study art objects at a scale of detail never obtained before.

The 3D recording is using the last digital recording techniques like photogrammetry, and a short while ago 3D scanner. By controlling the reconstitution in the three dimensions, the 3D records are handling the volumetric surface of the wall or of the support. Then 3D recording is different from 2D recording which is realizing de facto a conic projection with the well-known distortions. Digital 3D techniques are allowing differentiated processing of the wall, integrating 2D or 3D various records (photographs, macro-photographs, frames) depending on the needed level of detail. But it is necessary to point out the time involved to do it, then the cost of a high quality 3D reconstitution. 3D records are naturally a way to use virtual reality techniques, offering a dynamic walk into

the discovery of the art space, opened then to a new public area without any risk for the originals (fac-simile).

[2] Acquisition par object characterization

The choice and the preparation of a support are a major issue in the relationship between the artist, the art object and its raw material, whatever the support is a stony surface for cave art or a volumetric support of various raw material (ivory, antler, bone, stone, amber, etc.). Numerous studies have discovered the important marks of preparing stony walls by pricking, scraping, polishing and others, and drafts before painting, engraving or sculpturing of a figure (Iakovleva and Pinçon 1997). Concerning portable art, the relationship is stronger because the available volume and the morphology of the support will be often the reason of the choice of the figured animals. And its attitude is integrated in a composition which will be embedded into the support. Studies have also revealed the sound importance of the stony walls inside the caves, by resonance (Dauvois and Boutillon 1994).

Characterization is concerning also the art object itself, by its morphology (outline, surface, volume) and the techniques used for its representation: painting (stencilling, blowing etc.), engraving, incision, pricking, sculpturing (low-relief and high-relief in cave art; in the round, flattened in portable art) and casting. The techniques of production of the figures is handling numerous parameters, like the use of volumes of the wall, the lightening with natural or artificial light, the looking at the figure under different points of view or constrained by the geometry of the place, the choice of the raw material and the preparation of the colour, the tools needed to realize the figurations, determined by experimentation and use-wear analysis. For example, the spectrometric analysis on colour samples of the Lascaux cave (Menu and Walter 1996), have shown the existence of mixtures of colours with organic binders.

The representation of an object is following a complex life cycle from the initial draft, but often modified by repentances, transformations, re-use, integration in a new composition, modification, quite-complete or partial destructions and substitution. The specialist must reconstitute such a story of the art object.

[3] Acquisition by object determination

When the represented art object is an animal, zoology is helping us to determine the species, the sex, the age, the anatomic accuracy, the anatomic ratio exactness. Zoology may explain also the realism of a particular attitude. It owns to the specialist of Palaeolithic art to study the completeness of the animal, the richness of anatomic details, the obvious wish of deformation or exaggeration, in relationship with the realism or the schematization of the representation. It is also necessary to study, which is evident for any art historian, the figuration convention (face, side-face, ¾ face), the perspective rules, the animation and the composition of the scene, involving to reveal a typology of styles of figuration. Data Analysis is a useful statistical technique to determine such styles of figurations and their regional widening. For exam-

ple, the typological analysis of "Contours découpés" of magdalenian horses by correspondence analysis (Buisson et al. 1993) is showing the large homogeneity of these portable art objects over all the franco-cantabrian area.

Some particularly rare objects are much less easy to determine, for the evident reason that the palaeolithic artist has not intentionally represented an animal. They are called generally anthropomorphs or anthropozoomorphs, these often schematic figurations, mixing human and animal anatomic features.

The signs, at the opposite, are very numerous objects with a so wide morphology, that very few specialists had the audacity to design a systematic description. Only, the use of semiotics allows approaching rigorously the problem, like G. Sauvet (1987) who has proposed a grammar for upper palaeolithic signs.

1.POINTS ET ELEMENTARY LINES
    - Points
    - Straight line: stickers
    - Simple broken line: chevron, hook
    - Curve line : simple, spirally, wavy
2.ELEMENTARY SURFACES
    -From straight lines to polygons:
      Triangle, square, rectangle, rhomb, pentagon ("tectiform"), hexagon.
    -From curve lines to circles and ovals,
    - Mixed of lines and curves: streamlined, escutcheon,
3. COMPOSITIONS
    - Clustering
      Of stickers around a centre: cross, star, y, direction sign, bundle,
      Of stickers around a line: comb, palm,
      Of stickers around/inside an elementary surface: grid surface,
    - Rhythm (repetition)
      repetition of points and linear figures
          duplication,
          drawing up,
          concatenation: zigzags, scallops,
      Repetition of elementary surfaces,
          encasement, check surface,
      Organization of space
          symmetry,
          division of the surface into registers.

Figure 1 A grammar of palaeolithic signs (Sauvet 1987)

[4] Acquisition: Dating, Location and Association of art objects

Extrinsic information must be handled, beginning with space and first the location of the art objects in their surrounding space (cave, cave entrance, cave depth, rock-shelter, open-air site, open air rocks, portable support), and then inside with the location on a wall for cave art or on a support for portable art.

Another extrinsic information is the association with other art objects, which may be:

- a superposition of paintings or engravings often difficult to decipher, which may be get visible by image processing,
- a composition of several figurations on a wall or a support, which is often interpreted, not as a random association, but as the result of a design of the palaeolithic artist, and then carefully located on a chosen panel, specially prepared for that,
- a naturalist scene, easily understandable from the knowledge acquired from the ethology of the represented animals.

Another extrinsic information is chronology, which may be obtained by several ways:

- association of the object with a dated archaeological layer: portable art object or fragment of a frieze fall down in a dated archaeological layer,
- wall painting or engraving recovered by an archaeological layer,
- cave art with a unique archaeological layer or hearths or isolated bones or charcoal snuffing out of a torch etc.,
- absolute 14C dating of a painting made with charcoal colour (for example, the bison cellar of Altamira cave by Freeman and Echegaray 2001).

SECOND PHASE: STRUCTURING

The structuring phase is processed by correlations between intrinsic information and extrinsic information obtained by the previous acquisition phase.

The sequential analysis is reconstituting the whole set of actions and decisions taken by the Palaeolithic artist : choice of the representation space (cave, cave entrance, cave depth, rock-shelter, open-air site, open air rocks, portable support), use of tools and colours, preparation of the portable or wall support, technique, process and sequence of production of the figures, composition of the scene.

The chronological analysis is making a synthesis of all the elements allowing dating a composition of figures from superposition, absolute 14C dates and archaeological context (for example, the four steps chronology of the superposed engravings by incision and pricking of a rock of the archaeological park of Foz Coa (Portugal) (Baptista and Gomes 1995)).

The stylistic analysis of the figures is concerned by the analysis of the following features: proportions (anatomic ratios), production technique, representation rules, perspective rules, animation, deformations and exaggerations, involving the evidence of chronological phases or production schools (for example, the school of engravers of hypertrophied horses of La Madeleine (Apellaniz 1987)).

The intrasite spatial analysis is a method designed to study the spatial variations of the intrinsic information acquired from the objects of a site. It is the case, for example, concerning the correlation analysis of the represented bestiary and its topographical location. We will develop here the famous study made by A. Leroi-Gourhan (1965) concerning the preferential location of certain association of animals inside the cave.

The correspondence analysis is separating distinctively different areas:

- The central composition areas where are represented the associations horse-bison or horse-aurochs (depending on the respective zoocenose of bison and aurochs),
- The periphery of the central areas where are represented ibex, reindeers, dears and does,
- The entrance areas where are represented deers and does,
- The end areas (crossing, dead end and small lateral dead end) where are represented mainly felines, bears and anthropomorphs,
- Mammoths and rhinoceros are in a special case to be located in the central areas for the early periods (Aurignacian and Gravettian) and in the periphery of central areas for the late period (Magdalenian).

The intersite spatial analysis is a method designed to study the spatial variations at a regional scale. A good example is the study of the assemblage of animal species of the cave art of Western Europe. It is a correlation analysis between the represented bestiary, the location of the art caves, and their chronology. Such a study has been first directed by A. Leroi-Gourhan (1965), and after expanded by Sauvet G. and S. (1979) several times on a more complete assemblage and the use of correspondence analysis. The analysis is showing the regional and chronological variations of the represented bestiaries during the upper Palaeolithic in Western Europe .

THIRD PHASE : THE RECONSTITUTION OF THE SYMBOLIC SYSTEM

The third phase is corresponding to the highest ambition of the study of Palaeolithic art that is it is the integration in the cultural system and then, the intention to try to decipher the symbolic meaning of the Palaeolithic art.

The reconstitution of the technological and stylistic know-how has been detailed previously, and it is not necessary to come back again on it.

The reconstitution of the value of art objects in the social system has been relatively not deeply studied in Western Europe, for the evident reason that few portable art objects have been found in association with dwelling structures, at the opposite of the discoveries of portable art objects made in the numerous settlements in Eastern Europe.

Those studies allow handling either the identity or differentiation of portable art objects in the intra-group social structure, or the identity and differentiation in the inter-group social structure. For the same reasons, the social role of cave art (initiation, preparation to hunting, communication) is a field of research always to investigate.

Finally, the reconstitution of the symbolic meaning of Palaeolithic art objects is always a virgin field, by a lack of methods to handle it. Several ways are open, sometimes explored, but their results have not convinced the scientific community:

- Correspondence between a hunting territory and a bestiary represented in a symbolic space,
- Correspondence between the intra-group social identity and a system of identification or a system of values, inspired by the environment ("totemism"),
- Correspondence between the events at the origins of tracks found in art cave and the evidence of an intermediation system with the strengths which are believed to control the world ("shamanism"),

Then, it is trivial to say that the scientific studies of art Palaeolithic are only at the very beginning.

CONCLUSIONS

A short description of contemporary methods for studying Palaeolithic art is showing how computerized techniques are embedded in the methodological approach: semiotics for description of art objects, statistics (using exploratory data analysis, and mainly correspondence analysis), image processing (for 2D and 3D acquisition but also for improving the quality of the record), virtual reality. Palaeolithic art studies are then a good example of the interest of use of computerization in Archaeology, and how may be used computerized techniques within a methodological framework to obtain a successful integration.

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