IMAGE-STYLE ANALYSIS: THE 'PICTWORK'

Introduction

What has satellite technology got to do with anthropology? Unsuspecting anthropologists may be forgiven for thinking that their endeavours are located at a safe distance from the fast-moving developments of space-age science. This is not, however, the case.

Ample opportunities are currently being presented by computer science which offer anthropologists, ethnologists and art historians scope for extending their researches into what were previously unachievable areas. Quantitative image-style analysis is one such area. This is a new field which has only been made possible because of an already developed technological base and such applications as satellite remote-sensing and digital image-processing.

The remote-sensing and image-processing applications with which we are nowadays most familiar appear in magazines and books as the satellite pictures which illustrate aspects of the earth's, and other planets', surfaces, and as the meteorological satellite pictures associated with televised weather forecasts. For those unacquainted with the scientific terminology, it should perhaps be stated at the outset that remote sensing refers both to the equipment - sensing devices and cameras - and to the techniques which are used to obtain information about surfaces at a distance. This is usually thought to mean from a sensor on a space platform or aircraft; however, even an ordinary hand-held camera being used to photograph a person, wall or object is, in effect, an instance of remote sensing.

The complementary technology aligned with remote sensing is digital image-processing. Here, the remotely-sensed image data, which were recorded digitally on to computer-readable tape are fed into image-processing machines where they can be displayed as

images upon a monitor screen. These screened images can then be subjected to a wide range of processor measurement and analysis techniques which deliver information of a quantitative kind. Many new and useful applications have already stemmed from the adroit adaptation of this technology, including medical imaging, forensic fingerprint recognition, signature recognition, factory robotics and industrial quality-control visual systems.

I am currently carrying out technical research upon flat artworks, or pictures, at the Image Processing Centre of the Computer Teaching Centre of the University of Oxford. The conceptual home-base of my research is within social anthropology, and for two closely related reasons: first, image-style analysis is to be conceived of as cross-cultural and comparative in terms of the visual material to be analyzed; and secondly, the field of social anthropology provides those sources of intimate knowledge about diverse cultures which must prove essential at the stage of interpretation of stylistic features and their meanings.

Initially, the technical research required my getting to grips physically with image-processing equipment (the Gemstone Canpus image-processing system) in order to study and assess the uses and techniques of image analysis within the geographical and earth sciences. This survey of existing machinery, methods and software left me assured of the merits of using image processing science for the task of image-style analysis.

Now, in conjunction with my colleague, the statistician Qazi Mazhar Ali of the University of Oxford's Department of Statistics, I am making progress in the programming and testing of specialized image-analysis techniques. These are exclusively measurement-based techniques which relate to a selected and defined number of features common to pictures. The techniques allow for the formal aspects of image styles to be modelled mathematically. What this capability means in practice is that it becomes possible to represent, or plot, the shape of an artist's style from image-processed measurements of artworks; to plot progressively movement or stasis within a style; and to determine theoretically measured distance between styles themselves.

However, before it can be thought worthwhile to embark upon expositions of either image-style analysis or style-modelling techniques, it is necessary to know first, what sorts of visual material there are; and secondly, what sort or sorts we intend to earmark for style analysis. The purpose of this report is to focus on these two prerequisite requirements.

1. Objects and Surfaces

Traditionally, we are disposed to consider things as objects, rather than as shapes which just happen to maintain particular types of surface characteristics. It is hard at first to adapt to looking at objects simply as surface types, when it is so much our inclination to conceive of them as solid bodies bearing our

symbolic hierarchies of value and association. Think only of an apple. Nevertheless, for the practical purposes of image-style analysis of art works, there are no objects as such, only variously contrived material surfaces. These surfaces may conceivably be of any kind of appearance - shiny, dull, rough, smooth, regular, distorted, coloured, toned, transparent and so forth - or any combination of such appearances. The 'skin only' approach to these is determined by the fact that the information required for style analysis is spectral and spatial surface information.

Optical systems and detectors are required to record images of the electromagnetic radiation which is reflected from art-work surfaces. This imitates in principle the procedure whereby satellite instrumentations record images of the electromagnetic radiation reflected or emitted from the earth's surface (Curran 1985: 100). As yet, procedures and conditions for the sensing and recording of art-work surface information are arbitrary and experimental. Comprehensive standards remain to be devised. Even so, it is already possible to state that the surface sensing of art works for data relating to style will be confined largely to the visible spectrum, a likely exception being reserved, however, for the feature of texture, which may well require resort to another surface-sensing strategy. Sub-surface sensing techniques, namely X-ray images of art works, will not be active aspects of the image-style analysis package.

Altogether, surfaces of art works accessible to vision or to surface-sensing apparatus will be assessed with image-processing equipment for features which are tonal, chromatic, spatial and textural. For the remainder of this report, however, I will concentrate, albeit in broad terms, upon the features of texture. It is, quite simply, the most fundamental aspect of all material surfaces, and the feature which I take to be the corner-stone for setting up an image-processing science which can be put to the style analysis of art works and artefacts.

We must remember always that the so-called textural 'surfaces' which we are considering in this image-processing context, are discrete (digital) data of instrumentally-sensed physical surfaces.

2. *The Anthropurgic Surface*

This report is concerned with preparing the ground of essential definitions, classes and categories which refer to very particular types of surfaces, and most especially to enable the operation of sensing and image-processing science for research upon these surfaces. The surfaces in question I term 'anthropurgic', which is used here to mean 'wrought or acted upon by man' (*OED*). If, as is the case, the intention is to consider for analysis only material surfaces which have been marked or made by virtue of human act, this immediately excludes from our sphere the systematic study of naturally occurring surfaces (by these I mean rock surfaces, tree bark, leaves etc.). We are left, then, to contemplate

systematically the domains of artefact and art-work surfaces.

Traditional distinctions between art work and artefact, art and craft, are unnecessary for style analysis. Any such distinctions can be set aside as matters for post-analysis discussion. In the meantime, I shall label both art works and artefacts, or the visible man-effected things which these erstwhile terms represented, as anthropurgic visual material.

From this starting-point (see Figure 1), we are free to proceed to regulate any material designated for style analysis along lines which refer always to surface characteristics.

3. *Texture: Macro-, Meso- and Micro-Textures*

It quickly becomes apparent to an observer of material surfaces, that surfaces themselves vary hugely in scale, texture and spatial organization. Satellite remote-sensing science has begun the task of dealing with the textural aspect of surfaces using an approach based on tone measurement of images (Haralick *et al.* 1973; Weska *et al.* 1976; Haralick 1979). In terms of size, terrain and geographical texture, analysis may safely be positioned within a macro-texture range of considerations and measurements - one which is able to fit the Himalayas if necessary.

Reflecting the human scale, anthropurgic visual material, by contrast, demonstrates a relatively modest range of textural proportions, despite the extremes of pyramids and modern sky-scrapers. This material can be designated a meso-texture range.

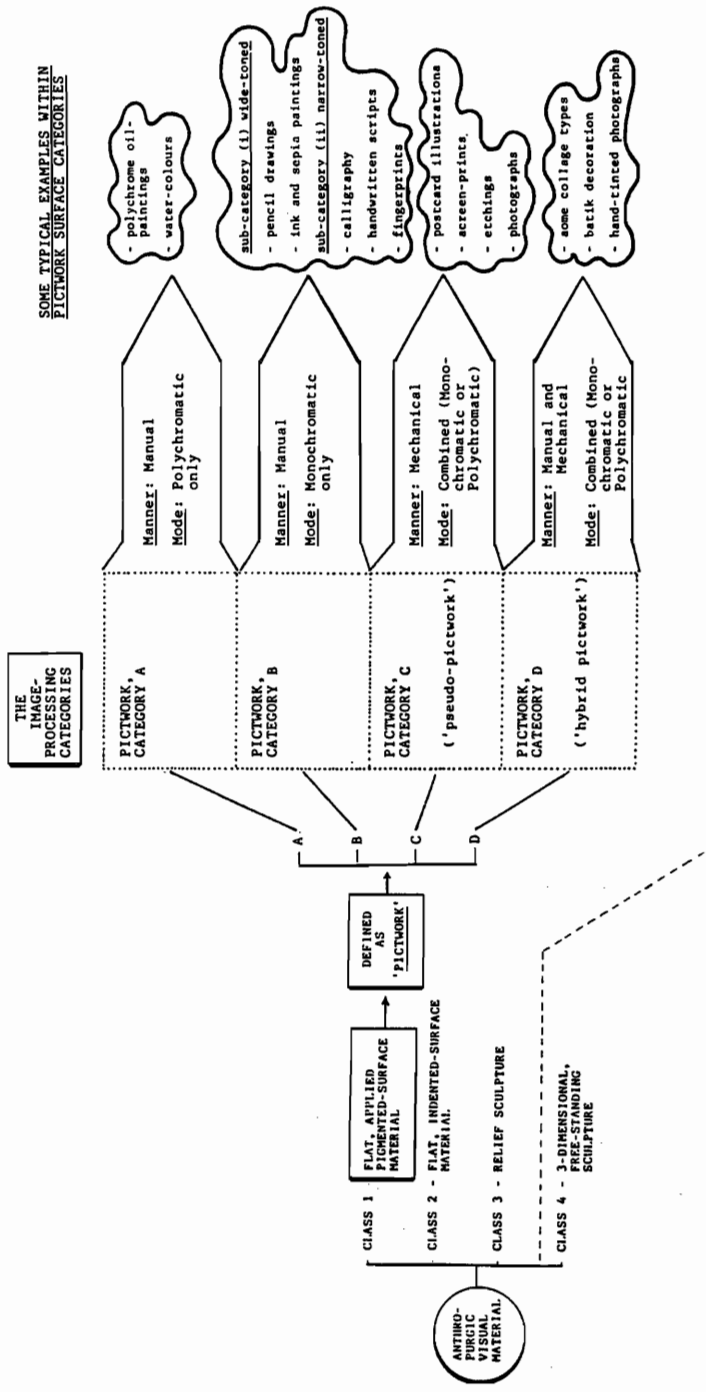
By considering also the possibilities of micro-texture surface-analysis applications by image processor for microscopic surfaces and membranes, it becomes apparent that a comprehensive set of strategies will eventually accrue for measuring textural properties across all three of the above-mentioned ranges. However, the actual techniques employed for coping with each of the different magnitudes of texture may in due course vary.

4. *Surface-Texture Classes*

It seems to be more or less a demand of the technological structure of sensing and image-processing science that one focuses upon problems of analysis in a global fashion. This is so too for putting into context the textural properties of anthropurgic visual material; for if these properties are to be measured by the technology, we may argue that they must also fit into a general logic of that whole technology. Examination of anthropurgic visual material from the textural aspect will undoubtedly make a contribution to the greater body of image-processing knowledge as regards the meso-range of surface textures.

To accommodate the range of surface textures to be found with

Figure 1. Pictwork Image-Processing Categories, with Typical Examples of Category Surfaces



anthropurgic visual material I have created, at least for the present, four separate surface-texture classes. This has not been decided merely randomly. It is clear that the 'manner' of surface execution, registered in texture, is a critical stylistic factor and feature. An individual maker's subtlety of textural performance requires to be registered within the measurement parameters of the appropriate class to which his work example fits. Each of these texturally organized classes is, in effect, a specialized channel structured to marshal material collocated within similar extremes of texture - a channel for directing this material towards further prepared categories of analysis which are governed by precise, repeatable decision rules (Curran 1985: 243).

Here we can call upon a helpful analogy, by imagining the fractionating tower as it is used in the petroleum industry to separate grades of oil. In our case, each class is separated from the next by degrees of textural surface development. A smooth-painted wall surface, for example, demonstrates a much smaller degree of surface-texture development than does, say, a deeply carved frieze along a building. Thus, each class is effectively designed to handle a general grade of texture. It would otherwise be too cumbersome to handle the complementary measurement data of surfaces, or to devise coherent database systems, without this initial streamliming into classes.

Conveniently, it happens that this system of separate surface-texture classes allows the element of aesthetic judgement to be excluded from the style-analysis process, as material is launched into the processing system entirely upon its measurable merits. The lines of demarcation, or thresholds, to be drawn between these classes as yet remain to be quantified. It is enough in this report to outline them in principle.

4.1 Visual Material, Textural Class 1: Pictwork (Figure 2)

This is the class into which we would normally expect paintings, drawings, and other flat types of pictures (including photographic prints and picture reproductions) to be marshalled.

The word 'pictwork' has been purposely coined to refer to defined types of flat-image surfaces which are anthropurgic. The word 'pictwork' was derived in order that any culturally rooted 'Is it art or is it craft?' arguments might for purposes of analysis be jettisoned. In short, a decision was made to ensure that any kind of flat material presented for image-processed style analysis could be treated in an identical fashion according to set systematic procedures. Thus, with all materials processed, the information sought would be purely formal/stylistic.

The class containing pictwork, or flat surface, material constitutes my own chosen area of interest and research. However, as this report itself demonstrates, in order to achieve a point from which to be able to define one's object of study, it frequently happens that a stage for positioning and defining the object is a first requirement. A pictwork is to be positioned and defined in relation to the three visual-material classes which I describe below.

The pictwork class is notable as one in which textures have

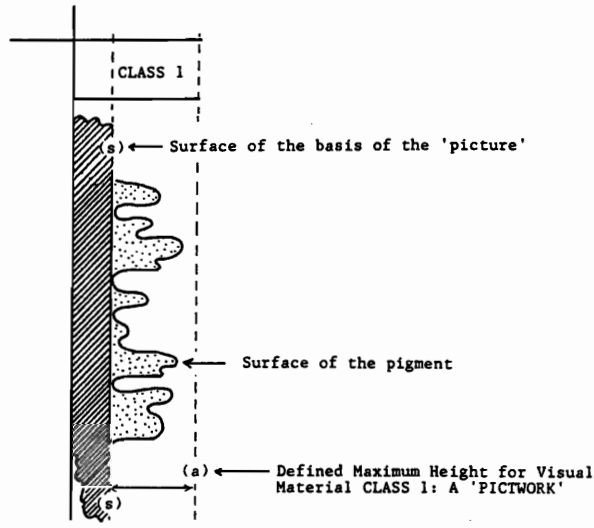


Figure 2. Anthropurgic Visual Material, Class 1: Flat, Applied-Pigmented Surface Material. A Pictwork.

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been physically applied to flat surfaces. It is visual material with an artificial, applied surface texture which has average textural elevations not exceeding the physically defined maximum (a), measured from (s) which is the lowest point of elevation. For example, in Figure 2 a section is shown through a piece of visual material, say, a 'painting'. The shaded part is the basis (a wall, panel or canvas etc.). The dotted part is the added material of the 'painting', such as pigment. This has a surface of varying height above the surface of the basis (s). The pigment does reach a defined maximum height (a), and so the 'painting' is defined as a pictwork class 1.

One detail ought perhaps to be clarified. In the world of actual anthropurgic surfaces, absolute flatness does not often occur. Nor is a pictwork surface required to be absolutely flat for defining purposes. The word 'flat' needs, therefore, to be interpreted broadly in this context, to mean surfaces with overall presentations which are 'flatish' or planiform. Notwithstanding, as this research develops, a concept which introduces a theoretically 'true flat' surface is eventually to be employed as a style measurement parameter.

4.2 Visual Material, Textural Class 2: Indented-Surface (Figure 3)

Woven surfaces, mosaics, inlay, scored rock, or other incised surfaces - these, and many other types including 'intrinsic' moulded surfaces, will be accounted for in those image-processing categories which are planned for this class. Unfortunately, space limitations here preclude any developed outline of these categories. (Only categories associated with class 1 pictwork surfaces can be

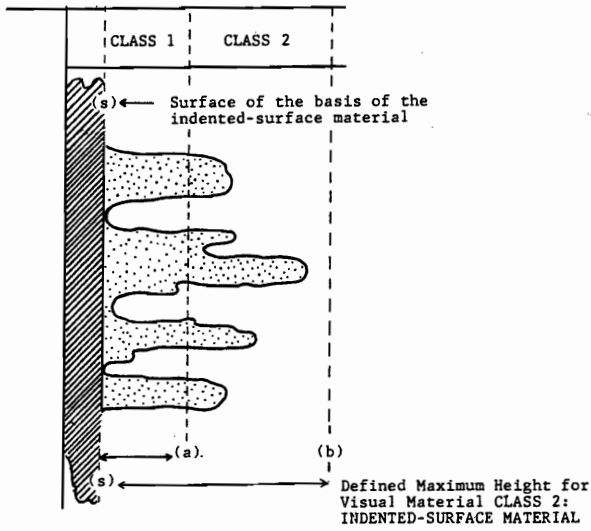

Figure 3. Anthropurgic Visual Material, Class 2: Flat, Indented-Surface Material.

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considered at any length in this report.)

'Intrinsic' means coherent; that is, made-up of ready-prepared, conglomerated or modular materials. Such materials may be variously fitted together, say, as with a loom, or by individually positioned tessera; or may be poured as with plaster, molten metal etc.

Class 2 indented-surface material is primarily a class for intrinsic surfaces as just described, in contrast to pictwork class 1 material which has applied surface pigmented at most to the relatively shallow thickness of (a). If, however, applied pigmented surfaces exceed the class 1 boundary definition of (a), then even pigmented works become defined as class 2 surface material. Paint achieves, so to speak, an intrinsic degree of thickness. Importantly, any wholly intrinsic material such as rock, bronze, glass, woven-stuff and wood is always to be defined as class 2 material from any elevation from (s) to a defined maximum under (b).

4.3 Visual Material, Textural Class 3: Relief Sculpture (Figure 4)

Within this class we find surface elevations from basis (s) to any height above and including (b). An open-ended maximum of (c) is required to contend with large-scale examples of the class, such as the colossal Mount Rushmore memorial in the United States of America. (Note that definition levels (a) and (b) are retained in this figure, as was (a) in Figure 3. When fixed, these levels will continue to be used as pegs for internal measurement calculations.)

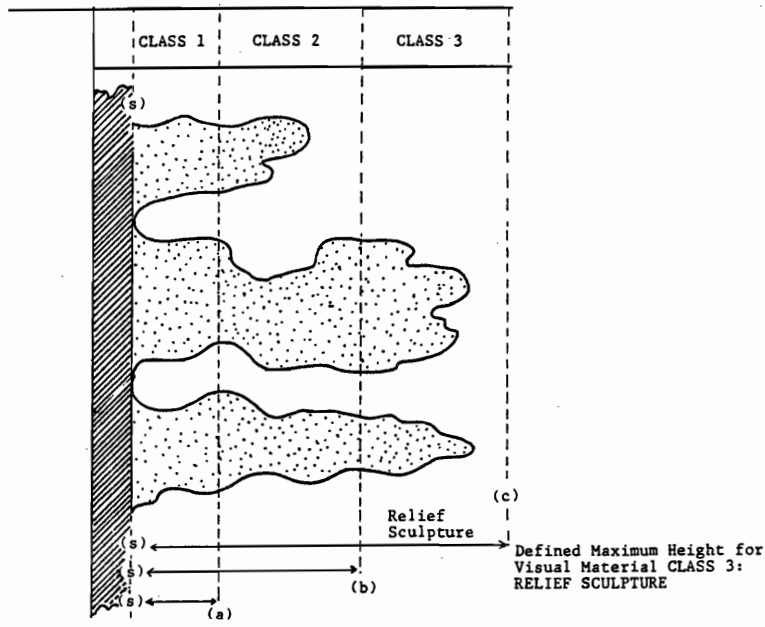

Figure 4. Anthropurgic Visual Material, Class 3: Relief Sculpture

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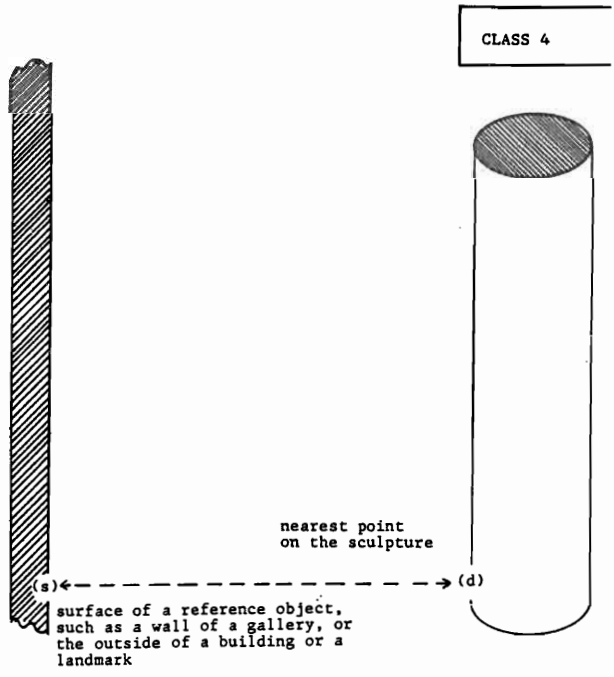
Figure 5. Anthropurgic Visual Material, Class 4: Three-Dimensional, Free-Standing Sculpture



4.4 Visual Material, Textural Class 4: Sculpture (Figure 5)

This material is free-of-the-'reference'-surface, free-standing and three-dimensional. It is at a distance from any selected 'reference' surface (s). Point (d) is reached through space and thus indicates a separate surface. Point (d) is in fact any point upon an example of free-standing visual material.

If a straight line is traced from along the surface of a piece of sculpture at any chosen angle, then that line must join up again with itself at the original point (d) (except in the special case of a Mobius band, when it will join after 2 x 360 degrees). This stipulation confirms that we are dealing with an object in the round.

The image-processing categories which will be associated with this textural class will also include developed categories for stone, wood, bone, metal and ceramic artefacts. Within this class, scope exists for developing a category to cope with the stylistic analysis of exterior-face architecture.

5. *Mixed Forms*

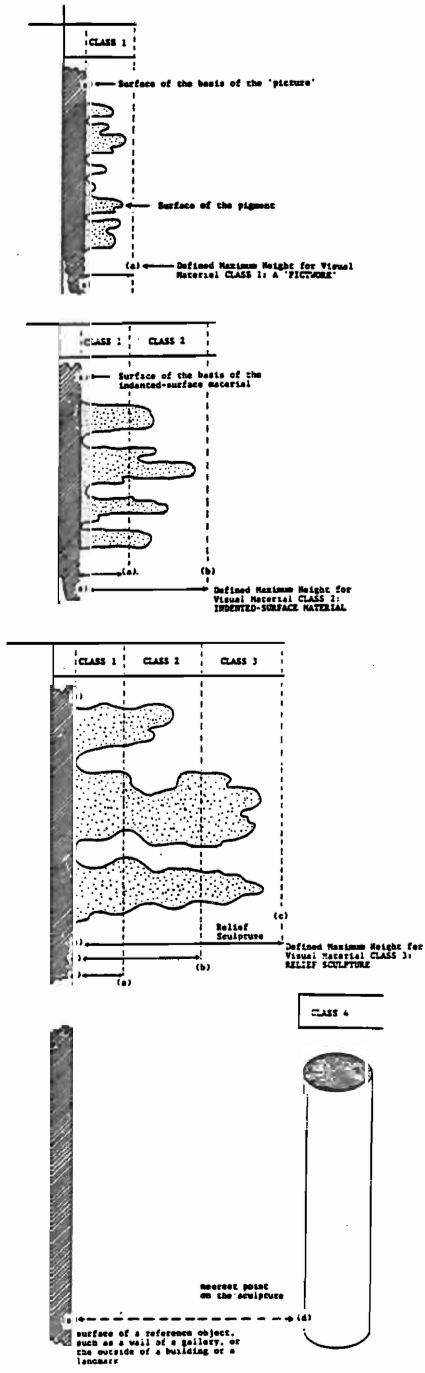
Mixed forms of the four classes also occur. There are painted reliefs and sculptures, and also bejewelled, dressed or otherwise materially encrusted pictwork surfaces. However, as I intend with the remainder of this report to deal with just one class of visual material, namely the pictwork, I shall avoid this general topic. Within the terms of the class 1 pictwork texture definition, certain mixed aspects of pictworks themselves appear, and I will show how they will be considered for image processing.

6. *Four Pictwork Categories*

As I have already remarked, each of the textural classes outlined above will spawn categories. These categories will be designed to make image-processing exploration into style a highly systematic operation.

In Figure 1 we follow a sequence where a flat surfaced type of anthropurgic visual material is defined as a member of textural class 1, a 'pictwork'. Four categories of pictworks are then displayed, and some typical examples of surfaces within each category are indicated. These categories exist to enable compatible surface types to be searched by computers for even the most sensitively tuned style information. A uniform one-category system could never cope with the different kinds of pictwork surfaces, and enable important style-feature transformations to be measured. Each surface effected by a medium, say oil-paint or water-colour, therefore, possesses measurement-parameter requirements dictated by that medium.

Figure 6. Combined View of Textural Classes



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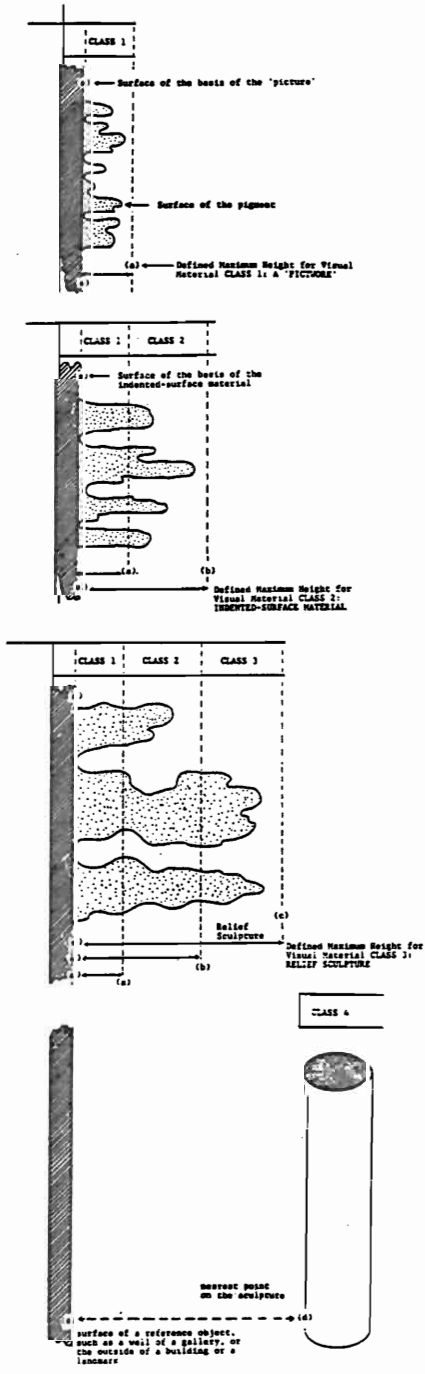

The categories exist mainly for the appropriate tuning of parameters; that is, for example, to allow subtle measurement of both the relatively cumbersome brushstrokes applied to a surface by an artist, and, as sensitively, the especially smooth mechanically-pigmented and coated surfaces of photographs (Gonzales and Wintz 1987: 55).

The arrangement of precedence which I have given the four categories is another concern. The categories have been so arranged to give manual polychrome surfaces first place in the schema. This is an arbitrary decision to give the most formally replete of the wholly manual categories a certain pride of place. It does not affect the fact that in whichever order these categories are ranged, they remain only as working categories.

The four pictwork categories which I list below, each with a short description, are categories of manner and mode. The possible manners of a pictwork surface are: first, the trace of a direct human act, e.g., of pigment placed by hand upon a surface; secondly, the trace of a mechanical or indirect pigmentation to a surface; and thirdly, a trace of combined direct human and indirect mechanical pigmentation to a surface. Henceforth, I will keep to a terminology of three manners, following the above sequence: they will be called *manual*, *mechanical* and *combined*. The possible modes of a pictwork are: first, a surface, by whichever pigment, restricted to a monochromatic (tonal) presentation; or, secondly, a surface, by whatever pigment, of polychromatic presentation. Henceforth, also the terminology will recognize two modes, *monochrome* and *polychrome*.

6.1 Pictwork, Category A (Manner: Manual; Mode: Polychrome)

This is defined as a category for surfaces which have been manually wrought (i.e., 'worked into shape or condition' (*OED*)) in any pigment polychromatically.

Pigments are 'colouring substances' (Levy 1961: 87). Polychrome means many colours or hues; here, however, I define polychrome to mean that there can be a barest minimum of two applied pigment colours or hues on a surface (excluding white, which is to be disregarded as a colour), upward to an unspecified number of hues. A hue is another word for a colour; or, better, it is a colour's family name - red, green, blue, brown etc. I align this term's usage to that of the commonly recognized Munsell colour measurement system. Some typical kinds of pictwork category A surfaces would be oil paintings, water-colour paintings, paintings on bark, tempera paintings, and multi-coloured pastel and/or crayon drawings.

6.2 Pictwork, Category B (Manner: Manual; Mode: Monochrome)

This is defined as a category for surfaces which have been manually wrought in any pigment, monochromatically. Monochrome, as the word suggests, means having only one colour. Many people readily associate the word with black-and-white images; this is due possibly to a familiarity with black-and-white television, photography, or vintage cinema. In the pictwork context, however, the dictionary

sense stands: monochrome pictworks may be of any hue as long as the tints, or light-to-dark degrees of that hue, are all offspring of an original parent hue.

As a general rule for all categories of pictwork, the natural colour, or colours, of raw surfaces (e.g., paper, cave wall, bark, hide, canvas) will be disregarded as elements to be considered in defining categories. Categories will be defined only in respect of a surface's positive reportage of its having been physically added to with pigment hue. Positive additions are called *active elements*. In other words, we are defining categories as pigment-positive surfaces. *Passive elements*, such as natural or unperturbed surface areas associated with original images are, however, to be considered as authentic aspects of style from a statistical point of view. Image-processing computers excel at the separation of these elements into measured amounts, and it is of importance to know just what areal amounts, if any, makers tend to leave untouched in their works. A purposefully primed or tinted canvas would, for example, be an active element, whereas a raw canvas, or a manufactured sheet of drawing paper, of any tint, would qualify as a passive element.

Pictwork category B is for convenience sub-divided into two sub-categories. Sub-category (i) contains monochrome surfaces which display a relatively wide tonal (dark-to-light) spread. Examples of typical pictwork category B(i) surfaces would be grisaille (or monochrome) oil paintings, water-colour paintings, tempera paintings, and so forth, plus tonally graduated drawings. Tonal gradations of drawings would be resultant marks from physical substances including chalk, pencil, silverpoint, sanquine, charcoal, ink etc. Sub-category (ii) contains monochrome surfaces which display a relatively narrow tonal spread. Examples of typical pictwork category B(ii) surfaces would be solid-coloured wholly untoned drawings and paintings; pictograms, hand-written letter characters (calligraphy), alpha-numerical characters, and scripts; human finger, hand, and any direct body-surface prints.

6.3 Pictwork, Category C (The 'Pseudo-Pictwork')

(Manner: Mechanical; Mode: Combined - Monochromatic or Polychromatic)

This is defined as a category for surfaces which have been mechanically produced in any pigment, monochromatically or polychromatically.

To understand what is meant as 'mechanically produced' in a pictwork context, it is necessary to consider the following idea. Manually wrought, as it pertains to pictwork categories A and B above, implies the possibility of a most fully expressed action between the pictwork surface and the executant (artist). With a paint-dipped finger, a loaded brush, a charcoal stick, pencil etc., an executant marks a surface whilst being at the same time fully connected to the characteristics (steady or unsteady as may be) of the body's motor system. The traces left upon a surface will, therefore, in terms of texture, most fully represent the physiologically instigated 'touch' of the executant. Mechanically produced pictwork surfaces, on the other hand, are texturally

delivered by an assortment of possible contrivances - at varying distances, so to speak, from an executant's possible fully expressed action. Airbrush-technique work and computer graphics emerging from a printer, are just two examples of degrees of distancing from direct manual control. There are, of course, many borderline cases between manual or mechanical dominance, which will demand some general ground-rules for processing analysis.

Category C exists, first, to recognize the fact that there are pictwork surface types which are distanced from the category A and B types which account for direct human expressed action, texturally registered. And secondly, very practically, this main category exists to register the ranges of distinctive textural, tonal and spectral effects which are achievable by means of mechanical contrivances. I should stress that the noun 'contrivance' is not used in any pejorative sense; rather, it reflects a revived obsolete sense of the verb 'contrive', which is 'to bring about by ingenuity or skill into a place, position or form' (*OED*); in this case, a thing called a pictwork surface. The setting into place, position or form, of the pictwork surface is accomplished by the 'steadying' means of the contrivance - which is an instrument, or procedure, designed to effect humanly instructed action upon a surface, rather than humanly expressed action. This is the prime distinction.

Examples of typical kinds of pictwork category C surfaces are magazine, book and postcard illustrations; advertising posters, serigraphs (screen prints), lithographs, lino-cuts, wood-block prints, etchings, engravings, aquatints, mezzotints; photographs, daguerrotypes; and also printed text and number systems. A photo-reproduction or print of an original category A pictwork surface, say Van Gogh's *Sunflowers*, would thus be termed a pictwork category C, mechanical, polychrome surface. Because category C is the place for photo-reproductions of original category A pictworks, such as the one mentioned, I have termed category C the 'pseudo-pictwork' category. Keeping in mind the idea of a mechanical copy of an original being a 'pseudo' version of the original, will make category C's position in the scheme more readily memorable.

6.4 Pictwork, Category D (The 'Hybrid Pictwork')

(Manner: Manual and Mechanical; Mode: Combined - Monochromatic or Polychromatic)

This is defined as a category for integral surfaces which combine, to any degree or extent, both manually wrought and mechanically produced pigment textures, i.e. textures achieved with any pigment, monochromatically or polychromatically.

When a picture is painted or drawing drawn and its author decides subsequently to stick a photograph, or possibly a patch of fancy wallpaper on to the original masterpiece's surface, then a hybrid form of pictwork is created. Likewise, if someone takes a colour photograph of the *Mona Lisa* and - either drawing or painting - adds a moustache, then again a pictwork category D is created. This category especially reflects what we find happening on a world-wide basis where manually wrought and mechanically produced surfaces

are juxtaposed and variously combined to fulfil all manner of needs and objectives, from cultural to commercial. To enable this category to be remembered in the scheme more easily, I have termed it the 'hybrid pictwork' category: this, of course, implies two varieties producing a new combined version.

Examples of typical kinds of pictwork category D surfaces are hand-tinted photographs, hand-tinted mechanically originated prints and engravings; batik fabric decoration, where patterns are drawn on a surface manually and are then dye-coloured mechanically; and some types of collage work.

Let me illustrate some distinctions using this last example. A collage is a picture or visual arrangement made up partially or entirely of pieces of pasted-on paper, material, photographs, illustrations, textured and figured material (O'Dwyer and Le Mage 1950: 32). Thus, a collage arrangement made up from pieces of original painting surfaces would still remain a pictwork, category A surface, assuming, that is, that it keeps within the defined textural threshold; as a collage arrangement made up entirely of mechanically produced pigment surfaces would remain a pictwork category C (pseudo-pictwork) surface. Only when proportions of manual and mechanical surfaces are found on a common surface do we have an actual pictwork category D (hybrid pictwork) surface. If a collage-type of arrangement happens to exceed the pictwork textural definition by having, perhaps, large textural additions affixed to its surface, such as pieces of wood or 'found objects', then, another textural class is entered, and the work must be analyzed using that other class's criteria.

7. Summary

In this report I have outlined four texturally based classes for what is generally termed anthropurgic visual material. Each class has its own categories which are designed to relate to the requirements of image-processing technology, for the express purpose of enabling image-style analysis procedures to be developed. These intended procedures are all to be related to instrumentally sensed material surfaces, to texture, tone, colour and spatial features, rather than to any other attributes or qualities possessed by objects.

I have discussed here only one set of categories, those which fall within a single class designated by the overall term 'pictwork'. It is this class and its categories to which my researches are directed. Discussion of the texture-based pictwork concept has been a prerequisite step to making understandable the conceptual foundation of technical papers on image-processing analysis which I hope to publish in due course. I hazard that useful progress in the field of artistic image-style analysis will require the availability of some such categories as these. Only with the aid of

these, or very similar, categories can a statistical approach to the actual physical surfaces which are distinct and measurable aspects of image styles be made to work.

PETER STRONG

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