How it all Began

There is a long version and a short version. The long version goes back to a dream in 1961. The short version effectively began with a bibliography, a trip, scholarships and several grants and then a G7 Project.

1. Bibliography
2. Trip
3. Scholarships
4. G-7 Pilot Project 5

1. **Bibliography**

In 1977, Professor Marisa Dalai Emiliani, with the guidance and inspiration of Professor Eugenio Battisti, organized the first world conference on perspective. Because I had just finished a doctorate on the subject with some of the leading experts in the field (Professors B.A.R. Carter and Sir Ernst Gombrich), I was invited to prepare the bibliography for the conference. It was initially assumed that this would be a small appendix. Various experts (Professors Chastel, Edgerton, Maltese etc), sent in their contributions. We then learned that Professor Luigi Vagnetti had been working 35 years on a bibliography so it was decided to wait until he published his work in 1979 before going to press. Shortly after that work appeared Professor Vagnetti invited me to visit him in Rome. He urged me to expand the scope of my bibliography by writing to libraries in Eastern Europe, Asia, Australia, Africa and South America. Some sixty five letters were initially sent to major libraries around the world. Of these sixty replied. Eventually contact was established with 180 libraries.

In the process more than six meters of file cards and six meters of xeroxes were collected. The file cards were arranged either alphabetically or chronologically. Inevitably I wanted to find something alphabetical in the chronological list and conversely. The need for multivalent access to information posed itself. For the next five years (1979-1984) a coherent plan for dealing with these problems emerged.

At the time I was continuing with my research on perspective and Leonardo da Vinci at the Herzog August Bibliothek in Wolfenbüttel. One day in the early spring of 1984 there was a visit from the outgoing and incoming president of RLIN (the Research Libraries Information Network), Dr. Marcus McCorrison and Dr. David Stam. They suggested that the Getty Trust should be interested in the work. Partly through their recommendation I was invited to the Getty Centre for the History of Art and the Humanities.

2. Trip

Meanwhile, in 1981, thanks to the generosity of my friend, Dr. Rolf Gerling, I was invited to join him on a ninety day tour of the Mediterranean that took us through Spain, Southern France, by ship to Tunisia and onto Sicily, across Southern Italy, by ship to Patras, through Greece, the West and South coasts of Turkey and then back through Anatolia, Bulgaria, (the then) Yugoslavia and the Austrian Alps, ending on the shores of the Lake of Constance in Switzerland. This 19,000 km. journey inspired a re-thinking of two of my fundamental conceptions of cultural history, namely, the need for recontextualization/reconstruction and for increasing the sample with respect to comparison.

Re-contextualization/Reconstruction

Standing on the Acropolis, I looked at the Parthenon the marble friezes of which were largely in the British Museum in London and had difficulty imagining how they fit together. Standing in front of the friezes in London some years earlier I had experienced the reverse side of this problem, trying to imagine how the friezes fit into the original building. In other cases there were related problems. In Sicily and in Turkey we often walked among ruins of what had once been great temples. In Tunisia we walked through ruins of Roman towns. But even with a guide book and a brilliant imagination it was impossible to picture clearly what these monuments and towns of the past might have been like. It became obvious that one could not really understand the past without reconstruction. But these were often influenced by particular schools of thought. So the challenge arose of creating a system that would allow one to view multiple reconstructions, rather than merely presenting the fashion of the day as if it were the truth.

Need to Increase the Sample in Comparisons

The word colosseum invariably conjures up a buiding in Rome. I was quite unaware that there were some twenty six colosseums built in Roman times including ones in Arles (France) and El Djem (Tunisia). To understand the characteristics and significance of colosseums it is essential to take all the examples into account. It became clear that in order to make valid claims we need to increase the sample, to look at all the particulars before making claims about the universals.

These concepts inspired two articles *Reality, Knowledge and Excellence* (which was subsequently published in slightly altered form as *Computers and a New Philosophy of Knowledge*) and *A Proposal Concerning the Reorganization of Knowledge*. These articles became the starting points for the underlying universal approach to culture in SUMS.

3. Scholarships

In 1986-1987 I had the honour of being named Canada's first Getty Scholar at the Getty Center for the History of Art and the Humanities in Santa Monica. It was there that the bibliography was typed into a computer and the ideas concerning multivalent access to information began taking an electronic form.

Immediately after the year at the Getty, I was fortunate to receive a Canada Research Fellowship which gave me five years (1987-1992) to pursue my ideas. In this period the particular database aspects of the bibliography and the universal cultural aspects introduced by the trip were integrated. A first prototype of SUMS used Toolbook as an authoring tool.

In 1991, the support of Professor de Kerckhove, through a grant from BSO (Utrecht) to the McLuhan Program, made it possible to begin working on a serious demo. In the process the limitations of Toolbook led to a decision to create our own software in C++. Grants from the Canadian Heritage Information Network (CHIN), the Metro Board of Education and North York Board of Education made it possible to continue.

Internet

In 1994 it was recognized that SUMS offered important innovations in terms of browsing on the Internet using home pages. In 1995, with the advent of Java and VRML, it was decided to integrate these features into the software.

Links with Education

A pilot project at York Mills Collegiate (1994-1995), led by the head librarian, Mr. Keith Medley, demonstrated that the principles of SUMS could be used directly in a school environment. The success of this venture inspired a former student, Mr. John MacDonald to introduce a SUMS partnership with Brother Edmund Rice Secondary School. The co-operation of John Volpe, a high school principal helped to extend this to three elementary schools (St. Rita, Pope Paul and St. Luigi) in the context of a Technological Literacy project. This led to a Partnership Award (1999) from the Learning Partnership.

Applications in Government and Industry

In 1995, when an application for a grant from the Canadian Advanced Network for Research Industry and Education (CANARIE) was encouraged but not immediately funded, the industry partners decided to continue nonetheless. The Canadian Hydrographic Service (CHS) formed a consortium with the Centre for Art and Technology at Carleton University to convert their 900 hours of training into SUMS and to explore applications of SUMS for training and higher education. Bell Canada, another member of the CANARIE proposal, decided to continue support for short term applications through Media Linx. To this end they provided equipment and resources to produce working prototypes of SUMS in two fields: health and education. A change in direction within Bell led to an interruption.

High Bandwidth Experiments

The many demonstrations of SUMS included some to senior members of industry and government officials (1994). This led to an invitation to give demonstrations at two successive boot camps of the Systems Engineering Society (SES) one at the NRC in Ottawa, the other at the CBC in Toronto devoted to the future of broadcasting. From this emerged the idea of a high speed test-bed environment that would link the Bell Centre for Creative Communications at Centennial College, CBC and the McLuhan at OC-12 level (622 megabits/second) which would then link to the CANARIE network and to Europe via the Teleglobe Cantat III line at ATM speeds (35 megabits/second).

Research

With a view to research into future applications Bell also contributed towards an onyx Reality Engine 2, towards which, Silicon Graphics Inc. (Canada), another of the CANARIE partners, also made a generous donation in kind. This machine was intended to permit us to include the National Research Council's 3-D camera, the GMD's DVP and their work on virtual museums in the context of SUMS demonstrations.

International Links

Demos of SUMS attracted attention from increasingly wider audiences, including the CIDOC (Comité International pour la Documentation de l'Art) section (Quebec City, 1992) of ICOM (International Committee on Museums) and the Couchiching Conference (1993). Thanks to support from Industry Canada we were invited to participate in international meetings such as CEBIT (Hanover, 1994), the G7 Information Society Exhibition (Brussels, 1995), the European Commission (Brussels, 1995, figure 1), the G7 Summit (Halifax, 1995) and at the Information Society and Developing Countries (ISAD) Conference and Exhibition (Midrand, June 1996, figure 2).

4. G7 Pilot Project 5: Multimedia Access to World Cultural Heritage

In the spring of 1996, SUMS was one of four projects to be chosen as part of G7 pilot project five, representing Canada at the Information Society and Developing Countries (ISAD) Conference in South Africa (Midrand, May 1996). The booth focussed on four themes:

Capture	NRC Laser Camera (Ottawa)
Archive	Museum of the History of Science Project (Florence)
Display	Infobyte Reconstruction of Nefertari (Rome)
Navigate	SUMS (Toronto)

This had three major consequences for SUMS: it became 1) the Canadian test site for IBM's Vatican Library Project; 2) the first Canadian company to be included as a partner in ACTS (Advanced Communications and Technologies Services): the VVP (Distributed Video Production) project of the GMD (Gesellschaft für Mathematik und Datenverarbeitung); 3) SUMS was invited to participate in at least three other ACTS proposals. It was foreseen that these would involve collaboration with Canadian applications. At the G7 meeting in Brussels SUMS was the only software of its kind described as a tool for advanced conceptual navigation in cyberspace.

Since that time, SUMS has played a quiet role in developing co-operation between the GB's global efforts and the initiatives of the EC. SUMS accompanied the EC's delegation on Euro-Japanese Culture (Gifu, April 1998) and Euro-Mediterranean Culture (Cairo, September 1998). At the European level there has been co-operation with the Istituto Centrale per il Catalogo e la Documentazione (ICCD, Rome), DGXIIIb now IST (Brussels). It played a role in the Memorandum of Understanding (MoU) for Multimedia Access to Europe's Cultural Heritage, the MEDICI Framework and the founding of E-Culture Net.

In 1994, a Dutch Television station (VPRO) did a two hour documentary on the Information and included 8 minutes on SUMS. This was seen by a student at the Hogeschool in Maastricht who subsequently came for a term in the spring of 1995. The next year two more students came. On the basis of this the Hogeschool Maastricht and the Universiteit Maastricht joined forces to create a Maastricht Media Institute (MMI) which was intended to develop SUMS with the help of 2-3 programmers and a staff of 20-30 researchers. A change in economic climate coupled with a change in key decision makers led the university to close the Institute in 2004 at just about the time when it was originally to have reached its full size.

A next step came from an unexpected source. In 2003, two Russian students from Smolensk, Vasiliy and Alexander Churanov, began to work on the demo during a one month visit. This has led to further visits, the addition of a third student, Andrey Kotov, which has resulted in this demo. There are currently plans for a new European University of Culture with campuses in Berlin (art and aesthetics), Bologna (humanities), Madrid (languages and literature) and Paris (philosophy and Internet). It is foreseen that the demo will be developed in Paris in the context of the new department on Internet and Culture.

Figure 1. The Hon. Dr. Jon Gerard, Minister of State for Science and Technology; the Hon. John Manley (Minister Of Economics); the Hon. Jean Dupuis, (Minister of Culture) and the Canadian Delegation to the G7 Exhibition and Conference (Brussels, February 1995), including two representatives of SUMS, namely, Rakesh Jethwa (back row third from right) and Andrew McCutcheon (back row, far right).

Figure 2. The President of RAI at the stand of G7 Pilot Project 5 (Midrand, May 1996).

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System for Universal Media Searching

The Philosophy of SUMS and SUMMA

The System for Universal Media Searching (SUMS) is a first step towards a System for Universal Multi-Media Access (SUMMA). Underlying this new approach are seven basic concepts: Simplicity, Questions, Levels, Strategies, Choices, Categories, and Universals-Particulars and Three Premises. A description of these will clarify why and how SUMS is different to our existing Internet solutions.

Basic Concepts

1. Simplicity
2. Questions
3. Levels
4. Strategies
5. Choices
6. Categories
7. Universals-Particulars

Three Premises

1. Simplicity

Many believe speak of simplicity through phrases such as Keep It Stupid and Simple (KISS). The general result of this quest is to reduce the functional dimensions of searching to a single field and hope that users will be happy or at least satisfied. Meanwhile, these same systems continue the Mediaeval tradition of *horror vacui*. A major site is often equated with overwhelming the user with a tremendous amount of choices at once such that it often takes longer to determine which choice might lead to what one is seeking. Moreover these systems hypothesise no problem in filling the remainder of the screen with banner advertisements such that one is constantly being distracted from one's goal.

SUMS approaches this from a different kind of simplicity which in Mediaeval jargon is called *cognitive* responsiveness. The above approach treats the mind only has a certain amount of capacity for attention. If one is searching for something then the brain can expect to search for something should be as invisible as possible. In this way one retains a maximum of attention for one's goal. For this reason less on the screen is often more because we can concentrate on what counts. This may be contrasted with the meaning of advertising or entertainment. If our goal is education or learning we should not be distracted by those whose goal is selling and buying.

This commitment to speed of simplicity through phrases such as Keep It Stupid and Simple (KISS). The challenge is to attain simplicity without abandoning or compromising the content. On the contrary, a strategic simplicity allows intelligence to flow and increases the meaning of accompanying information. Simplicity increases the speed of searching and simplicity is the step away distractions without reducing the intelligence, focus and depth of the search. How can such simplicity be achieved? This is the role of the other functions of SUMS.

2. Questions

Search engines today typically promise to find us answers directly using search and retrieval techniques. On the surface they are very successful. Google typically provides thousands and even millions of hits. This kind of success is a problem in itself. We can spend hours, days, months, years, decades, centuries, millennia and still not exhaust even the challenge was finding enough hits. Today the challenge lies in limitation such as Goethe recognized long ago, in his *Faust*, in the pact with Mephistopheles. Instead of being given a million hits, we want the answer to our question or at least the options rather than answers. SUMS offers the five basic questions of reporters plus why? It does in at least five distinct ways.

i) Use Who, When, Where and Where to Delimit What and Who.

Present day search engines depart from an assumption that every user is potentially searching for everything. On the contrary, most of us are searching for something specific or thinga about some specific problem or series of problems. If we identify what we are looking for then we can effectively place the topics for which we are searching

In the case of beginners SUMS asks users to choose from one of 10 goals: Everyday, Emergency, Business, Education, Entertainment, Government, Health, Legal, Leisure and Religion.

For example, if we our goal is religion then we are searching for churches and religious places and we are not usually searching for Buddhism, Christianity, Government buildings, Legal offices etc. If our goal is Education we are typically not searching for the above mentioned institutions and searching instead for schools, colleges and universities.

Hence knowing a user's goal helps a) to define that for which they are searching and b) immediately eliminates a great deal of that for which they are not searching.

Once we know the why of the search it is wise to learn the how. If the user's goal is religion it is important to know whether they are looking for Christian, Hebrew, Islamic, Hindu, Buddhist, Jain, Sikh, Bahai religions. Next it is useful to know what they are looking for, e.g. the period 1800-1850 and temporal limits (e.g. only in England, in Europe etc.). At this point we have defined the topic for which we are searching and Who which are the normal entry points in library catalogues.

ii) Use Where and When to Delimit Who and What

For more advanced users with a defined topic one can proceed more directly. One can use the questions Who, What, Where and When simultaneously. For instance if I type: Who = Leonardo, I am potentially searching for everything Leonardo wrote. If I type Who=Leonardo + What=optics I limit the search to what he wrote on optics. If I then add + Where=Milan and + When = 1505-1508, I am only searching for a small amount of materials by Leonardo on optics in Milan from 1505-1508. Using SUMS this process is reduced to a single search using four fields.

iii) Identify a basic question and use it questions to Delimit the

The six large questions in the upper part of the screen also have another function. They help identify the main goal of the search. Who indicates searches for persons, Where indicates searches for places, Where indicates a spatial focus on a given area or place; When indicates a temporal focus on a given period, time or date. Once this main focus is identified then the question tend to limit the range of the questions that are of interest. Even if my focus is Who, i.e. biographical, say in Goethe, I may still be interested in his work in a specific place, e.g. Weimar (i.e. Where), at a given time (i.e. When).

iv) Pose questions as if they were statements of choices

The notion of asking questions goes back at the history of western. The Internet is fully aware of Frequently Asked Questions (FAQs) are a useful tool in approaching retrieval. Companies such as Ask Jeeves have commercialized this idea.

Instead of creating long lists of questions SUMS poses questions implicitly through a small series of choices usually in the form of 1 word statements. Underlying this approach is a simple strategy. Questions have a certain order depending on the depth to which one delves. For example it is of no use to ask which edition a person wants before they decide which author they wish to find. Similarly it is useless to ask what kind of a book is one interested when we know its title and edition. SUMS approach to simplicity does not remove complexity. Instead SUMS confronts the user with one aspect at a time on order that the complexity of the whole does not overwhelm one at any time.

v) Use further questions to Delimit the content one finds.

Once one has found one's main topic of interest one can ask for further questions. For instance if one is searching for a series of further questions to be asked concerning its quantity (size, weight etc.), quality (paperback, hardbound, leatherbound etc), spaces (places where distributed) and time (how long the edition remained on the shelves etc.), which further defined knowledge about the object. We shall return to this in section 6 below.

3. Levels

Even ten years ago there were serious concerns whether web "crawlers" could ever hope to crawl through all of existing knowledge in the World Wide Web. The assumption of our search engines today seems to be that since the technology is fast enough to "meta-crawl" everything, they should present us with everything. The good news is that this brings enormous results. The bad news, as suggested earlier, is that the results are so enormous that we cannot cope with them.

To meet this challenge SUMS begins with a distinction between a) pointers to knowledge, b) the object of knowledge and c) analyses and commentaries about that object. Pointers to knowledge are the equivalent of a virtual reference room. They refer to libraries, in classifications, thesauri, ontologies; 2) Definitions are in dictionaries; 3) Explanations are in encyclopedias; 4) Titles are in library catalogues, book catalogues, bibliographies; and 5) Partial Contents in the form of abstracts, reviews and tables of contents. Knowledge entails 6) the full contents of a book, painting or other object.

In addition, analyses and commentaries which were traditionally classed as secondary literature entail 7) Internal analyses when the study focuses on a single text, painting or object as in a monograph or catalogue raisonnée; 8) External analyses when other objects are studied. Finally there are 9) Reviews and Commentaries. These are often "reported" and SUMS tries to provide a rule-based approach to "reported" SUMS thus arrives at 10 levels of knowledge.

These Levels again lead to further distinctions. For instance, Level 8: External Analysis leads to basic comparations:

1. Copies
2. Versions
3. Related Drawings
4. Related Paintings
5. Other Works by Author
6. Other Paintings by Theme
7. Other Media
8. Further Analyses

Further Analyses allows one to make external analyses in terms of Who (Persons), What (Objects), Where (Places), When (Events), How (Instructions) and Why (Reasons). Many early attempts at virtual museums aimed only at offering an example of Level 6: Full Contents. Many Internet examples address one of the other levels in isolation. For instance there are a number of sites on dictionaries, on encyclopedias and on reconstructions.

SUMS proposes that work between existing efforts in two hierarchies. The Dewey Hierarchy is concerned with links between the levels of knowledge: i.e. how a term is/can be linked with dictionary definitions, encyclopedia explanations, titles, partial contents, full contents, analyses and commentaries. Dewey hierarchies are well developed in this given stage. For instance, while it is easy to deal with pointers to knowledge (especially levels 1-3), before one has committed oneself to a given title, there is no need for the analysis levels (7-10). Hence the levels not only clarify where one is, they can be linked with the appropriate stage of knowledge. Thus we need to deal at any given moment. This is another example of how SUMS simplifies the amount of material without 'dumbing down' the process. Indeed, by providing the user with the appropriate at the right stage of their search, SUMS can increase the complexity of the approach as a whole, while simplifying the individual steps.

4. Strategies

Another important ingredient in the process of searching has to do with the scope and depth that wishes to search. Sometimes we are searching very specifically for a given item. At other times we are interested in what other items surrounding that term and need to understand the contexts associated with that term. As we widen the scope of the terms for which we are searching we may need also to widen the scope of the sources consulted. To meet this challenge, SUMS introduces seven basic strategies.

1. Guided Strategy is the simplest of these. As the term suggests this is a mode for beginners who wish to have the equivalent of a guided tour as they make their search for a specific world.

2. Direct Strategy allows for search directly for a given term in a database devoted to that term.

3. Personal Terms Strategy assumes that the user is interested not only in a given term but also in the terms surrounding it which have been identified in an expert system by other users who have spent months, years or a cluster of months, which may readily range from 50 to 500 or more. The search may begin with a given database but these same terms can be used as a basic vocabulary for searching in other libraries, museums, archives etc.

Once we choose a term we are given a number of further options in the choices box.

a) At the simplest level we can search for a basic definition within the perspective database. If we choose further definitions the system goes to www.onefind.com which surveys 120 dictionaries for further definitions of the same term.

b) Alternatively we can choose explanations which takes us to a list of basic encyclopedias, including the Encyclopædia Britannica (1911 ed.), the Encyclopædia, the Catholic, Columbia and the Wikipedia.

c) We can also choose Titles and go directly to a list of titles on the subject.

4. Database Fields Strategy. To know what to search for it is very useful to have clues as to what one can hope to find. In the case of a given database one may want to know what information is known by the fields under which facts have been collected. This offers a fourth strategy with SUMS.

5. Subject Headings Strategy uses the categories of library subject headings to increase the scope of the controlled vocabulary, which can be used in searching for terms related to the topic at hand. This entails access via simple alphabetical lists.

6. Standard Classification Strategy uses the relations of a standard classification such as the Library of Congress or Dewey Classification to increase the scope of searching. Instead of searching for a specific term one can a tree structure where, while it is dealing with pointers to knowledge (especially levels 1-3), before one has committed oneself to a given title, there is no need for the analysis levels (7-10). Hence the levels not only clarify where one is, they can be linked with the appropriate stage of knowledge. Thus we need to deal at any given moment. This is another example of how SUMS simplifies the amount of material without 'dumbing down' the process. Indeed, by providing the user with the appropriate at the right stage of their search, SUMS can increase the complexity of the approach as a whole, while simplifying the individual steps.

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6. Categories

Whereas the introductory strategies of SUMS are a kind of hierarchy, the more advanced strategies have a virtual character. Instead of 10 knowledge levels there are 10 hierarchies. Instead of 7 choices this SUMS building on Aristotle's work, Aristotle identified 10 basic categories for knowledge: 1) substance, plus nine categories, 2) Quantity; 3) Quality; 4) Relations; 5) Place; 6)Time; 7) Position; 8) State; 9) Action and 10. Passion (Affection). Three of these categories, namely, Quantity, Quality and Time recur as classes 5,6 and 7 of Choices. In Aristotle's approach, Relation is limited to what Peresuit would call Ordinal: Comparative relations. In SUMS this becomes a class of Choices. Place, Position and State are combined into a single class of Choices (Spatial) and Action and Passion (Affection) are combined into a single class of Choices (Agency). In SUMS these become subsets of Questions. Why (Figure 1). As one advances from SUMS to SUMMA and shifts from pragmatic claims to versions striving to approximate reality and truth, the Aristotelian categories are shifted in alignment with the six basic questions (cf. figure 2).

Aristotle	Peresuit	SUMS	SUMMA
Substance: Divisio	Subsumptive: Division	Levels: Term	What
Substance: Partitio	Subsumptive: Partition	Levels: Term	What
Quantity	Ordinal: Comparative	Quantity	How
Quality	Ordinal: Positional	Quality	How
Place	Ordinal: Positional	Space	Where
Position	Ordinal: Positional	Space	Where
Time	Ordinal: Temporal	Time	When
Relation	Ordinal: Comparative	Quantity	How
State	Ordinal: Conditional	Quality	How
Action, Passion	Determinative	Quality	Why=How

Figure 1. Correspondences between Aristotle's categories, Peresuit's relators and SUMMA.

What	Where	When	How	Why
Levels (Term)	Space	Time	Quantity, Quality	Questions
Subsumptive	Ordinal	Ordinal	Ordinal	Determinative
Division	Positional	Temporal	Comparative	
Partition			Conditional	

Figure 2. Correspondences between questions in SUMS/SUMMA & relators of Peresuit.

Universal- General	(Not in Space-Time)	How	Where	When
What/Who	Why (=how)			
Relations: Subsumptive	Determinative	Ordinal Comparative		
Entities	(Activities)	(Dimensions)		
Type/Kind (ie a)				
Genus/Species				
Whole/Part (has a)				

Space-Time Horizon

Particulars-Individuals	(In Space-Time)			
Subsumptive	Determinative	Ordinal	Ordinal	Ordinal
Whole/Parts	Why	Conditional	Positional	Temporal
Subject/Properties	Limitative	Comparative		
Substance/Accidents	Destructive			
	Injuring			
	Passive			

Figure 3. Six questions linked with universals/particulars and Perresuit's relators.

7. Universals-Particulars

In the longer term this points towards a basic reorganisation of knowledge which has been discussed elsewhere. A fundamental quality of this approach will be to organise knowledge in terms of their basic relations as outlined by Peresuit, using the six basic questions of simple questions established by SUMS (figure 3). This will the goal of SUMMA.

SUMMA (System for Universal Multi-Media Access)

SUMS is concerned with searching in existing knowledge which has already been classed by librarians and other knowledge experts. By contrast SUMMA is concerned with knowledge structures that represent the frontiers of knowledge today. SUMMA entails searching, organising, archiving and creating knowledge. Ultimately SUMMA is concerned with developing ontologies, world views and reaching new synthesis. SUMMA adds three further levels to the strategies of SUMS.

8) Comparative Analysis

Not yet functional is a further level which will combine classifications in new ways.

The approach of the USA based on Dr Dahlberg's matrix offers an example of an entry into this level. Whereas strategy level 6 in SUMS allows one to connect with standard classification schemes such as library systems and other collections, this level is concerned with classifications of knowledge that represent the frontiers of knowledge today. Dahlberg's approach is concerned with knowledge structures that represent the frontiers of knowledge today. Dahlberg's approach is concerned with knowledge structures that represent the frontiers of knowledge today. SUMMA entails searching, organising, archiving and creating knowledge. Ultimately SUMMA is concerned with developing ontologies, world views and reaching new synthesis. SUMMA adds three further levels to the strategies of SUMS.

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10) Historical Worldviews

Today's electronic systems assume that our contemporary world-view is the only viable system. Earlier cultures had other world views, which organised their knowledge and facts in other ways. SUMMA aims to orientate users as they move from one world-view to another. This strategy helps to understand how facts, ideas and concepts have evolved over time.

10) Synthesis and Creation

A tenth strategy is concerned with collaborative work in arriving at new synthesises of knowledge and creating new knowledge. Here three-dimensional virtual environments are particularly useful.

Three Premises of SUMS

1) SUMS emphasizes clearly between transitory and enduring knowledge. Search engines such as Yahoo attempt this by providing a category for Reference. This covers basic categories such as dictionaries and encyclopedias but overlooks how this subject has its own reference sources. SUMS addresses this problem by identifying different levels of knowledge to distinguish between objective and subjective dimensions (see Levels below). In addition choices in quality and quantity help establish reference standards within a society or internationally.

2) SUMS effectively creates the equivalent of standardised style-sheets through a coherent presentation interface, which is also a set of criteria for searching. One of the fundamental problems of the Internet in its present state is that there is a complete absence of an accepted style-sheet. Hence one author lists articles under Publications, a second under Articles, a third under Papers, a fourth under Reports and so forth. Even the simple distinction of upper and lowercase letters can cause problems for finding materials which have things in common. Some of the efforts at metadata address these problems but will not solve them. Imagine trying to index a book or journal in which every author followed their own eccentric way of documentation with respect to footnotes, headings etc. For this reason publishers impose a common style-sheet, such as the Modern Languages Association (MLA) or Chicago rules, when preparing a work for publication. The Dublin Core Metadata Initiative provides a standard set of terms for searching and presenting facts, the equivalent of a controlled authority list.

3) SUMS separates operating space from presentation space. In most programs the space for making decisions and operations is not separated directly from the presentation space. In Windows, for instance, some decisions are above the workspace, others are below, while subliminal lists continually impinge on the workspace. SUMS separates these spaces by creating a specific area for lists of choices (see below).

Appendix 1. Peresuit's relators in terms of the questions (Who), What, Where, When, How, Why.

What

Subsumptive

Type/Kind

Principle/Manifestation
Species/Genus
Species/Organisation

Whole/Part

Organism/Organ
Composite/Conclusions
Matrix/Particles

Subject/Property

Substance/Accident
Possession/Possession
Accompanance

Where

Ordinal

Positional

Figurative
Spatial
Toward
At
Any

When

Positional

Temporal

How

Ordinal

Conditional

State
Attitude
Energy

Comparative

Degree
Size
Duration
Identical
Similar, Analogous

Dissimilar

Why

Determinative

Active

Productive
Causing
Originating/Source

Limitative

Restrictive

Orienting, Establishing Frame of Reference, Point of View

Destructive

Injuring

Suppressing, Eliminating

Curing

Interactive

Concordant
Differing
Contrary

Passive

Produced
Limited
Destroyed

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Perspective

Following a PhD (Warburg Institute, University of London, 1975) on the history of the two main methods of perspective, the author was invited to prepare a standard bibliography on perspective for the *Convegno Internazionale: La prospettiva rinascimentale* (Milan, 1977) conceived by the late Professor Eugenio Battisti and organized by Professoressa Marisa Dalai Emiliani (now Sapienza, Rome). This work led to the creation of a Perspective Unit at the McLuhan Program in Culture and Technology (1990-1996). The unit offered two graduate courses and was open to educators, scholars and students at all levels.

The Unit then became part of the Maastricht McLuhan Institute (1998-2004). The unit collects materials on the history, theory and applications of perspective, projection methods and spatial concepts. It uses electronic media to explore new approaches to knowledge and education. It houses a standard database with definitions, bibliography (15,000 titles), slide collection (c.12,000 images), microfilms (150), videos and books.

Perspective involves time as well as space. Because it is integrally connected with both the rise of narrative and literacy, perspective offers important insights into the interdependence of western literature and art. Alternative methods in non-Western cultures (aspective, inverted perspective, axial perspective, parallel perspective) are also studied. Because it transforms depicted and real spaces, perspective demonstrates how construction and representation of the man-made world change the world of nature; how mastery of key spatial elements transforms the very concept of environment. Technical applications range from art, mathematics, cartography and astronomy to recent developments in holography, stereoscopy and virtual reality. Metaphorical applications include literature, philosophy, psychology, psychiatry, sociology and anthropology.

A basic goal is to use electronic media to gather what is known on perspective in the form of a knowledge package which serves as a prototype for new approaches to knowledge in other fields. The System for Universal Media Searching (SUMS © 1992-2004) demo combines the format of a traditional book with databases for new multidimensional access to knowledge and information on perspective.

- Perspective SUMS demo

Books

Sources of Perspective
Literature on Perspective

Articles and Reviews

1975 Perspective Institute
1977 Review Lindberg Theories of Vision
1977 Review Edgerton Renaissance Rediscovery of Linear Perspective
1979 Military Surveying and Perspective
1979 Review Wheelock Perspective, Optics and Delft Artists
1980 Panofsky's Perspective A Half Century Later
1980 Problem der Perspektive
1980 Ptolemy and the Origins of Linear Perspective
1980 Review Bek Towards Paradise on Earth
1981 Review Kemp Leonardo da Vinci The Marvellous Works
1982 Visualisation and Perspective
Italian Version
1986 Literature on Perspective
1986 Perspective, Anamorphosis and Vision
1988 Review Ruurs Saenredam
1988 Review Kubovy Psychology of Perspective
1988 Perspective Courses
1991 Review Kemp Perspective Science and Art
1992 Perspective and the Scope of Optics
1992 Space, Time and Perspective in Print Culture and Electronic Media
1993 Developments in Perspective
1993 Computers and Renaissance Perspective
1993 Narrative, Perspective and the Orders of the Church
1984 Review Alpers Art of Describing
1995 Electronic Media, Rebirth of Perspective and Fragmentation
German version
1994 Percezione, prospettiva e rappresentazione nell'America Settentrionale
English Version
1995 Electronic Media in the Study of Alberti
1996 Piero della Francesca and Two Methods of Renaissance Perspective
2001 La ricostruzione storica della citta
2003 Paradoxes of Perspective Ideal and Real Cities
Abstract

See also:

- Perspective
- Leonardo Studies
- New Media
- New Models for Culture
- E-Culture Net
- cv

Kim H. Veltman
Perspective Unit, Europalaan 73, Maastricht CN 6226, Netherlands
Tel. 0031-(0)43-363-5574.
E-Mail kim_veltman@hotmail.com

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New Media and Augmented Culture

The author's Leonardo da Vinci Studies and work on a standard bibliography on perspective brought to light limitations of traditional print media and prompted study of the potentials of new media. In the 1990s this led the author to become an advisor to the Head of Advanced Networks, Northern Telecom (now Nortel Networks) and to the President of Bell Media Linx, linked with Bell Canada. From this emerged two books and a series of articles. This ongoing work is leading to a new demo which surveys developments in new media.

Books
1999 *Frontiers in Conceptual Navigation for Cultural Heritage*, Toronto: Ontario Library Association, 1999.
Understanding New Media: Augmented Knowledge and Culture, 2001 (Calgary: University of Calgary Press, 2004, in press).

Articles

Creativity

2000 Content, Form and Expression
2001 Open Source and Culture
2002 Jewels of Tomorrow
2003 Historical Heritage and Future Creativity
2004 Edutainment, Technotainment and Culture
Italian Version

Education and Research

1991 Knowledge Packages
1991 Databanks in Education
1991 Museums, Education and the McLuhan Centre
1992 McLuhan Global Village Demo Room
1992 National Networked Centre for Education and Training
1993 Electronic Highway and Education, New Doors to Keep Open
1994 Databank on Perspective, the Concept of Knowledge Packages
1994 Knowledge Package Construction
1994 How the Information Society can Transform Education
1995 Art and Science with a Child's Point of View
1996 Acceptance of the CAPIRE Prize, Kos, 1996
1997 Why Computers are Transforming the Meaning of Education
1997 New Roles for Education through the Internet
2001 Response to Keynote Lecture by Donald A. Norman
2003 Roadmaps for Research and Research Topics
2004 Potentials of New Media for Education

Economics
2000 Globalisation et nouvelles technologies les choix: Abstract

Computers

Interface
1994 System for Universal Media Searching (SUMS)
1994 Front-end for Multi-valent, Multi-cultural Searching
1996 SUMS Six Steps in Development
1996 SUMMA System for Universal Multi Media Access
1996 Future Strategies and Visions, SUMS and SUMMA
Abstract
1998 Interfaces for Cultural Heritage
2000 New Interfaces

Internet
1996 McLuhan's Distinctions and the Internet
2002 Domain Names and Classification Systems
2000 Le nommage et indexage comme vision panoptique du réel
2000 MEMECS Namur
2002 Internet domain names and indexing
2004 American Visions of the Internet

Networks
1998 European Network of Centres of Excellence in Digital Culture and ICT
2002 European Networks of Excellence and Japanese National Silk Roads
Abstract
2001 Towards a new European Vision of Research
2001 Need for a Cultural Grid: Abstract
2002 E-Culture Net
2002 European Network of Centres of Excellence for Augmented Digital Culture
2002 European Networks of Excellence and Global Digital Culture
Abstract
2003 E-Culture Net Thematic Network (2003-2004)
2003 Grid for Culture
2003 E-Culture, Art History and Museum Studies
2004 Challenges and potentials for sharing between networks
Short Published Version
2004 Needs Challenges and Thoughts for EU

Knowledge
Memory Institutions
1990 Can Museum Computer Networks Change our Views of Knowledge?
1992 Ubiquitous Museum (UM)
1993 Past Imprecision for Future Standards,Computers New Roads to Knowledge
1993 Marshall McLuhan Information Technology Research Centre
1994 Review Failla Lacche Giapponesi nel Museo Chiossone
1995 Future of Public Galleries in the New Technological Age
Abstract
1996 New Roles for Libraries in the Digital Age
Short Published Version
1997 Digital Reference Rooms
1999 Towards a Global Vision of Metadata. A Digital Reference Room
1999 Digital Reference Rooms:Historical and Cultural Dimensions of Knowledge
2001 Museum im Internet-eine Bildungschance
2001 Developments in Virtual Museums
2001 Répercussions des nouveaux medias
2001 Trends and Perspectives. The New Technologies

Monastery
1997 Proposal for a Monastery of the 21st century
1997 Electronic Monastery for Quality, Subjects and Creativity

Knowledge Organisation
1980 Thoughts on Computers and Knowledge
1981 Proposal Concerning the Reorganization of Knowledge
1981 Reality, Knowledge and Excellence
1983 Thoughts on the Reorganisation of Knowledge

1984 Multidimensional Bibliography and Classification
1986 Review Giesecke Buchdruck in der frühen Neuzeit
1991 Computers and a New Philosophy of Knowledge
1993 Computers as an Historical Tool for Mathematics, Science and Art
1993 New Media and New Knowledge
1993 Computers and the Transformation of Knowledge
1993 Electronic Media and Levels of Interpretation
1995 Images and Words, Fractals and Fuzzy Logic
1996 Content Ordering or Ordered Content
1996 New Approaches to Searching, Teaching, Repairing, Advertising, Selling
1996 Panel Prometheus Unbound Again
1996 Space, Time, Information and Knowledge
1996 Questions and Choices
1997 Hypermedia, New Approaches to Cultural Heritage and Knowledge
1998 Frontiers in Conceptual Navigation
1999 Conceptual Navigation in Multimedia Knowledge Spaces
1999 Maastricht McLuhan Institute Mission
2000 Cultural and Historical Metadata. MEMECS
2000 New Media and Transformations in Knowledge
2000 Augmented Knowledge and Culture: Abstract
2001 Syntactic and Semantic Interoperability
2002 Frontiers of Digital Interpretation
2002 Books, E-Books and Augmented Books
2002 Challenges for a Semantic Web
2002 Four Ways that Digital Communications are Changing Scholarship
2002 Connectivities of Content, Context and Communication
2002 Standard and Variant Names and Classifications
2003 Challenges for ICT Applications in Culture in the Next Decade
French Version
2004 Kultur und Wissen im digitalen Zeitalter
English Version
2004 Towards a Semantic Web for Culture
2004 Challenges for the Semantic Web and Information systems from Culture
2004 Infrastructures for Ways of Knowing
2004 New Ways of Scholarly Work in a Networked World | Lecture

Visual knowledge
1981 Proposals Concerning a Chair in Visual History
1993 Computers and the Visual Arts
1993 Electronic Media and Visual Knowledge

Virtual knowledge
2000 Virtuality and the Discovery of Reality
2001 Scientific Visualisation and Virtual Worlds
2002 Challenges of Virtual and Digital Culture
2003 Being There and Here New Forms of Interactivity

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New Models for Culture

The author's studies of perspective and culture during the 1970s and 1980s led gradually to a conviction that standard histories of art and culture (e.g. Janson, Summers) are much too Eurocentric. How can Europe, which is less than 5% of the world population create new models of culture which re-assess Europe's contributions and at the same time duly give credit to other cultures throughout the world? A central premise is that Europe's uniqueness is to be found less in its exclusive symbols and more in its inclusive approaches to knowledge and culture. This work has led to a number of articles and is leading to a series of courses for the Paris branch (Internet, Philosophy) of the new European University of Culture scheduled to open on 1 September 2005.

Courses: Roadmaps for New Europe
Seminars
1. Fundamental Premises
2. Europe and the World
3. Individuals and Schools in Cultural History and Cultural Studies
4. Methods in Culture, History, Historiography

Lectures
5. Towards a New Model for Culture

Articles

Culture
1995 New Media and Copyright from an International Viewpoint
1996 Future of the Memorandum of Understanding (MOU)
1997 What Must be Done to Realise these Scenarios
1997 Why Culture is Important
1997 Frontiers in Electronic Media
1998 Computers and the Importance of Culture
1999 World Access to Cultural Heritage. An Integrating Strategy
2000 Augmented Books, Knowledge and Culture
2001 Promoting the Future of Online Culture
2000 Challenge of Augmented Culture: Abstract
2001 Developments in Digital Culture
2003 Challenges for ICT in Cultural Heritage
French Version
Spanish Version
Expanded Version for Book
2004 Europe's Cultural Heritage in the Digital Age
2004 E-Culture Net and a New European University of Culture

Art
1986 New Classification for Art
1990 Progetti computerizzati nella storia dell'arte
1999 Goals of Culture and Art
Abridged
2001 History of Art About and by Means of Computers

Diversity
2001 Can Culture Survive in a Global Village? Abstract
2001 Cultures et langues de l'Internet
English Abstract
2002 Media, Languages and the Integration of the Processes of Communication
2003 Contemporary World Issues in Cultural Diversity
French Abstract
2003 Towards New Cultural Histories in a Networked World
Russian Version
2004 Learning and Communicating with Old and New Media

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Leonardo da Vinci: Studies

Following a doctorate in the history and philosophy of science at the Warburg Institute (London 1975), the author was invited to work with the late Dr. Kenneth D. Keele, M.D., F.R.C.P. as a senior fellow at Wellcome Institute for the History of Medicine (London 1975-1977). This was followed by further years of post-doctoral fellowships at the Herzog August Bibliothek (Wolfenbüttel) during which time Dr. Keele remained a mentor. This resulted in books and articles. Ongoing studies are leading gradually to a first Collected Works of Leonardo which is being developed as one of the SUMS demos.

- Leonardo da Vinci SUMS demo

Books

1. Linear Perspective and the Visual Dimensions of Science and Art, (Deutscher Kunstverlag, Munich) l986.
2. Leonardo's Method, Brescia: Centro Studi Leonardiani, 1993.
3. Continuity and Discovery in Optics and Astronomy (2 vols. 600 pages each, unpublished)

Articles

1979 Leonardo's Perspective and Optics
1980 Studi di Leonardo sull'ottica
1982 Leonardo Studies Progress Report and Long Term Plans
1983 Thoughts on a Microfiche Roll Edition of Leonardo
1985 Review Leonardo da Vinci Anatomical Drawings
1985 Groteske Köpfe
1986 Collected Works of Leonardo da Vinci (Plan)
1986 Leonardo and the Camera Obscura
1987 In memoriam Dr K D Keele
1992 Methode und Struktur in Leonardos Werk
1992 Leonardo da Vinci zum menschlichen Körper
German Version with Coloured Plates
English Version
1997 Review Leonardo da Vinci CD ROM Corbis

See also:

- Perspective
- Leonardo Studies
- New Media
- New Models for Culture
- E-Culture Net
- cv

Kim H. Veltman
Perspective Unit, Europalaan 73, Maastricht CN 6226, Netherlands
Tel. 0031-(0)43-363-5574.
E-Mail kim_veltman@hotmail.com

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Kim H. Veltman

14 CLASSIFICATION

1. Introduction
2. Optics
3. Perspectives
4. Definitions
5. Descriptive Elements
6. Theories
7. Conclusions

1. Introduction

From the outset, the classification of perspective proved problems. Etymologically it was linked with optics, which was a subject that was not generally accepted as it was linked with architecture, which equally eluded simple classification. By the nineteenth century the nature of the problem began to come into focus. Systems of classification had longer histories in other disciplines. Perspectives could be classified according to their subject matter, their purpose or their geometrical underlying. Perspectives had the embarrassing characteristic of belonging clearly to all of these. It belonged to art, because it created special effects in paintings and it was accordingly classed under drawing. At the same time it was a subject that was taught in schools of architecture and was accordingly classed under building. Perspectives could also be classed according to its use by famed artists or famous geometers. Finally it also involved assumptions such that it was also classed under technology. These broad groupings, plus the historical one concerning it with mathematics, meant that it concerned in the Library of Congress classification to this day. On the surface, this was merely a matter of semantics, a search for convenient cubbyholes in the case of a bonkless subject. There were, however, deeper implications. Each of these groupings had its own tradition, its own assumptions and its own terminology. Perspectives belonged to all these categories to the extent that, when the artistic aspects of perspective came under fire, it could reasonably appear to some that perspective had died although the number of treatises on perspective in these other disciplines could be shown to be increasing exponentially. Perspectives had been a victim of its own success. Because perspectives of one kind or another had become so ubiquitous, it was assumed that an alleged decline in the connection with drawing meant that perspective became entangled in conflicting philosophies of artistic education and was accordingly in decline. In fact, it was in decline in certain circles but was simultaneously growing in other disciplines and was undergoing a transformation in its own discipline. The nineteenth century was a period when mathematicians had established the mathematical foundations of perspective. These were further clarified by Guidebolds del Monte and Jacques Ozanam. Perspectives had been a subject taught in academies of painting and architecture and had been taught in universities since the sixteenth century. As a result of the growth of the sciences and the rise of the modern geometry, this more general concept embraced both descriptive geometry and perspective. The problem of classification was complicated by the fact that perspectives could be based on various geometries. Finally it also involved assumptions such that it was also classed under technology. These broad groupings, plus the historical one concerning it with mathematics, meant that it was also classed in the Library of Congress classification to this day. On the surface, this was merely a matter of semantics, a search for convenient cubbyholes in the case of a bonkless subject. There were, however, deeper implications. Each of these groupings had its own tradition, its own assumptions and its own terminology. Perspectives belonged to all these categories to the extent that, when the artistic aspects of perspective came under fire, it could reasonably appear to some that perspective had died although the number of treatises on perspective in these other disciplines could be shown to be increasing exponentially. Perspectives had been a victim of its own success. 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The problem of classification was complicated by the fact that perspectives could be based on various geometries. Perspectives could also be based on various sciences and objects, was classed as a subset of a new visual method. Meanwhile, where perspective stands in relation to other disciplines, it is a subject that has been classified in various ways. The purpose of this chapter is to try to give further insight into these problems of classification it will be useful to consider each of them in turn.

2. Optics

Etymologically, both the term for linear perspective and for optics stemmed from the Latin, perspectiva.[1] Already in the fourteenth century, Bradwardine had distinguished between "two kinds of sight, one by direct rays and another by bending with by geometrical perspective."[2] Perspectiva was also used interchangeably with optics in the second sciences.[3] which subsequently led to its being classed among the mechanical arts by some mediaeval writers.[4] Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[5] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[6] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[7] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[8] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[9] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[10] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[11] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[12] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[13] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[14] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[15] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[16] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[17] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[18] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[19] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[20] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[21] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[22] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[23] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[24] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[25] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[26] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[27] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[28] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[29] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[30] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[31] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[32] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[33] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[34] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. 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Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[39] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[40] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[41] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[42] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[43] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[44] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[45] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[46] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[47] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[48] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[49] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[50] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[51] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[52] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[53] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[54] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[55] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[56] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[57] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[58] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[59] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[60] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[61] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[62] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[63] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[64] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. Although perspectiva was used by Bradwardine and others to refer to the study of the mechanical aspects of the mediaeval sciences liberal[65] arts and yet, ironically, by the late thirteenth century, it emerged as chief of the sciences liberal[66] arts. Although it was a subset of optics, it was also a subset of the mechanical arts and was accordingly classed among the mechanical arts. 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shades and shadows in the process. This in turn inspired a clearer formulation by the brothers Ferdinand and Alexandre Dupuis (pl. 1820-1840), who argued for the use of both geometrical and perspectival models in the process of nature drawing.[72] This approach won such acclaim that it was introduced into Germany in the next decades by Wolfgang (1825-1874), Fristeberg (1854) and Dornschke (1876), and into the Netherlands by Parv. (1853). Bergmann's pioneering work (1857) and Schmid's (1869) were followed by a series of German books on nature drawing which emphasized the use of perspective, namely, Seeberger (1871), Huther (1872), Audel (1880), Kuchinka (1880), Lang (1880), Steigl (1880), Kajetan (1881) and Gennerich (1882). The result of these developments was that perspective became integrated into the whole spectrum of drawing, ranging from natural objects, and man made objects to imaginary landscapes and architecture. Perspective was given a brief consideration in some of the key programmes. In the Encyclop.die (1754) drawing was defined as the art of imitating and the chief objects of study were listed as the human figure, animals, landscapes, draperies, flowers and fruits.[73] Joseph Schmid's programme for imagination via models had five basic steps: 1) exercises for the education of the hand for drawing; 2) drawing exercises in making and inventing beautiful forms; 3) exercises which lead to development and comprehension of the forms in perspective; 4) exercises in real or imaginary perspective of natural objects and 5) exercises in perspectival development.[74] Peter Schmid's programme for nature drawing via models had four steps: 1) bodies of plane figures; 2) bodies of curved figures; 3) practical perspective; and 4) shades and shadows.[75] His successors, the brothers Dupuis, took for granted the use of perspective in their programmes and concentrated on defining more precisely the models to be used. Ferdinand Dupuis outlined five levels of inorganic models: 1) simplest geometrical figures; 2) simple geometrical figures; 3) composite geometrical figures; 4) characteristics of one and two dimensional heteromeric figures; and 5) furniture, ceilings, pillars, columns and ornaments.[76] Alexandre Dupuis had a four stage programme for more organic forms: 1) heads, plastercast, and live; 2) human form; 3) ornament; 4) flowers.[77] Bergmann's programme (1857) read like a synthesis of the two: geometry, light, flowers, ornament, landscape, figures, animals, perspective, light and shade.[78] The Universal dictionary of the nineteenth century (1870), in its article on drawing, cited a passage by Delacroix, which gave some indication of his important perspective had, in the meantime become a "tool" which had to be reproduced. It was not just a tool for the artist, it was a tool for theory, but it appears and this is the task of the person who draws and the painter. The latter achieves by means of gradations of tints that which the other began by means of proper disposition of lines. In a word it is perspective which one needs to place, not in the spirit, but in the eye of a student. I will say to the instructor: with your proportions and perspective by the pupils, you will not teach him other things than what he knows in his eyes... Whatever be the object that a person who draws proposes to reproduce, they are still obliged above all to know and to respect the laws of perspective. There is linear perspective and aerial perspective. The former, for which descriptive geometry furnishes the rules, suffices for drawing, which only makes use of projections [and] contours. The second, which has as its object the gradations, shades, which play in the air, is a kind of perspective which modifies its application in coloured images, either monochrome, as are drawings in sepin or china ink, or multicoloured. One might say that on a canvas, drawing gives the linear perspective and colour the aerial perspective.[79] The latter part of this passage is particularly interesting because it suggests that the earlier debate of line versus colour, of the Rubenists versus Poussinists had now been resolved through a synthesis of the two, between colour perspective. Even more instructive was the section on drawing in the Dictionary of Pedagogy (1881). The author emphasized the importance of perspective and noted that: the developed theory of perspective gave cognizance of the procedures imagined by geometers in order to obtain optical appearances in all cases in which it is necessary for a professional painter and especially an architect to know how to execute the same.[80] It was conceded that: "the goal of study is drawing after nature and the first step in the preliminary study begins with the study of geometrical forms and drawings based on a model."[81] This elementary course was, however, considerably more complex there one might imagine as becomes clear from the teaching in elementary schools as reported in the Dictionary (1881): Elementary Course: Tracing of straight lines and their division into equal parts. The evaluation of the relation of lines to one another, reproduction and evaluation of lines. First principles of drawing of ornament. Circumferences regular polygons, stepped moes. Copies of geometrical figures and ornaments. Low relief. First notions of geometrical drawing and elements of perspective. Geometrical representation in projection and perspectival representation in projection, then with shadows of geometrical solids and simple ordinary objects. Geometrical drawing. Use (at the board) of instruments serving the tracing of straight lines and circumferences: rule, compass, square and protractor. To limit oneself in this part of the course, to have pupils understand the use these instruments of which they will acquire skilled use in the upper level course. Upper Level Course Drawing with a raised hand Drawing after an engraving and after a relief of purely geometrical ornaments, mouldings, ovals, heart-shaped spokes, indentures, etc. Drawing after engraving and relief ornaments taking their form from the realm of vegetation, leaves, flowers, fruits, little pulvinites, Indentures, Greek ornaments. Lessons on the theory of shadows. Explanation of the blackboard by the teacher (3 lessons). Drawing in the human body: its parts and proportions. Geometrical drawing. Execution on paper, with the help of instruments, geometrical traces which have been made on the board in the middle level course. Principles of wash drawing with flat tints. Drawing reproducing motifs of decoration of plane surfaces or of a low relief: Mouldings, Indentures, Spokes, ceilings. Wash drawing in shades and in the colour of a number of these drawings. To bring into relief with dimension figures, with sides, and geometrical representation in projection of geometrical solids and simple objects such as assemblages of timber, woodwork, exterior dispositions of apparatus of stone, big pieces of ironwork, furniture of the most ordinary type, etc. Use of wash drawing to express the nature of materials. Wash drawings of plans and maps.[82] Most interesting of all was the philosophy that lay behind this process. It was not just a matter of teaching the gifted to draw well. There was a conviction that the study of: drawing should not only guide a group of those who would devote themselves to acquire the talent of representing visible things either by pure imitation or in imagining and in inventing in this way to the point of art, and also for those who would not aspire to acquiring this talent, but who would be in a position to acquire in pursuing this study, if one founded it on the imitation of excellent models would teach them what is, in fact, exact or inexact, correct or incorrect, beautiful or ugly, graceful or ungraceful, suitable and unsuitable, such that it would thus teach to see better and to judge better and that it would form, finally, [a good] eye and taste, the usefulness of which is almost universal.83 This passage helps to understand why drawing had become universal, why methods which had in the sixteenth century been aimed only at a select body of professions (painters, architects, goldsmiths, etc.), had spread in the seventeenth and eighteenth centuries to artistic schools and academies, and in the nineteenth, to trades, secondary schools, primary schools and ultimately all interested laymen. Drawing, and the perspective it entailed had become part of learning how to see, a basic tendency in a level of mass culture which was as equivalent to civilization itself. Ironically once perspective had become so integral a part of drawing, it became typical to think of it as a part of drawing and hence overlook the many titles relating to perspective as they appeared.

6. Mathematics

The changing relations between mathematics and perspective are no less complex. Any attempt at a thorough treatment would lead far more deeply into the history of mathematics than is here possible. For our purposes it may suffice if we outline the shifts in the classification of mathematics as reflected in mathematical consciousness of books on perspective. The latter fifteenth century brought a particular fascination with the concept of proportion which led the Dominican friar, Luca Pacioli (1494), to compose his monumental Compendium of geometry, proportion and proportionality. For Pacioli, perspective was a branch of proportion and for this reason his compendium became the first printed book to deal with perspective in a subsequent sermon on August 1508 (see p.) he praised the universal applicability of proportion, mentioning perspective in connection with painting in a long list of disciplines which if attended, namely, theology, philosophy, medicine, astronomy, chorography and cosmography, architecture, inventors of machines, painters, sculptors, musicians, poets, rhetoricians, grammarians, lawyers, mathematicians and all types. In latter part of the sixteenth century, Barbaro (1569) wrote a book on measurement of distance, heights and depths to which he added three books on proportion and proportionality. This fascination with proportion as an organizing category was an inspiration for the proportional compass or sector in the early seventeenth century and the resulting books by Faulhaber, Brauner, etc. maintained the idea of perspective as a branch of proportion. Kepler (1571-1630), Marolois, Euclid (1615), Hondius (1623), wrote books on perspective, and during the mediaeval Arabic tradition, surveying emerged as an important part of optics. With the development of perspective there were also connections between perspective and surveying, whereby perspective became associated with measurement in the tradition of Dürer, and actually identified with measurement by the author of the book edited by Rodler (1531). Perspective in this tradition was more consistently treated as a mathematical discipline, literally, to mean measurement of the earth, (yn metrwy). As a result geometry and perspective were in some senses synonymous. However, the systematic programme of reviving classical mathematics which began at Urbino with Commandino and Guidobaldo del Monte, meant that perspective was increasingly listed under optics as a fundamental branch of optics. This process continued through the eighteenth century, Lambert and Euler. In the final decades of the century this tradition led individuals such as Tinseau d'Amondas (1777, 1780) and Monge (1785, 1795, 1798, 1799) to integrate developments in practical disciplines such as architecture, dialling, stereotomy, (Frézier), perspective, and surveying in the theoretical discipline of geometry. In the first decades of the nineteenth century this new field evolved mainly in Paris, through Monge (1811, etc.), Hachette (1815, 1817, 1820, 1827, 1838), Potier (1816, 1817) and Vallee (1819, 1822, 1828), Duchesne (1828, 1829), Olivier (1831, 1839, 1840, 1842, 1844, 1847), Leroy (1834, 1837, 1838, 1842, 1845, 1846), Bardin (1837), Mathieu (1843), Crodel (1844), Jacotin (1848), Poudra (1845, 1862), Poudra and Pillet (1860) spread to other countries including Italy (Tabacchi, 1813), Karlsruhe (Schreiber, 1822, 1828, 1833, 1839), Rome (Soreni 1826), New York (Davies 1826, 1844), Cambridge (Hayward 1829), Berlin (Wolff 1835, 1847), Munich (Haindl 1835), Nrnberg (Gugler 1842), Winthertur (Ziegler 1843), Vienna (Stampfl 1847), Pavia (Pasi 1844) and Padua (Tabacchi 1844). Descriptive geometry now became a general heading under which perspective was classed. Tabacchi (1813) was one of the first to relate perspective to descriptive geometry in Italy. Hachette (1823) was probably because he was the first to include descriptive geometry in his New elementary treatise of perspective. As he explained in his preface: It happened to me on several occasions that I asked artists who told of their desire to know perspective, whether they had any hint of the first elements of geometry. They replied negatively saying that they had no need thereof, that they wished to know only one rule for drawing their painter's perspective, and that they only one rule for drawing their painter's perspective. In my opinion expressing such a desire would be like asking to write without wanting to learn to read. My way of reasoning soon convinced them, but never quite persuaded them altogether. I did, however, observe that among those who turned to me, those who resigned themselves to study the preliminary principles, learned perspective easily and truly, whereas those who in the beginning should not have been, I said, to the rule, reduce the elements of perspective to its essential elements and place them at the disposition of readers without any notion of mathematics, which is fortunately quite rare. I have therefore divided this work into five parts. The first part deals with elementary geometry which I have stripped of all matters foreign to our subject, such as those concerning the measurement of surfaces, etc. The second contains the elementary principles of descriptive geometry, which is nothing more than a consequence or application of the principles of part one. The third deals with that part of optics which concerns our subject directly, namely optics considered with respect to painting rather than to physics. The fourth deals with the rules of projections of shadows very necessary not only for painters, but also for architects, designers, etc. The fifth deals with perspective, properly speaking, and the linear perspective to which I propose to deal.84 Haindl (1835), included descriptive geometry as part one of his, Course on the science of drawing and, as mentioned earlier, Brisson (1827) developed a Theory of shadows and perspective, which was subsequently appended to editions of Monge: (e.g. 1838, 1847, etc.). In the second half of the nineteenth century this remained a part of descriptive geometry with a number of publications in Paris by Leroy (1850, 1859, 1861, 1865, 1867) and Olivier (1851, 1863, 1866), a popular new work by Catalan (1850, 1857, 1861, 1864, 1867, 1868) and others by Babinet (1850), Amiot (1852, 1869), Bisson (1856), La Gournerie (1860), Hughes (1864), Du Peyrat (1865), Dalivalle (1869, 1894), Pillet (1879, 1899), Lagrange (1877) and Martin (1897). Cunningham (1867) in his, Notes on the historical method and technical importance of descriptive geometry,85 assessed these developments in terms of three trends: a move towards descriptive geometry as a science in France; in relation to the art of drawing in Germany and an independent movement in England, which emphasized practical geometry (fig.). With the advantage of hindsight it is possible to recognize further trends which offer a corrective to this picture. For instance, in 1862, Lamé, who became a mathematical physicist, wrote certain texts on descriptive geometry by Wooley (1850), Heather (1851), who was translating the ideas of Monge; Binns (1865, 1867), and Millar (1878). In New York, interest which had been sparked by Davies (1826, 1844, etc.) was developed by Warren (1860, etc.) and Mahan (1867). In Italy, interest in descriptive geometry was focussed in Northern cities such as Padua (Bellavitis, 1851), Turin (Plana, 1888), Milan (Brioschi, 1888), Pavia (Casorati, 1888), Bologna (Cerebile), there were four German speaking centres which emerged: Leipzig (e.g. Bnau, 1852; Schreiber, 1865 and Wiener, 1885), Berlin (Stoevesandt, 1856; Pohlke, 1860, 1873; Wolff, 1861; Flohr, 1866); Vienna (Heissig, 1859; Schleisner 1871; Fialkowski 1882) and Stuttgart, (Gugler, 1856, 1875, 1880; B"lken, 1866; Riess, 1871; Schaefler, 1871). In these developments descriptive geometry was a number of publications in Paris by Leroy (1850, 1859, 1861, 1865, 1867) and Olivier (1851, 1863, 1866), a popular new work by Catalan (1850, 1857, 1861, 1864, 1867, 1868) and others by Babinet (1850), Amiot (1852, 1869), Bisson (1856), La Gournerie (1860), Hughes (1864), Du Peyrat (1865), Dalivalle (1869, 1894), Pillet (1879, 1899), Lagrange (1877) and Martin (1897). 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