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# ***Multimedia systems and cognitive aspects in the training of airline pilots***

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<b>Introduction</b>	<b>pag. 3</b>
<b>1 Basic Theoretical Training</b>	<b>pag. 4</b>
1.1 Transition Courses	pag 9
<b>2 Audiovisuals in Training</b>	<b>pag. 11</b>
2.1 Video Tapes	pag. 14
2.2 C.B.T. (Computer Based Training)	pag. 18
<b>3 The Multimedia Interactive Systems in connection with the Cognitive Aspects of the Training</b>	<b>pag. 29</b>
<b>Bibliography</b>	<b>pag. 47</b>

## *Introduction*

The aim of this study is to illustrate the way in which audiovisual and multimedia systems in general are used in the training of technical, navigation personnel in the airline industry.

By using Alitalia's training structure as a model of reference (an airtransport company of the I.R.I. group), the instruments used in the last ten years as auxiliaries in the training of airline pilots will be described.

The transformations of these didactic models have (by keeping up with technological innovations) produced some observations, arising from which are the mental processes that underlie an individual's capacity to learn and remember. Also under examination are some aspects of perception and learning that seem strictly linked to the potentiality of newly available auxiliaries, be they audiovisual, computer related or multimedia.

It will be the objective of this report to differentiate the audiovisuals into diverse types that distinguish themselves by their capacity to work out certain tasks.

Using material currently in use in the training of airline pilots, advantages and disadvantages will be assessed, with particular attention given to the most recent systems in use that integrate videodisk and computers.

A very brief look at the prospective future will conclude the research.

For those readers already familiar with the material concerning "training and aviation", it is advised that you go directly to Chapter 3 thereby avoiding the description of the systems used in the past.

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I would like to thank Francine Bercich for translating this text into English. She has undoubtedly been put to the test with this demanding interpretation which, even for a mother speaker of Italian, contains difficult and esoteric terms.

I am not capable of evaluating the final result as my knowledge of English is not that proficient, however I am sure that, given the task involved, she has done an excellent job.

## *1 Basic Theoretical Training*

The training of an airplane pilot encompasses many phases and extends for the entire period of his or her operating life.

To pilot an aircraft requires the skill and application of a vast number of rules and procedures that are continually modified, evolving at the same pace as the changes of the methods that are used both in the air and on the ground.

Moreover, along with the continual updating of the procedures concerning new skills and flying regulations that the increase in air traffic necessitates, airline pilots from most airline companies also have to operate different machines at different times during their careers.

Obviously, continual and appropriate training is indispensable, and it is therefore easy to understand the amount of attention that the airtransport industries give to training, which is of extreme importance both economically and for the public image which comes from the final quality of the results.

A key word in the airtransport industry is in fact "Safety", and right from the beginning companies have been selling their image on the total reliability of their pilots and their machines.

But training costs and the need to remain competitive in the market place require the optimization of the available energies and resources in order to obtain the best results in a time that is, within reason, the briefest possible.

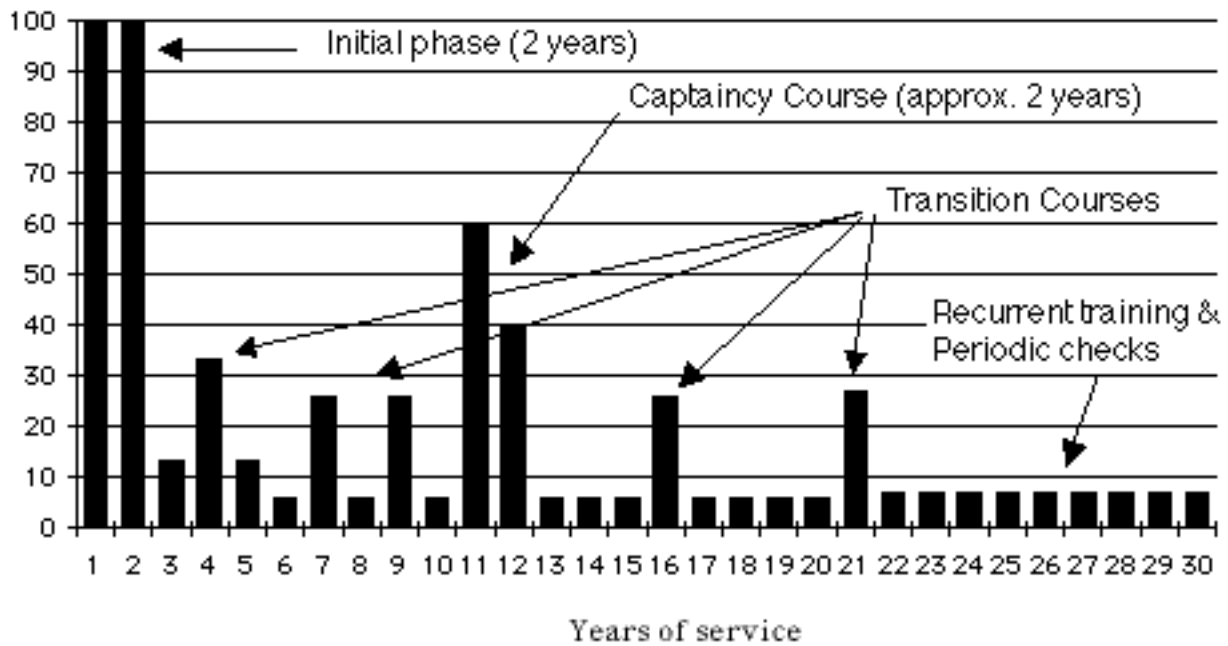
To train a pilot to his/her starting level today takes on average two years.

That is to say that in two years of continuous training, a student, even if s/he already has a private pilot's licence, can move up to the first step on the long career that will see him/her pass from First Officer to Captain, through different types of planes and with the relevant training courses, the last of which is the course for qualifying as a captain.

We can attempt to illustrate the procedure approximately by using a graph showing the average percentage of days spent training and the relative cyclic controls; controls that an airline pilot has to carry out from the moment s/he begins the first phase of training until the time s/he finishes his/her professional, active service.

The example is based on the data relative to the average outcome of flying activities and training carried out by our national airline, Alitalia.

% Flying hours / Training hours



As can readily be seen, a good deal of an Alitalia pilot’s flying service is carried out in training and, at certain times during his/her career, even after the purely initial phases, more than half of the activities performed are considered to be instruction activities.

The relationship between the number of flying hours and the number of training hours does not, however, highlight the part of the schooling that goes on on the ground as an auxiliary introductory course to the flying phase. Not all the training hours have to actually be considered as flying hours of training. Indeed, a great deal of these hours is spent away from the planes and, therefore, far from the area in which the pilot is directly productive to the company.

To have a more precise idea of just how many courses the company has to carry out annually, it is necessary to examine some of the data concerning approximately 2,000 Alitalia pilots.

When entering the company every pilot is put in at the end of an ordered list of seniority respective to his/her appointment. This list comprises all the pilots in the company. With this “List of Seniority” the adjustments (changes of plane or of qualifications) that the pilot will have to make during his/her career can be regulated.

Thus, the amount of training that the airline pilot receives is not only determined by the specifics of his/her job. In fact, it might seem that apart from the initial training that puts the pilot in a position to “pilot” a plane, the rest concerns the experience which, in every profession, is a matter of time rather than instruction.

In reality though, the career of a pilot brings about some changes in his/her job that not only require the ability to pilot, which is generally the same for every type of plane, but also just as important is the knowledge of different types of equipment and instrumentation, both in practical and mental terms.

To clarify the complex series of professional changes that take place during this career, a brief illustration can be given pointing out the subdivision in grades and levels.

The grades, from the lowest to the highest, are:

- a) - Pilot
- b) - First Officer
- c) - Senior First Officer\*
- d) - Captain
- e) - Senior Captain\*

Excluding the “Senior” grades, that indicate only the attainment of an age in the grade and therefore do not contribute to determining a difference in career that would require new training, we can define two groups that in reality are distinguished by two different Lists of Seniority.

First group: Pilot Seniority List (comprising simply Pilots and First Officers).

Second group: Captain Seniority List (comprising all Pilots that have passed the necessary tests for the course of captaincy).

Besides this there is a second subdivision which goes together with the subdivision of the grades; it is the subdivision for levels, that is to say for the type of plane flown.

The recently appointed pilot begins his/her career flying planes in a short radius (DC9-30 or MD-80). Then, after a few years, s/he moves onto larger planes and with a wider radius of action (Airbus A-300 or A-321), to then finish his/her piloting career on intercontinental flights (BOEING 747,767 and McDonald Douglas MD 11).

During this stage s/he generally passes the ministerial minimum number of flying hours (and therefore of experience), as well as the required seniority in order to be called by the company to follow the training courses for captaincy.

In the case of a negative outcome s/he remains in the position attained before s/he had joined the course which, in general, is as First Officer. (Long distance planes Boeing 747,767 or MD11).

In the case of a positive outcome on the other hand, s/he is redispached on to smaller crafts, and for shorter distances (DC-9 or MD-80), this time though as Captain.

S/he will later leave the superiority list of Pilots to go to the bottom of the Seniority List of Captains and, in the course of time, as those most senior to him/her stop working, s/he will continue as Captain on increasingly larger planes until the end of his/her career.

A few graphs will be able to better show the number of courses foreseen each year, both for “passenger craft” and for new appointments. These appointments are related to the physiologic shortage of personnel and the increase in predicted activity, and confirmed by the recent acquisition of planes.

We can begin by showing a table which indicates the development plan for the air fleet, spanning eight years, and relevant to every single type of aircraft.

Development Program of the ALITALIA Fleet

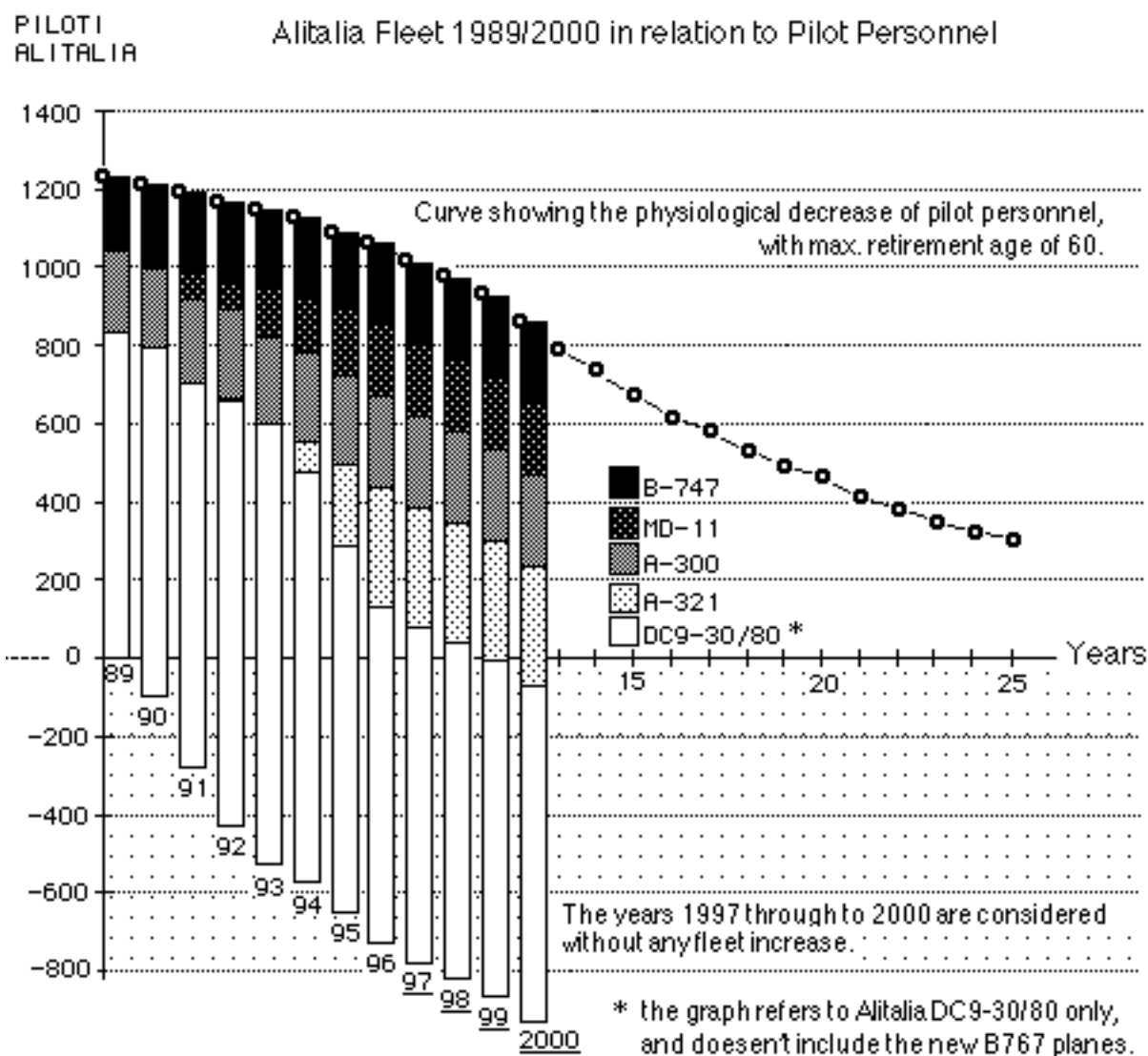
	1989	1990	1991	1992	1993	1994	1995	1996
B.747	11	12	12	12	12	12	12	12
B.747-F	1	1	1	1	1	1	1	1
B.767							3	6
MD11			4	5	8	10	11	13
A-300	14	14	15	15	15	15	15	15
A-321						5	13	20
MD.80	42	51	58	72	76	83	92	97
DC9-30	43	43	43	38	38	26	10	
TOT	111	121	133	143	150	152	157	164

The following graph shows, on the other hand, the superposition of this fleet development program in relation to pilot personnel (comprising pilots and captains).

The combination of this data, and its visualization in graphic form, highlights the number of new pilots to be appointed and, therefore, trained from scratch in the next few years. In the upper part pilots already on staff are cited, while in the lower part are those of the next probable appointment.

The graph, as indicated, takes account of the physiologic decrease of personnel relative to the maximum retirement age, that for pilots is sixty. But it is probable that many of them interrupt their working career at a younger age, taking into account the fact that the minimum retirement age is fifty.

This graph was calculated before the fusion between Alitalia and minor companies using the relative data from pilot and plane forces only .



From the above it is evident that for every one of the more than one thousand Alitalia pilots about six “Machine Transition courses” are foreseen during their career. This is without taking into account the fact that the company frequently acquires new models of airplanes or the exclusion of obsolete ones from its fleet.

## 1.1 Transition Courses

We can now examine only one of the more frequent phases of this continual training, called the “Transition Course”.

This phase, repeated several times during flying service, is one in which pilots are taught the systems and the equipment of a new plane, as well as the various relevant procedures of use, both normal and emergency.

With the transition courses it is possible to obtain the ministerial and piloting qualification of a specific aircraft.

It should be taken into consideration that at Alitalia, after a few years of service duty on other planes, pilots return to flying the same machines on which they had previously qualified. Also in this case unfortunately, given the amount of time elapsed, it will be necessary for the pilot to again follow a transition course in order to regain the qualification required for that specific machine.

For this transition course, as for all the others, there are three phases:

- Ground Course (with a final company exam)
- Flight Simulator (with a final company exam)
- Training flight and qualification (with a ministerial exam)

Let us now exam only the subdivision of the first phase of a machine transition course: the Ground Course.

The Ground Course, defined also as the “systems’ understanding” phase, is carried out in three different areas and at three different moments, the one interdependent on the other.

There is a phase in the classroom in which, by means of the use of audiovisual equipment, one gets a general knowledge of the plane systems. Linked to this, there is the part of CPT (Cockpit Procedure Training) and in parallel, CSS (Cockpit System Simulator), both kinds of airplane cockpit, static simulator through which the student has the possibility of visualizing the procedures for the workings of the system, for which he has already had instruction in the classroom.

The first part of this course, which is the theory covered in the classroom, is done using an audiovisual system (including videotapes and slides + audio) which take the place of the instructor.

Both the videotapes and the audiotapes combined with the slides, are controlled directly by the students. They are required, however, to observe a rigid schedule of projection in order to be able to combine the hours of the audiovisual with the hours of the following interconnected lessons of the CPT (Cockpit Procedures Trainer), and the CSS (Cockpit Systems Simulator. The CSS and CPT phases, in contrast, are still carried out with the help of Ground and Command instructors that, following a pre-set order of tasks to be performed, allow the student to recognize, although not necessarily at this stage to understand, the various normal and emergency procedures that s/he will be required to know how to apply in the subsequent training phase of flight simulation.

This type of categorization and standardization of the various training phases is, in reality, only the last link in a chain of methods used over the decades of aeronautics' practice.

Previously, the subjects, systems, and procedures were taught by different instructors to classes full of students. The necessity, however, of guaranteeing a positive level of standardization of the information supplied, and probably the need to keep the costs low for everyone on the course have, with time, transformed what were initially only visual teaching aids, into complete and autonomous systems. The figure of the instructor, still present in that transformation phase of the courses, is reduced as a result of the apparent richness of information that is supplied, thanks to the arrival of the videotape and entire videoed lessons.

Helped by the integration in the same period of the CSS and CPT, the classic lesson with instructor and various accessories has lost importance, and is split into different phases that still today make up a transition course.

Let us examine in more detail the various phases of this slow transformation that the audiovisuals and new technologies in general have produced in the world of training airline pilots; a world continually evolving which count on another fifty years of practical, didactic experience; practice begun in a rigidly military field and continued now, in larger measures of student numbers and investments, also in the civil arena.

## *2. Audiovisuals in Training.*

Let us begin by talking about the most simple auxiliary, audiovisual technique with which some parts of the pilot flying course is now rarely explained i.e. the projection of slides combined with listening to an accompanying tape.

The most positive characteristics of the slide projections, linked and controlled in sequence by audiotape, are found in the conditions which need to be created in order to follow the projection. But we will soon discover that, as happens for many of these innovations, the immediate advantages if used improperly, risk impoverishing the didactic qualities of the courses that use it.

In general the situation is that typical of the cinematographic projection: big screen, a dark room, high dose of concentration and absence of almost all “lateral” disturbances, audio or visual.

But the absence of disturbances also signifies the possibility of a greater concentration of information per time-unit. And this is where the first problem originates.

It is improbable enough, in fact, to prove concentration and involvement through a sequence of slides that shows switches and systems due to the fact that it cannot be treated like a story or a narrative. In this situation also there is a risk that a part of what has been said will be lost by the minimum distractions.

The impossibility then, or at least the difficulty of interrupting the projection, involves the duty of endeavoring to perceive all that has been said and shown, with the difficult task of retaining all the information covered.

The advantage easily risks turning into a defect.

If, in fact, with the audiovisual auxiliary of the teacher, the projection becomes the substitute for it, one of the essential conditions of training is lost, and that is the re-elaboration of the information received which makes it individual property.

Unfortunately (for this type of audiovisual), the mind does not learn in a linear fashion but through interruptions, repetition and connections. All are difficult forms to propose in the form of a unidirectional, informative package.

What is more this information has to be received, evaluated, and assimilated in order to become part of the knowledge.

It is not difficult, however, to imagine how access to a large and diversified quantity of information, allows the area dealt with to be more easily controlled.

Because, in the first place, with a large volume of information it is obviously possible to cover unexpected blanks, or omit what is already known. In the second place, because it is the interaction between what we already know and what is subsequently learnt, that is at the basis of a further acquisition process of information available for cognitive re-elaboration.

*"The whole is more than a sum of its parts and the constructed interaction of complementary processes is the secret to every creative activity in life".<sup>1</sup>*

It is in the nature of learning itself that the bonds and recognized links between new information and mnemonic traces recovered at a moment are autonomously defined. Often it is from the numerous excess of information that seems less important, that the necessary associations and combination of new data can be formed.

*"Well, I believe that reaching this gulf of multiplicitous potential is indispensable for every kind of knowledge"<sup>2</sup>*

But the projection of slides of the objects showing what the instructor was describing was only the first step towards the use of tools different from those that were in common use until the end of the Seventies.

The classes back then, with more students, already required instruments capable of complementing or, at least, assisting the teacher in the classroom.

It was rightly thought that to illustrate, for example, the function of an instrument, its connections and reactions to the system to which it was connected, a verbal description was not sufficient. The instructor in fact used exaggerated models of the instruments (normally made of wood), and large designs hung on the wall that were later substituted with lessons dealing with different arguments.

It is easy to understand how such practicality, utility, and production will take slide projections into a lesson of this kind.

However, it should be noted that at this stage, the lesson in its form and fashion was not that different from the one that had preceded it. In every teaching course there has

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<sup>1</sup> Josef Maria Jauch "Sulla realtà dei quanti" Milano, Adelphi, 1980

<sup>2</sup> Italo Calvino., "Lezioni Americane" Milano, Garzanti, 1988

always been the figure of the teacher, the class of students, the bilateral exchange of information, as well as the usual interruptions typical of every teaching course we know.

But it is during this particular part of the changes undergone in the training courses, that the first true separation between the “classical” lesson and the “new” one begins. That is to say the moment when audiovisuals stop being just auxiliary instructional tools and become fundamentally essential, and an autonomous part of the lesson.

It is difficult to say if the main reason has been the desire to use the most innovative technical tools available, or if a declared need for the standardization of the training results and, consequently, of the instruction courses posed the problem of giving classes the same teachers.

However, the results emphasize that, at a certain point, what were initially auxiliary instructions at the teacher’s disposal, have instead become the substitute for it.

At the beginning, parts of the lessons were taught by a “silent” teacher, who operated the projector and recorder for a while, moving then onto the discussion of how much is projected. In time, and ironically with the perfection of the audio/visual combination, the instructor always had less and less time at hand; an advantage of the completeness of the projected lessons, but the disadvantage of having the discussion and re-elaboration of the supplied information.

Essentially we can say that in a period of some ten years the figure of the instructor, even if we are referring to the initial theoretic teaching only, is becoming less important.

Today s/he has practically disappeared from the preliminary lecture scene of the airplane transition courses.

## 2.1 Video Tapes

Starting from the early eighties and continuing right up until today is the use of the videotapes as a new auxiliary, instructional tool.

If we were to evaluate the inadequate effectiveness of the audiovisual systems based on the slides, and certainly reinforced by the need to use new methods that allow at least the same results as before, those responsible for the training would decide to gradually substitute the audio tapes linked to the slides with some of their servile recordings on videotape.

The first result is disappointing because a few advantages are, in part lost due to the isolation and the relative concentration. But an undisputed advantage, even if tendentiously undervalued and controlled, is immediately singled out in the possibility of interrupting and repeating the most difficult part, without having to struggle with the complicated working of the "audio/slide". What is more, this allows us to catch a glimpse of the enormous didactic possibilities, such as images in-motion and, most of all, the reappearance of the instructors as videorecorded narrators of the lesson.

However, the tool, due to the fact that it is more evolved, is immediately more difficult to organize. In this case one quickly becomes aware that to overcome the difficulty emerging from the use of the older instruments, it is necessary to arrange the projections in a narrative structure, however slight it may be. This involves a production, almost from nothing, so as to enable the videocassette to be produced by the company itself.

This, in fact, was done in the mid-eighties when a television studio equipped with director's desk, telecameras, telecinema and computer graphic equipment was constructed in the airline company's offices. Indeed it includes all the material and equipment necessary to produce the audiovisual material for the training. (It has to be considered that at present the use of videorecording material by other departments is so wide spread that a further enlargement of the television studio was required).

The staff who work on the inside of this studio have first hand experience with the real difficulties of this new means of communication.

The more removed one is from the simple transposition of the slide+audio or from their mere reconstruction on videotape, the more one notices the struggle with

linguistical, psychological, perceptive, and cognitive problems that are not easy to control and overcome, not even with the means and structures available.

One of the first results is that, due to the minimum time required to obtain the student's attention, one is often obliged to greatly prolong the duration of the recordings to the detriment of the cost effectiveness of production and ironically of its use.

A reading of the videorecorded material of that period, and in particular of some twenty or so relevant tapes of the Ground Course of the DC9-30 and the Airbus A-300 (for a total of about ten hours of lessons per plane), shows that the difficulty encountered emerges from the situations, or information easy to remember.

It is not enough to have a mere description of objects, instruments or equipment, but rather it is often indispensable to also accompany these descriptive parts with break facts of questions and relative answers.

The value of these interruptions is that of forcing the student to re-elaborate the information received. In a way it is like proposing a training method directed by the audiovisual itself. It is an attempt to transform the information given into information recorded, by passing from the so-called short-term memory (STM) to long-term memory (LTM).

There are many studies in this field including many theories asserting the way the brain processes the enormous mass of signs that it receives through the senses, but they are still in the discussion stage.<sup>3</sup>

The psycholinguistic research has demonstrated, for example, that the acoustic sensorial information is conserved in the STM to later diminish because the LTM is capable of conserving information of a semantic nature only.

What becomes clearer is the concept that there is not mnemonic retention of numbers, data, values etc... unless they are conceptualized and re-elaborated mentally.

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<sup>3</sup> Noam Chomsky has made an important contribution in the field of linguistic theory by highlighting the difference between a superficial structure and a deep base of language comprehension. According to this hypothesis, a discourse is comprised of its sense and significance, and not the form in which it has been structured. For this reason, at the base of the comprehension and, therefore, the recall of a phrase (just as for a sequence of images), there would be the comprehension of a kind of semantic macrostructure and not the recall of the elements of which the phrase is composed.

Only through a semantic and cognitive reconstruction of the information can there be long-term memorial retention.

Some not so specifically dualistic models recognize, if not a distinct existence, at least a distinct function between STM and LTM, and in these perspectives the LTM and STM processes would not be part of the successive phase of the retention, but contemporaneously and interactively a part of the sensorial analysis. In in way, however, the STM phases would describe the recorded fact in a more transitory way compared with the deeper analysis that constitutes the horizon of LTM.

The fact remains that the use of videotapes produces a new way of imagining the training. And also, in this case, particular attention is required to avoid any advantages of this new tool turning into a defect or a complication for the trainee.

In particular the need to control the form, flow and quantity of information sent (other than its characteristic nature) becomes indisputable. The correct value is given to the introductory, descriptive and relaxation of the attention parts, as functional parts of the student's mental re-elaboration and, therefore, necessary to his/her comprehension. Moreover, the recovery of information is stimulated and the number between one recovery and another is kept under control.<sup>4</sup>

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<sup>4</sup> The most potent mechanism for the passage from STM to LTM is, as has already been pointed out, the rehearsal or, as defined in Italian the reiteration or subvocal repetition, consistent to the use of the parallel, buffer-memory (echoic or iconic).

Since the short term memory has a reduced capacity, each new element that is immersed there over the fixed capacity limit from the memory span ( $7 \pm 2$  discrete units), would tend to decompose and be completely forgotten if it were not exposed to rehearsal.

Obviously, the subject can decide whether to undergo rehearsal of certain sensorial characteristics of the element (for example the sound of a verbal unit) or its significance.

There are two kinds of rehearsal - one mechanic, preservationist (as in the repetition of numbers: 1,2,9,-1,2,9...) the other, elaborative, or rather, elemental analysis in order to relate it to the information already imagined in LTM.

The control mechanisms, in general, comprehend a vast range of strategies that control pattern formation and the systems of codes and mnemonic tricks (to increase the retention capacity and the facility of recall).

What has emerged from the analysis of the available material, and from the above mentioned is still open for discussion and being worked on by the TV production center, its directors and pilots, and the instructors in charge of managing or collaborating in the production of this material.

## 2.2 C.B.T. (*Computer Based Training*)

It is noted that the eighties have seen the rapid spread of informatics and the technologies related to it in every field and discipline of study and research.

The computerization at Alitalia, begun many years ago in the administration and the more typically techno-scientific areas is now also used in those sectors that have been up until now exclusive, including the area of training flight personnel.

In the same way that happened with the video tape, the changes put in practice and the instruments already widely utilized, by means of the combined use of new technology, form the basis of the C.B.T. (*Computer Based Training*) system.

It is necessary, however, to describe what distinguishes the first level of C.B.T. from what is possible today to obtain with the combination of more communication systems.

The recent use of the computer as an auxiliary instruction tool has seen the development of a myriad of different modes of intervention; from the simple dialog of a student researching information on the internal of a database, to the more recent interview examples with an Expert System that manages a multimedia system, and interacts with the student by means of more sensory channels, thereby deducing training models on the basis of the heuristic procedures in its possession.

The first CBT systems of easy access to text or image archives have shown right from the beginning their benefits and defects.

An undisputed benefit of these tools is the possibility of defining, time, interruptions, repetitions, and part of the routes of the process of communication in almost total autonomy of the student.

Its limitations include the unchangeability of the route and the ambit, necessarily reduced of ability, that can be treated time by time. Another limitation is the forced unidirectionality of the communication process, at least with regard to the inability of these kinds of systems to master or have the minimum cognition of the student's model.

This unidirectionality of communication is perhaps the restriction limiting this kind of system, even though we are talking about a technologically very advanced and, above all, extremely malleable instrument which is, therefore, potentially very valid.

It is extremely important, however, to point out that in this environment of close, human-machine interaction, rigid forms of comprehension and interpretation of messages received are often produced.

It is easy to understand how a student can make his/her own interpretation from the information received, which in some cases can be profoundly mistaken.

The act of interpretation is not one of merely deciphering. In this case one deals with grasping the interpretation as an action that confers a sense of wide proportions of the discourse, based on partial decoding. Besides this, the comprehension is often an interpretation of an abductive kind. (Refer to the work covered by U. Eco in which the ambits of inference, induction and abduction are defined.)<sup>5</sup>

A training system that does not foresee a frequent comparison of maturation among the students, or between students and instructors, can produce some extremely individual and rigid patterns of the supplied information during the training. All this will inevitably make the road more difficult towards global and correct integration of the further instruction that s/he is given.

Once familiarized with a concept, the need to understand it replaces that of describing it to her/himself and to the others. The description that one makes of it to the others is analogous with that made to oneself, and so one identifies with the process of comprehension that one has had of it. It is essential, therefore, to be able to maintain the exchange of opinions between a group of students rather than generating a sort of “interpretive solitude” which is very frequent in this kind of individual training.

Moreover, the interpretation and the comprehension of this linguistic phenomenon, and of the visual one as well, is not based simply on that which is said or seen. In a certain sense, the presumed “objective” of supplied information is always partial since it has to rely on who receives it..<sup>6</sup>

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<sup>5</sup> Umberto ECO, *Trattato di semiotica generale* - Milano, Bompiani, 1988

<sup>6</sup> To be able to carry out a communicative act, we always base ourselves on a complex extralinguistic ability. To know the significance of the adopted terms would not be enough to actually understand the significance of the information itself.

Phrases like: “before giving the milk to the baby, you have to boil it”, or: “Franco killed the man with the rifle”, “Franco killed the man with the scar” ecc..., are examples of how

In reality the objectivity of a piece of information, just like that of an image, is a long way from being a fact .

The studies are seen in reference to the interpretive collaboration in the reading of a text carried out in semiotic research. <sup>7</sup>

The importance of the reader's interpretive inference of a text's structure, in its own superficial structure, is emphasized in these studies. What is more, it should be pointed out that the semiotic concept of a text is wider than that of purely linguistics, leaving the door open to the more specific intervention in the iconic or visual ambits in general.

But let us return to our application in the training sphere. The first instructional systems that, for their specifics, were able to be projected, taking into consideration the previously treated problematics, were those based on the computer.

They have been given many names already and diverse initials have been identified to indicate the didactic systems that make partial or total use of computers.

The initials C.B.T.,( stand for Computer Based Training) is read in these times of instructional systems assisted by the computer, taking the name C.B.I., or Computer Based Instruction, and C.A.I. systems now called I.C.A.I. (Intelligent Computer Assisted Instruction) that sees programs of artificial intelligence commanding the various training phases of teaching.

A classic example of these instructional, computerized models is "Scholar", a first attempt at an ICAI system, whereby the strategies of inference are disconnected from the context in which the system is meant to operate (teaching South American geography ). In this system that deals with a basis of incomplete knowledge, and systemizing the similar reasoning processes of those commonly used by people, we find the referral model beginning the studies and the research in the field of the systems that deal with teaching strategies using the ICAI auxiliary.

Another study to construct a specialized system capable of operating as teacher is "WHY" where, through the use of heuristic rules, it is capable of stimulating, by means

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**necessary it is to master something more than what is called linguistic competence to be able to grasp the sense of what is communicated**

<sup>7</sup> ECO, Umberto., Lector in fabula - Bompiani (Milano 1989)

of analysis of the student's errors, the reflection and the verification of formulated counter-proposals from the system's program. <sup>8</sup>

Substantially in these systems the instruction is supplied in two different ways; in the first case the student is in control of the operations and chooses the route for researching information; in the second case it is, instead, the computer in control of the game. In both situations, however, all that is usefully exchanged is information facts.

When the student guides the lesson, s/he can put questions to the computer and have them answered. When the computer is in charge it can decide to voluntarily supply this information, or ask the student to supply it in its place.

In this model of interaction there is the tacit assumption that teaching consists of the exchange of verbal information between the student and the expert system in the form of questions.

The system is constructed in a way in which it predicts every possible incorrect reply on the part of the student. It is so ready, in case it were necessary, that it can slip on to a further data base capable of supplying more information. This reorganization on the basis of the answers is called Ad-hoc Frame-Oriented (A.F.O.) C.A.I., and is the first step towards a decidedly more individualized instruction. (The term "frame", as it is used here, precedes that which was used more recently in the research of knowledge representation in AI).<sup>9</sup>

The AFO - CAI based itself originally on the principle of response-stimulus, studied by Skinner. Skinner's observations were carried out to formulate "the law of the effect", according to which, among the diverse answers given to the same situation, those that are accompanied, or immediately followed, by a sense of satisfaction, will stay the same -- more firmly connected with the situation, in a way that when it reproduces such answers it will apply greater probability to them. In the answer-stimulus model, Skinner's studies highlighted a behavior that is called "operating conditioning", according to which the

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<sup>8</sup> Avron BARR, e Edward A FEIGENBAUM, "The Handbook of Artificial Intelligence" Stanford, Pitman Books LTD London, 1982, pp. 240/243

<sup>9</sup> Marvin MINSKY, "The Society of Mind" Simon and Schuster NY 1986 (Cap. 24.2 pp. 245 "Frames of mind")

continual reinforcement of certain answers by means of confirmation or gratification, produced the learning.<sup>10</sup>

A system that made great use of the AFO and CAI models was formulated by Jamie Carbonell about 1970. It was something of a more complex “problem generator” as were almost all the CAI systems back then; it resembled more the automated teacher that took into account improbable accomplishments, as capable of induction as humans, and capable of creating a reactive, training environment in which the student, through his/her errors and curiosities, guides the instruction process.

Perhaps unintentionally (at least in the intense sense of J. Searle)<sup>11</sup> the problem here shifts from the philosophic, epistemological ambit to that more pragmatic, empirical one of the internal objectives of the system.

The fundamental argument remains that the instruction always has as its aim, both on the part of the instructor and that of the student, to obtain an objective affirmation that expresses the sharing of an argument on the part of both people.

But let us return to our computerized systems and their uses in the training of airline pilots.

As can be seen in a document published in the deeds of the national conference on the CBT of 1988 regarding the training of Alitalia’s navigational personnel,<sup>12</sup> the use of a computer and videodisc based system for pilot training in connection with the “ground courses” was actually predicted for the early nineties .

This interactive system, called WICAT (World Interactive Computer Aided Training), has already been acquired by Alitalia with the aim of flanking and slowly substituting the modes used up until today.

The company has not acted autonomously this time, but perhaps due to the cost of these systems, and from the point of view of their excellent trackrecord, it has joined with the other European companies like: LUFTHANSA, SWISSAIR, KLM, and SAS.

The interactive system produced by WICAT has been a substantial step forward in comparison with all the other systems presently in use. It is composed of a mini IBM

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<sup>10</sup> SKINNER, B.F., “Verbal behaviour”, New York,Appelton, 1957

<sup>11</sup> SEARLE, John R., “Menti cervelli e programmi” Clup-Clued (Milano 1984)

<sup>12</sup> Luciano FESTINESI, "Convegno Nazionale sul CBT" Università di Torino 1988

computer which is linked, in Alitalia's case, to a dozen terminals with color graphic and high resolution monitors.

All these terminals are equipped with keyboard, mouse, and touch screen. Linked to the central unity, there is an optical disc reader that contains images and audio which appear on various monitors during the lesson.

The student seated in front of one of these essentially finds him/herself, at the beginning of the lesson, in the same state as when s/he sat down in front of the monitor to assist in a videotaped lesson. Only that in this new state, besides the images in motion and audio from the previous lesson, s/he is in a position to autonomously choose to follow the standard training route proposed by the calculator, or review one or more parts of the course that have not been understood previously.

Also in this case, the computer pauses to set the questions, but in this time evaluates the answers and chooses whether to continue or to redo what has been misunderstood.

The first real advantage of this new didactic system is in the direct participation of the student with the construction of the lesson.

Even if one deals only the illusory participation (the student can actually only choose which part of the lesson to begin with and eventually repeat), we can think of this system like a surrogate teacher that lets the student decide when and about what s/he has to speak. It is a teacher who, above all, is capable, even if only partially, of noticing whether the student has understood what has been said.

The absolute coldness of the older videotapes with their long verbal and visual descriptions is a mediocre success in comparison.<sup>13</sup>

But in reality we call this system an interactive system even if it is still a long way from real interaction. Let us now try to define what interaction is and what a system has to have to be able to actually utilize it.

Interaction can be defined as a reciprocal and contemporary communication activity between two elements. Both have to be able to interrupt, at their discretion, the speaker.

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<sup>13</sup> Recent studies of developmental psychology have pointed out how much difference there is between scholastic learning and natural, or active learning which occurs in the moment in which it is an active part of the process of information.

For example, Jean Piaget and his colleagues have highlighted the fact that the key to the learning process in children is activity. In effect, learning occurs through "doing". (Piaget, 1970; Piaget and Inhelder, 1969).

Moreover, everything has to be able to be reciprocal and simultaneous. (Videodisk, for example, are alternately managed and not contemporaneous from communication: “now it’s my turn, now it’s your turn”).

An apt comparison to define an interaction is the difference that exists between a conversation and a reading.

The problem is, however, to define what is the single, smallest element by taking into consideration the interruption.

The word?

The sentence?

One can be interrupted half-way through a phrase, recognizing the presence of the intervention but equally finishing the word or entire sentence. The speaker's problem is not so much the immediate reaction, the response, as the recognition of the interruption, of the intervention.

The sense of the interruption is also that of allowing the conversation to proceed according to the cognitive model and the recovery of the concepts that are typical of the human mind.

After an intervention it is not, by any means, compulsory to continue on the same path that was being taken prior to the interruption.

Normally, in a truly interactive dialog, the course is not linear but nor for that matter is it by chance. A dialog follows the conscious' needs characteristic of the speakers.

We will not bother dealing specifically with the aspects of elocution, illocution, or perlocution but it needs to be pointed out, however, that the comprehension of a dialog or communication, as seen from recent studies in the field of cognitive science, does not come from the simple reading and eventual recognition of representation phenomena (be it a sentence, a photo, a switch, a system's design, or a warning light on).

Perception and cognition are inextricably linked to a globally lived history; a specific, cultural fact.<sup>14</sup>

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<sup>14</sup> A particularly interesting example of the cognitive component and the insufficiency of the sole, physiological investigation into the study of sensorial functions was carried out by W. Cain and his colleagues.

Through his work he was able to determine that, using a larger number of terms, and widening the linguistic field used for defining perceived smells, one can intensify the operative

This a difficult concept to accept, especially in a field that makes the exact sciences its own religion and bases its fundamentals on the unequivocality of the objective facts. But we must consider that the reality that appears to us, that we recognize and upon which we experiment, does not seem not to be independent from the observer (and this seems more important today even for “exact sciences” like physics).<sup>15</sup>

The progress of learning is strictly linked to the dialog process which is established between the object of perception and its own store of knowledge, in a way, its own common sense which is nothing more than our personal and social history.

It is inevitable to believe that an acquaintance and someone known, subject and object, are reciprocally in a relationship of mutual specification; emerging together. The consciousness as follows from the learning is an absolutely individual fact, and occurs as a phenomenon of cognitive re-elaboration of the information on the basis of the previously assimilated data. We can say that each new piece of information, be it linguistic or iconic, has to be filtered by the typical cultural model (an absolutely individual, conceptual substratum) before being able to become a part of the typical experience.

To have an idea of how each piece of information (also purely visual) is re-elaborated to be interpreted, we can look at the perception of colors like those illustrated by the study on perception theory.

In this field of research it is hypothesized that the recognition of colors is also a cultural fact. We know, in fact, that the colors have been selected based on visual experience, and perception of the color of a ripe tomato has the same meaning for a community, that is to say a linguistic group.

Only afterwards has science thought it opportune to formalize these perceptions and subdivide them in fractions that continuum that is visive experience, defining the

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sensibility, and readily recognize tens of objects by their smell without any uncertainty whatsoever.

<sup>15</sup> Josef Maria JAUCH, “Sulla realtà dei quanti” - Un dialogo galileiano - Milano, Adelphi, 1980

diverse wavelengths of electromagnetic radiation included in the visible field. However, it is emphasized that science identifies this reality only after what has been “made relevant”.

In the continuum of a human's visive perception, the portions that are certainly arbitrary have been recut and defined. In cultural and environmental situations different from our own, the separations could be more subtle and wider.

Different peoples divide the same visive continuum in different ways. For example, the Russian culture seem to know our blue as two segments called “goluboj” or “esinij”, while the Greco-Roman civilization presumably did not distinguish between our blue and our green indicating the two parts indistinctly, and not separately with the names “glaucus” or “caeruleus”.

If we examine, for example, the Artic peoples who have more than a dozen different names for the snow in its different states, we immediately become curious as to how much can be determined by the capacity to adapt to a specific environment.

A painter who has refined his/her sensibility of color can recognize and eventually categorize various shades of blue, that normally are generally recognized as different tones of the one color. If they are defined into further fractions of a specific identity and, therefore, recognition, s/he will have without doubt created (at least for the painter) a much richer reality. Not that the reality that appears to the painter is formally different from the one that appears to others, it is just that s/he is in a position to perceive the separation between the different shades that s/he shows with better definition.

A quite extreme and certainly much debated hypothesis on this concept <sup>16</sup> asserts that not only the lexical repertory, but the same syntactical structure of a language, determine the world's vision of a civilization.

*“One cannot imagine that certain people have a color-geometry different from ours? This surely means that one cannot imagine people who do not have our concept of color, and yet have concepts of color that, for us, are related in such a way that we will still call them 'concepts of color'“?* <sup>17</sup>

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<sup>16</sup> Sapir-Whorf cit. in ECO, Umberto., "Trattato di semiotica generale" pp. 115

<sup>17</sup> Ludwig WITTGENSTEIN, “Osservazioni sui colori” Torino, Einaudi, 1981

It might seem to be drifting out of our specific field of research into the tentativeness of indicating some concepts that underlie comprehension and communication in general, but the aim of these specifications is to emphasize the questionable nature of each affirmation that underlies the objective of the information, including those of the visual kind.

What we want to show clearly is that learning does not happen on the basis of passive recognition of symbols referring to the system through recognition, but more elaborately through the creative dimensionality of their meaning on the basis of a history that has been previously lived and already made its own.<sup>18</sup>

On the basis of these further indications, and referring again to the audiovisual system, WICAT, that is used for Alitalia training, we can state that this is without doubt a definitive step towards the automatized instruction that we have been wanting for ages. Only recently has it passed the purely experimental stage and, therefore, needs some further changes that will certainly help it to resolve the problems that still limit it. Being able to combine sounds, animated and graphic images, shows it to us without a precise and programmed instructional strategy. It allows the integration contemporaneously of different tools, but at times and costs of production that, for now, remain very high.

Once again what risks translating into courseware (as the courses, and the software they are composed of are called), that is summarized, concentrated and poor in

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<sup>18</sup> It would appear to be possible to talk about an ontogenetic and a phylogenetic characteristic of learning, along the lines of how it happened in the reproduction of the cells.

The necessary presuppositions of a state of complete dominion on normal and particular situations (those which are abnormal or an emergency, eg. on board a plane), originated from a complex class of regular and recurring interactions with the surrounding environment and its anomalies.

The capacity to assimilate a process of reductionistically simple interventions bases itself on the possibility to interact with what previously has already been assimilated, and has become an integrated part of a global condition of knowledge and competence on the state of things. (MATURANA, Humberto e VARELA, Francisco., *L'albero della conoscenza* - Milano, Garzanti, 1987, pp.75)

information, not damage of the needs of the principle subject of this training. But there is hope in the still tacit possibilities of this new technological instrument, and the time and work that will be dedicated to it will determine its success.

The instructional role of all these means however, is still an introductory one confronting the “real” teaching of a plane and its systems.

The main manoeuvre is carried out in flight, on the plane, and to perform emergency and dangerous manoeuvres one relies on flight simulation which is extraordinary realistic - so much so that there are some cases of pilots qualifying in “Zero Flight Time”, that is to say without ever setting foot on the plane that the simulator simulates.

### 3 *The Multimedia Interactive Systems in connection with the Cognitive Aspects of the Training*

*"Everybody experiences far more than he understands. Yet it is experience, rather than understanding that influences behavior" <sup>19</sup>*

If there is something certain about the future it is technology and, in particular, digital technology which will continue to grow and profoundly change our way of communicating with each other, as well as our way of perceiving, thinking, and interacting with the world.

We only have to think of the training of navigating personnel over the history of the last fifteen or twenty years to notice such evolution and transformation that, in little time, has taken us from the teacher's wooden and paper models of twenty years ago, to the actual, multimedia interactive systems of recent experimentation. This transformation was surely unimaginable then, just as it is difficult to imagine today the look of things to come in the next ten years.

This "technology of mediation" is in fact only on its first stage of evolution; it is still limited, stupid, and impersonal, and its full development is emerging as one of the main technological, cultural, and esthetic challenges of the computerized era.

It is of a certain importance to identify what conceptual difference lies between our daily means of communication and those that will be a part of the near future. Returning to a concept that in the past was very fashionable, it is possible to highlight a deep distinction between the means of communication defined as "hot" and that which is "cold".

We can start by defining briefly the basics of the hot means as like the extensions of a unique sense, the state, in which one is abundantly filled with data; contrarily is the cold

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<sup>19</sup> Marshall McLuhan, cit. da: Stewart BRAND, "The MEDIA LAB" - *Inventing the future at M.I.T.* Penguin Books, 1988

means in which such lack of definition and information requires a greater participation or, better said, an active presence in the communication process.

Marshall McLuhan emphasized, for example, the differences between a conference and a seminar, defining the former as a cold means, in which participation is less permissible and exclusion is more probable, whereas at a seminar, however, there is the same structure but inclusion and participation happen much more easily.

We can arbitrarily use the basic principles that distinguish a hot medium from a cold one to analyze the differences between passive attention towards a projection or audiovisual, and the participation necessary in a classic lesson that sees priority given to dialog between teacher and student.

The transfer of knowledge and competence passes through an interior restructuring and interpretation of the information that is received. All this is understandably much easier in a situation that allows this type of interaction and mental reorganization.

*Intensity, or high definition generates specialization and fragmentation in work as in relaxation. This explains why whatever intense experience that is able to be “learnt” or assimilated must first be “forgotten”, “censored”, and reduced to a very cold condition. The Freudian “censor” is not so much a moral function as an indispensable condition for learning; a work method of our mind..<sup>20</sup>*

Our brain seems to be capable of structuring records and experiences into complex plots that link up with the plasticity of the neurons and their connections in neuronal, “reverberating” circuits. To memorize would mean coupling sensations and perceptions of memories and specific contexts, and also elaborating them into categories through an individual process that is typical of biological minds.

Memories are not a process of direct, photographic transpositions, (every one of us remembers the same fact that happened to others in a distinctive way).

Thus, the same event assumes diverse connotations with time, as if it interacts again with the new mental context for each recovery inside of which it is recovered and, therefore, modifies itself; it modifies the network of connections.

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<sup>20</sup> Marshall McLuhan, “Gli strumenti del comunicare” Milano, Garzanti, 1976

In the consciousness of oneself, of one's own memories and surrounding environment, the senses undoubtedly have the role of primary filter, but the re-elaboration process of the events also has an extremely important role and contributes to determining a specific perception.

It is not by chance that, in these last years, what is emphasized is the characteristic of enforced contextualization of memories like the recovery of a specific capacity of the memory which is already known and applied in relation to the diverse mnemotechnics of the passed centuries.

A poem is not looked at as only a series of words but, also, for its emotive, cognitive, and musical value. It is opportune to look for links between what one wants to remember and points of referral that allow the conceptualization of a memory in order to remember it better. <sup>21</sup>

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<sup>21</sup> In neurophysiological terms this contextualization, or more precisely conceptualization, could depend on the connections that can be formed between nerve cells. This idea formulated over a century ago by Eugenio Tanzi, and taken up again in 1949 by Donald Hebb who, with more modern neurophysiological capabilities, hypothesized that a neuron that repeatedly receives signals from another neuron tends to increase its own sensibility with respect to these specific signals. These neurons connected between them in a functional way should make up a part of a network constituted by other neurons that, following an impulse joined to whichever one of these, would form a kind of reverberating circuit, (the memory being unstable for a brief period). Repeated stimulations instead would produce modified permanence in the connections and, hence, in the structure of these networks of interconnections; changes that would be the basis of the permanent or long-term memory. Hebb believed, therefore, that the pith of the memory was through research into the synaptic connections. More recently, the concept of two mnemonic processes in STM and LTM stopped being a purely phenomenologic observation and has been proven experimentally through laboratory research. (Refer MONTAROLO Pier Giorgio & SCHACHER Samuel, "Apprendimento e memoria in vitro", from *Le Scienze* n. 242, October 1988).

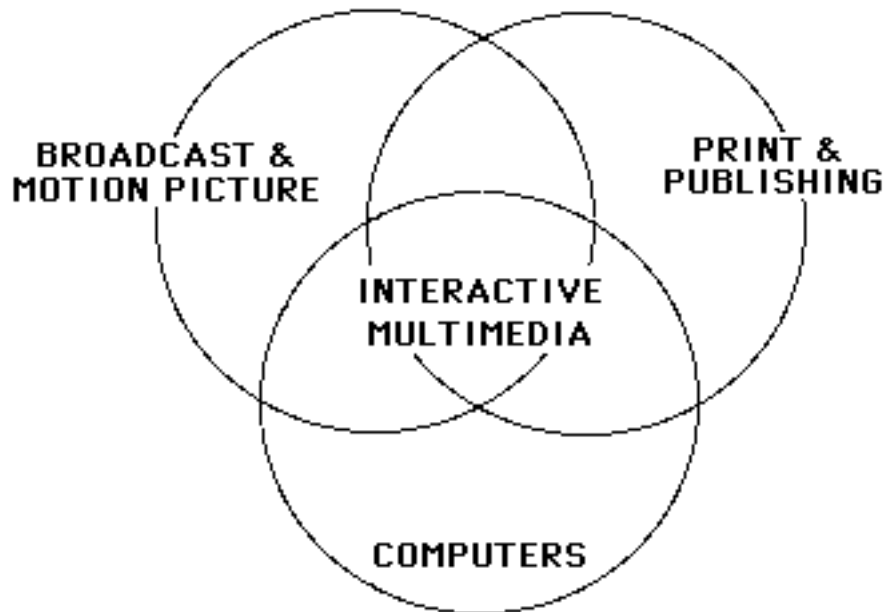
Through the combination of the studies on perception <sup>22</sup> and learning, the basis of human interaction with the instruments that technology makes available is studied. It is difficult to say exactly which discipline is more indicative of supplying the necessary instruments for a correct use of the new technologies.

Perhaps it is for this reason that the ambit of “Interactive Multimedia” is contemporaneously that of information, psychology, cognitive science, linguistics as well as the technology linked to the instruments used.

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<sup>22</sup> Integrated in the diverse characteristics of perception is the condition of subliminal perception, which is definitely not to be undervalued in any complete analysis of sensorial phenomena.

Of relevant importance in this sense is the study of the theory of the signal detention of Tanner and Swets, where one defines the threshold of detention, and in a certain sense, therefore, also of attention and comprehension, as not a rigid line of demarcation of the signal level, but rather a point of the probabilistic value on the inner continuum of the transmission of information, on which falls the subject’s voluntary decision to point out that the stimulus has been averted.



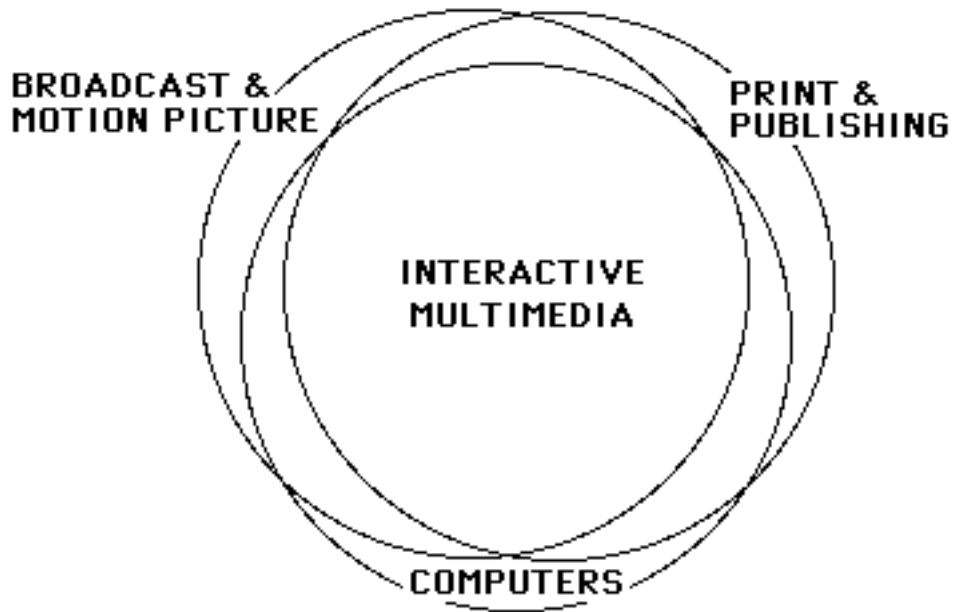
In these last few years the expansion of all these technologies that are in some way connected to the means of communication, has seen a partial superimposition of the ambits that had always been characteristic of every single sector.

Industries such as the cinema-television and information, or editorial in a general sense, are discovering common ground; interconnections that make the confines of their separation more subtle.

What greatly interests the world of training technique, or of auxiliary didactics in general, is this area of superimposition of the media of communication that is appropriately called "Interactive Multimedia".

With this definition one looks to individualize that common area of the technology of computers, videodiscs, and electronic editorials that has been growing in these last few years, and will probably have an even greater expansion in the near future.

An example strictly correlated to our research is provided by videodiscs which, have up until now been instruments of the "motion and pictures" sphere but are now making in-roads into the computer world.



But it could be misleading to deal so specifically with the various transformations that interest the media in general. It is instead more pertinent to think that the right way to treat these superimpositions of the fields of various disciplines is by considering it as an answer to the need to better prepare oneself with the human-instrumental relationship.

A better way of understanding what needs to be done is that of exploring the cognitive and sensory system of humans and discovering the most natural way for him /her to interact.

*...reassuming, I propose to interpret the cognitive processes as recursive processes of elaboration without end... <sup>23</sup>*

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<sup>23</sup> Heinz von Foerster "Costruire una realtà" in *La realtà inventata* pag. 43

Why is it better to understand rather than to memorize? Since understanding means acquiring, and an acquired thing becomes natural, it no longer requires the global use, the total attention of the brain to further re-elaborate, in order to be mastered.

For example the study underway at the Media Lab of Boston's M.I.T., following on from the S.D.M.S. (Spatial Data Management System) group, studies the particular ability that humans have to remember the position of an object, a written word or figure very well, and where it was last seen or left.

The key idea in the research of the SDMS group is the concept and visualization of "Dataland", a kind of informative-audiovisual interface that allows the use of this human ability to remember visual and spacial aspects of information received, thus recovering, in effect, a concept already characteristic of psychology - which the re-enforcement and mnestic recovery of perception.<sup>24</sup>

Perhaps without a precise resolve, but due to this innate capacity of ours to make use of avionic designs (the instrumentation on board airplanes), that we consider the disposition of the instruments on the internal of the cockpit extremely important in obtaining individualization more easily. To assist then not only the capacity to individualize but also to recognize every single object, other systems are used like the diversification of form, color or dimensions. (All the levers and main switches of a pilot's cabin differ from one to another).

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<sup>24</sup> It is necessary to define the ambits of competence of complementary phenomena which are sensation and perception.

A classically held view considers sensation as a psychic-physiologic, distinct phenomenon, and perception as a complex phenomenon, referred to as a whole of interdependent relations which have important parts: experience and sensorial integration.

Ultimately, the confine that delineates the separation between these two concepts has decreased.

Psychophysicist tends to assimilate perceptions with sensations. The global vision of psychology of Gestalt, instead, tends to identify the sensation as a part of that more complex phenomenon which is perception.

The visual forms, color lines, and proportions, are subject to articulation of complex combinations among them, just like the words in a phrase or in an entire discourse. The rules, however, that govern them are more complex than those of grammar and, at least, as complex as those that are still to be formed which are considered necessary for a complete linguistic ability.

A more radical difference is that the visual forms are not discursive, lineal or sequential. They are present contemporaneously and in disjointed form. Therefore, the connections that link them are all internal to the mind and materialize in one, unique, visual act. Their complexity is bigger than that of grammatical rules only and, perhaps, it is not even possible to try to form them into linguistic structures such as: competence, pertinence, etc ...

The length of a heard discourse that is remembered, depends essentially on the capacity of comprehending what has been said.

In linguistic terms there is no memory without comprehension.

In visual terms memory is in the connections.

“Linear” media, that is to say those means that consent to a sequential and unilateral communication are better for tasks of an empirical kind, like definitions or casual arguments. The multimedia ambit instead is characteristic of the conscience.

The conscience is always related to the context, to the perspective in which the context is perceived. It is much more than a mere information list or a description of the facts. The conscience requests connections and interactions. The conscience has a terrain, a topography, associated with it. The substance of information or data is a list, and this is a linear model. The connections between all these parts, is a multidimensional map of their bonds.

Our mind is exactly this. It is something more complex than a linear machine as are today’s computers; the mind is an associative machine.

Therefore, what the new “Interactive Multimedia” will have to overcome is the separation, typical of our time, between information and conscience. But in order to do this it will be necessary to work without too many ties to the many different ambits among them.

The impass, for example, that the world of Artificial Intelligence (A.I.) is living in, is the result of a epistemological choice of not following alternatives, and very probably, it is typically bound to the natural limits of the model that A.I. has chosen for studying the mind.

Psychology, neurophysiology, and the studies of Artificial Intelligence, have confronted the study of the brain, its organs, and expressions and manifestations with a

vivacious multiplicity of approach. These three addresses of research have, however, until now, existed autonomously. What is more, these have all taken for granted the Cartesian separation of mind and brain. Each one of them, in the specific ambit of the respective competence, has until now treated the brain purely under the chemical, physical, and biological aspect, and the mind as the whole of the separate, functional levels of the organ that produces them.

The example that is more commonly used to explain the relationship of the mind with the brain is that of the two parts that compose an information system: hardware and software.

The comparison, often attributed to John Von Neumann, establishes a similarity between the hardware of the computer and the brain as a whole neuron circuit, and software and programs with our mind.<sup>25</sup>

What is under discussion now is the mind itself, whether external from the brain or itself the result of the complex series of interactions that occur in it.

The studies on the plasticity of the brain, on its capacity to restruct and eventually reposition (in other places or other networks) the ambit of certain competences, can be mistakenly taken as an example explaining how the mind and mental functions can also exist in partially injured brains. This hypothesis leads to the assumption that if the mind does not have specific space and binding in the brain, it can avoid definite and absolute localizations, and redistribute itself in what remains of it. Indeed, the mind would not coincide with the brain but would live without being bound and conditioned to it.

It is this philosophical attitude that has always permeated throughout the Western culture, and also conditions the studies in more typically scientific ambits.

Traditionally, the problem can be posed in this way: are all mental phenomena such as desires, beliefs, impressions passions, in reality phenomena of the brain?

From Plato to Cartesius, dualism separates mind, soul and spirit (various definitions of one superior and pure state of our being), from the body by the material of the brain, all imperfect states which our human nature is obliged to consider. In order to understand the mind it would not be necessary, therefore, to know the brain, it in fact would not depend on it, but as we have said it would house it only.

In contrast to the Cartesian dualism, materialism answers the question that the mental states have, in reality, come from the brain in an affirmative sense. The principle argument that materialism has against the dualistic model is that of its total loss of

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<sup>25</sup> John Von NEUMANN, "The computer and the brain" - Yale University Press, 1958

adherence to the developments of the various disciplines taken under examination each time.

With the progress in sciences such as physics, neurobiology, molecular and evolutive biology and neurosciences, this distance has become more and more apparent. The weight of the empirical evidence seems, therefore, contrary to the existence of a kind of substance or spiritual essence.

Turning to the brain and its plasticity, the hypothesis that seems most plausible states that the genetic code of establishing an initial and more probable indication of the distribution of the networks of neurons determine the localizations of competence and specializations for primary needs. The following development and the plasticity effect of the brain produce, therefore, the consequent specialization attributed to more complex tasks that are not necessarily localized or that, if necessary, can be relocated.

The control of superior competence such as the spacial or linguistic capacity, calls into discussion an enormous amount of connections and neuronal reactions. It is difficult to define how the linguistic capacity consists materially, for example, to be able to be already certain that it is definitely relegated to a limited zone and determined by the brain. The deterministic theories of the localization of the competence are, therefore, put in doubt by the research into cerebral plasticity and, in particular, the investigation into the knowledge of the role of NGF developed by Nobel prize-winner Rita Levi Montalcini, thus, contributing to the redimensioning of the vision of a narrow cerebral determinism and its structural inalterability.

The more an animal species has a developed cerebral cortex, the more it is capable of modifying its own behavior rather than being less bound to a preconstructed program.

The cerebral cortex of humans, the most recent in philogenetic terms, is highly developed and consents to an elevated level of plasticity, in the sense that an absolute determinism does not exist on which the categories of various areas have to be from. Moreover, the various competences are as interrelated as they are elevated. In terms of complexity, it is difficult to imagine a real linguistic competence not strictly interconnected to spacial, mnestic, or logical capacity.

There has been slight criticism of the epistemologic model of neuroscience over the last few years, with particular reference to the research on a single neuron, compared to the result of another comprehensive study of neuronal networks' interaction.<sup>26</sup>

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<sup>26</sup> Domenico PARISI, "La mente come cervello" (Reti neurali e connessionismo) Su Sistemi Intelligenti anno 1 n° 2

From the same source a critic has also turned the world of information sciences upside down by describing how functional research can be the model used by A.I. that looks to say something about the nature of intelligence (but far from the identification with the brain); but voluntarily ignores all the physical characteristics and the way the brain's functions, having as a base the concept (of dual stamp) of multiple inallocability, that is to say that intelligence exists and is studied indifferently by the mechanic machine that supports it.

Exempt from both these forms of epistemologic aberrations seem to be the research models typical of "Connectionism". They propose the same psychological and neuroscientific methodologies of empirical research, and point to an integration in the characteristic models of the diverse discipline both for studying the mind as a capacity defined in purely behavioral terms, and for studying the neurophysiologies that underlie this capacity.

In epistemologic terms the connectionism seems to be able to represent a novel innovation with respect to the classic, dualistic approach of the mind-brain study. With the connectionism the electronic calculator stops being the first metaphor for the study of mind and intelligence, and the brain itself returns to being the center of attention.<sup>27</sup>

If the neurosciences, wanting to remain in the ambit of the natural sciences, do not say a lot about behavior and intelligence, then artificial intelligence on the other hand does exactly the opposite. It, in fact, attempts to say something about the nature of

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<sup>27</sup> At the center of the Connectionist's system, intelligence, or perhaps it is better to say information, is kept in the weight of the connections between the unity of the network. It is not established from the outside by a human being, but is self-learned in humans by the system through a process of continuous, assimilable revision of experience..

The classic systems such as Artificial Intelligence are, therefore, systems organized from the outside (human-programmer) and also from the outside is the contribution of the symbolic references that they devise. (In these self-learning systems there is no central list)

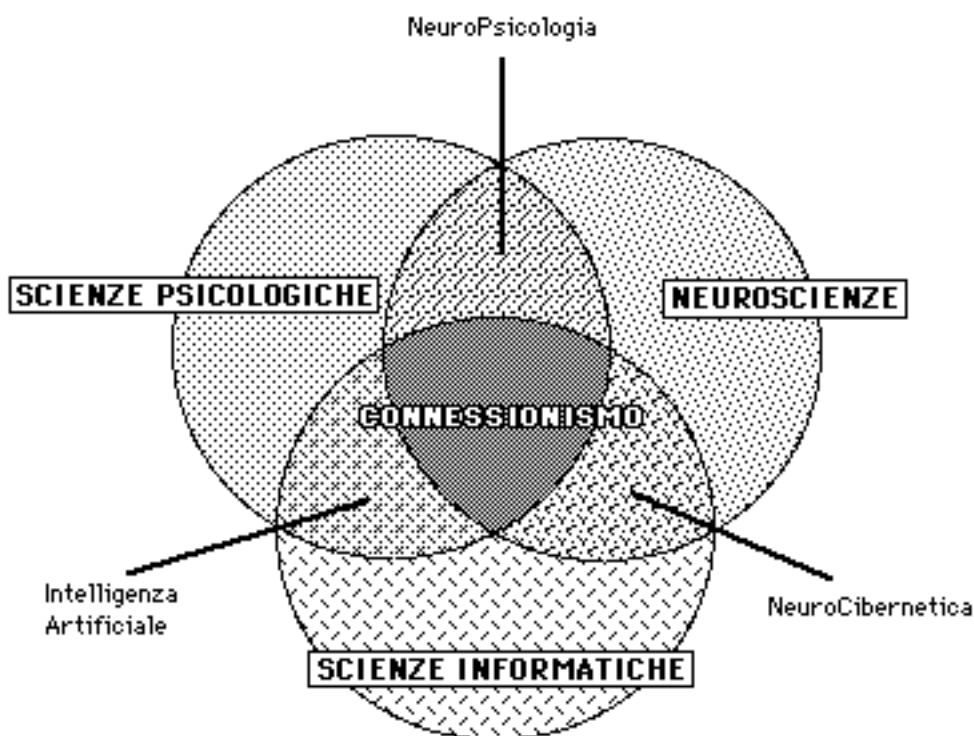
The Connectionist's systems are instead systems of self-learning and self-organization. The manipulation of information, and the constitution of the networks that represent them, takes place internally and without any human contribution. The result is a symbol, but its production as information is from the sub-symbolic whole and, in a way, apparently very similar to how it happens in our brain..

intelligence but, wanting to ignore all the physical characteristics and the way the brain functions, ends up not grasping some of the more important aspects and characteristics of intelligence itself.

Artificial Intelligence originated about thirty years ago differentiating itself from neurocybernetics which was useful at the time for studying the brain computationally, and the relationship between the brain and intelligence.

A.I., instead, was founded on the assumption that intelligence is independent from the support that it uses; it has developed by distancing itself more and more in the course of time from the initial model that was represented by the brain.

In this graph we look to show some superimpositions that the classic sciences have examined dealing with the brain and its functions.



Once again, as can be seen, the superimposition of different ambits or disciplines is the basis of the growth of a new field of research. In this example the way the connectionism positions itself is emphasized in confrontation with each of these disciplines, without necessarily excluding the contribution of the others, but integrating it as much as possible both as a common methodology of research, and as a possible point of meeting and confronting various theories and experimentations.

It is probably from the Connectionism, therefore, more so than from Artificial Intelligence, that we can expect the best results and technological instruments that are more suitable for the next systems of human-machine interaction.

The next objective is that of obtaining a technology of human-machine interaction invisible to the user. Central to this philosophy of computer technology is to make the computer itself obsolete. The aim is that of making the technological aspects so transparent that for the practical purposes the computer no longer exists.

In its most perfect form, ideal human-machine interface will have to allow a person to interact with the computer just as it would with another human being.

And it is for the purpose of obtaining results like these that the more complex aspects of the interaction between people are so rigorously studied.

It is ascertained, for example, that at the base of the mechanisms of communication comprehension there is the perception of signs, images, and forms. W. Koheler and other theorists of Gestalt have formulated a general theory of visual perception that is useful to us for comprehending the mechanisms of the interpretation of messages.

They assert that what we perceive of reality is something "different" and "better" of the sum of the parts of which it is constructed; which means that a message produces a complex effect that is better, and different from the intrinsic value of every element that composes it.

*"The aggregate is greater than the sum of its parts since the combination of the parts is not one simple addition but has the nature of a multiplication, or a fraction, or creation of a logical product".*

According to the theory of Gestalt, humans interpret and understand the reality the surrounds them according to the elementary arguments: the principle of similarity, where single elements belong to an identical whole; the principle of closure, where its open forms induce their closure, and incomplete objects to their completion; the principle of meaningfulness, where certain figures appear good and others bad according to their symmetry or asymmetry, simplicity or complexity.

The importance of the perception theory lies in the fact that it places the active and re-elaborative function of the receiver of the message as determinator, and states the reason for which banal, project errors of communication can be transformed into elements that, by themselves, radically overturn the meaning of the messages.

But in the theory of perception alone it is not enough to understand in what way our mind combines visual information with linguistic information. The

neurophysiological studies contribute to fix this gap, thereby raising new questions on the sub-division of the competence of our brain.

In fact, in a small percentage of human beings, the destruction of only one of the two cerebral hemispheres has allowed studies to be carried out on the differentiated, linguistic, and visual perception, and on the conscience itself.

One case in particular:<sup>28</sup> Paul, a fifteen year old, encephalopathic boy from New York, underwent an operation for the resectioning of the corpus callosum. The loss of the partially injured hemisphere, as well as the inability to communicate between the active parts of the two hemispheres, caused by the sectioning of the corpus callosum, did not affect the capacity for linguistic reflection.

If he was given a written order to only his right hemisphere like: “Laugh!”, Paul effectively pretended to laugh. If he was then asked why he was laughing, he responded something to the effect of: “You are a strange bunch ...”.

When the order “scratch!” appeared, and he was asked why he was scratching he would reply: “because I feel itchy”. This highlights how the predominant hemisphere does not have any problem devising descriptive cohesion in order to account for the actions it has seen taking place but are outside of its direct experience due to the lack of connection with the other hemisphere. The experiments carried out on Paul demonstrate an independent participation of both hemispheres to the linguistic reflections spoken.

All these experiments tell us something fundamental about the way, in everyday life, we organize ourselves and act on this continual concatenation of reflections that we call conscience, and that we associate with our identity. On the one hand it shows us that repetitive action of language is “condicio sine qua non” for the experience that we associate with the mental aspect. On the other hand, these experiences based on the linguistic aspect are organized on the basis of a variety of states of our nervous system, to which, as observers, it is said that we have no direct access but that we always organize in a way so that it is inserted in the logical connection of our “ontogenetic drift”.

In the linguistic domain of Paul he smiles without a logical explanation for this action, thus, his consciousness of being alive attributes this state to some reason, such as: “you are a strange bunch!”, keeping the descriptive cohesion of his story with this reflection.

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<sup>28</sup> Humberto MATURANA e Francisco VARELA, “L'albero della conoscenza” Milano, Garzanti, 1987

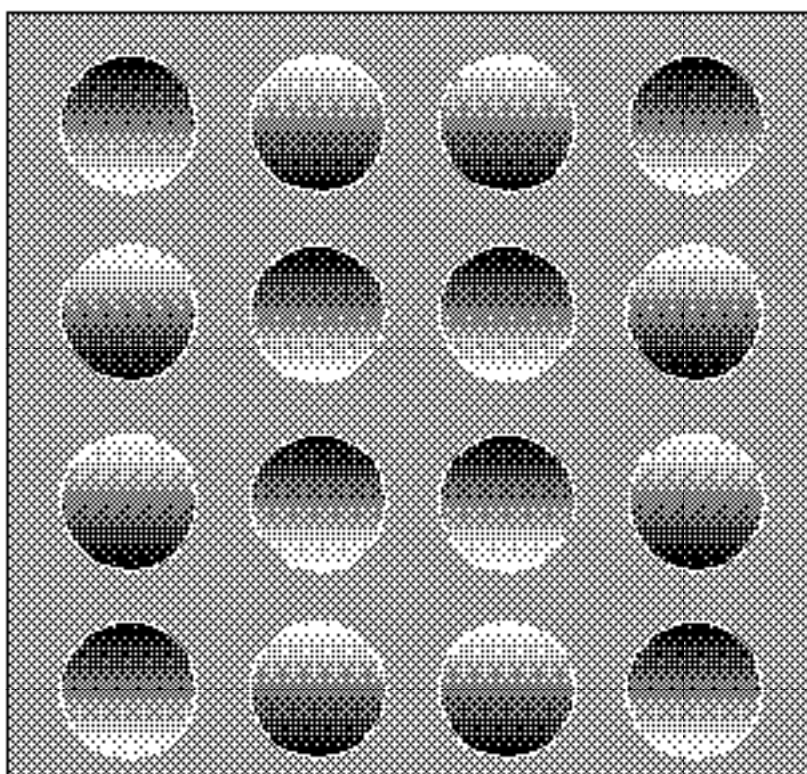
In Paul's case we can see how disjointed consciousness operates in the organism itself, it is something that reveals a mechanism that must operate in us constantly.

This shows us that in the network of linguistic interactions in which we move, we maintain a continual descriptive repetition that we call "ME", which allows us to conserve our linguistic operational coherence and our adaptation in the domain of language.

But it is definitely not easy to speak of phylogenetic and ontogenetic aspects of cognition. In order to better understand the sense of this affirmation we can refer to V.S. Ramachandran's study published in the journal, "Nature", January 1988, where he illustrates how the brain uses shading of the bidimensional images in order to reconstruct the tridimensional sensation of space.

The research shows thoroughly enough that, in general, it is the assumption of unidirectionality prevalent in the source of light, that determines the perception of deepness or of the relief of a flat image. This, the researcher considers, would be due to the fact that the phylogenetic evolution of the human brain has taken place in a planetary system in which there is only one sun and, consequently, only one source of light.

In the following mental elaborations that are part of the research, one makes use of various formal models, through which one can see different results for the one same figure.



The brain supposes that light originates from above. Therefore, in this figure one perceives objects circularly inclined in relief. If the page is turned upside down, one will perceive the eight circular objects as cavities in which the depth effect is overturned. This demonstrates that the brain elaborates sensations of depth in relation to the shading, taking into consideration its position on the retina.

This is a very interesting phenomenon through which one has the capacity of realizing just how complex the moments of vision, comprehension, and interpretation of the world that surrounds us are; and that we are used to considering as objective, separate, and independent from us.

W. Koeler (1935) proposed an interesting analogy on the relationship between stimulating objects and perceived object; the former can be compared with the hole of a rifle, while the second to the hole that the projectile makes in the target; one and the other are separated by one long chain of events: the exit of the projectile, the trajectory itself, the impact between the material of the projectile, and that of which the target is constructed. The hole in the target depends not only on the calibre of the projectile, but on the material of the target itself. Hence the perceived object has the outline not only of the stimulated object but also of the receiving subject.

*“The interpretation transforms and moulds the meaning of the message received, imprinting it with the habits and values of the receiver to the extent that, sometimes, it radically modifies the sense of the message itself”* <sup>29</sup>

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<sup>29</sup> Mauro WOLF, "Teoria delle comunicazioni di massa", Milano Bompiani 1988

This is a typical concept of the “selective perception” theory, and refers explicitly to the studies of communication research, in particular to those characteristics of persuasion of the message and mass media.

Research is used that has brought about the formulation of the hypothesis such as: the “derailment of understanding” (Cooper & Jahoda 1974), like some aspects of the “effects of assimilation or contrast”, or of selective memorization.

Obviously this poses the question of how important is the preparation of the user of the information, or how much attention one must give to the training sphere, not just to what should be communicated but also who has to be the active subject of this communication.

Even if in the first analysis, the interaction in multimedia communication might appear to be a weakly effective weapon in resolving the problem of ambiguity between the message sent and the comprehension obtained, we will see that, most probably, it is through this process that one is able to recover a part of that which one commonly does in other communication spheres, for example in language - that is to say the partial overtaking through cognitive restructuring of the ambiguity of communication states.

The future training courses in the next few years will probably be very different from those imaginable today.

The development of new fields of study like *Holography and 3-D Imaging*, *Computer Graphics and Animation*, and the *Vision Science*, will produce once again new tools and, consequently, new ways of understanding didactic information.

Gli sviluppi di campi nuovi di studio quali *l'Holography and 3-D Imaging*, *la Computer Graphics and Animation*, e *la Vision Science*, che in particolare si occupa di capire i fenomeni della visione umana e delle macchine, per poter aggiungere un canale ulteriore oltre a quello tattile e sonoro alla comunicazione tra l'uomo e la macchina, produrranno una volta ancora mezzi nuovi e conseguentemente modi nuovi di intendere anche la didattica informatizzata.

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**It is necessary, however, to pay particular attention to the results of this kind of empirico-experimental approach, and to how much of it can be used in reference to the communication of concentrated groups of individuals. (Limitation is understood in a quantitative sense, but also with reference to the specifics of the competence of single things like messages or information supplied to it).**

**Our research shows, in fact, that it needs to be pointed out that even if the examined average is the same, the message is detailed and only a general competence of the indicated research can be used in relation to the ambit defined by us..**

What remains to do, therefore, is to take an active part of this evolution given that in training simple memorization is a concept connected with duty, while knowledge is a fact of love and, therefore, of pleasure.

*Love is a better teacher than duty*  
(Albert Einstein)

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