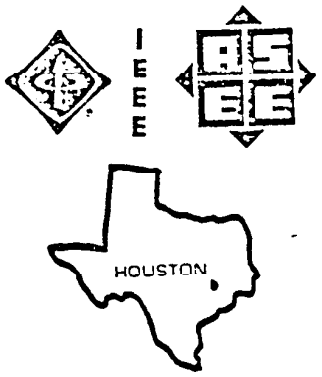

PSYCHOLOGICAL FUNCTIONS AS A BASIS FOR A TAXONOMY OF EDUCATIONAL OBJECTIVES IN COMPETENCE PROGRAMS TOWARDS A SYSTEMATIC APPROACH

Jean Le Mee
Professor of Engineering
Cooper Union
New York, New York

1. Introduction

There has been in recent years an effort made to introduce into higher education more concern for the learner and the learning process than was previously customary. The result has led to a number of experiments ranging from the Personalized System of Instruction (PSI)[1] used in individual courses, to Competence Based Curricula[2] or to the consideration of the implication of Psychological Types for Teaching.[3]

However, reviewing these efforts, this writer is struck by what he perceives as their excessive empiricism and their ad hoc nature, a result of which is that, though often complementary in principle, these approaches are not easy to reconcile with one another. It would be useful for instance, to be able to make simultaneous use of a taxonomy of educational objectives similar to Bloom's[4] and a type indicator such as the Myers-Briggs[5] in designing educational experiences best suited to certain categories of learners, but the ad hoc character of the taxonomy and the somewhat different classes of the typology make their concurrent use difficult. Similarly, the selection of competences and their organization into a competence based curriculum is, it seems, generally the result of a faculty and/or professional consensus with little philosophical or theoretical justification or forethought. The consequences are, in general, unplanned overlaps of the competences so defined, lack of understanding between their inter-relationships, lack of coordination, redundancy in some area and lack in others, added difficulty in the design and the process of assessment, etc.

A more fundamental approach seems, therefore, desirable. This approach should include the psychological domains as recognized by Bloom et al though extended and clarified, since these domains correspond, as we shall see, to a natural and traditional view. It should take into consideration the nature of the subject matter to facilitate the elaboration of educational objectives. Finally, it should also be amenable to the inclusion of a typology along the lines of the Myers-Briggs Index since considerable work has been done and that an extensive data bank exists for this index.

The present paper is the first step in an attempt to develop these objectives. It concentrates on a systematic approach to the classification and study of certain psychological functions which directly relate to the domains used by Bloom et al. It thereby provides a basis for a taxonomy of educational objectives and professional competences useful in the establishment of competence-based programs. The approach taken establishes also a framework for a psychological typology which can be related to the Myers-Briggs Index. Such a typology will be developed subsequently.

2. Educational Objectives

Overall educational objectives formulated for college and professional school students as they appear in catalogues and departmental literature are more often than not so global and vague as to be of little help in developing courses. The courses offered in these catalogues are themselves in general more the result of tradition, academic politics, fashion and other similar pressures within the limits set by the accreditation agencies than of rational thought, while their subject matter is often left to the discretionary power of an instructor, a department chairman or a faculty committee. It may, therefore, be said without exaggeration that what the student is made to learn is more determined by an accumulation of old prejudices than a clear vision of his future or a just appreciation of his present. Faced with this situation, individual instructors generally resort to the logical structure of the subject matter to develop educational objectives. Paradoxically, it should not be thought that this has always been a shortcoming. The very logic of the subject matter, not uncommonly, allows for clear organization and helps memorization and use. It is also often appealing by its sheer beauty. This last point, in fact, may be used in some cases to introduce a desirable affective component in

an otherwise rather purely intellectual exercise. Besides, to the extent that students and teachers, particularly in professional schools, form a fairly homogeneous group, characterologically speaking, the method best adapted to the need of the class will very often select itself if the teacher does not go too much against his own grain but follows what comes to him naturally. Such a system, however, has severe limitations since it tends to reinforce the already dominant traits of the group and to neglect those in need of development.

The advent of competence-based programs requiring by design to focus not only on the subject matter but also on the student, has made it imperative to broaden the view and keep account of the nature of the learner, of knowledge, and of their inter relationship. The attention of the course designer can no longer be limited to a piece of subject matter. The Mars-Hill College competence curriculum for instance, formally keeps account of the nature of knowledge, relying on Phenix's Six Realms of Meaning[6] which include: symbolics, science, aesthetics, values, synoptics and personal knowledge. The nature of the learner, though, is not systematically introduced into the objectives of this model. Other approaches base themselves on the nature of the learner and that of knowledge but do not clearly differentiate between the one and the other. Most educators are familiar, for instance, with Bloom et al's taxonomy of educational objectives[4] which distinguishes three psychological domains: cognitive, affective and psychomotor and uses them to order educational objectives. Though widely used, Bloom's scheme presents difficulties. As the authors themselves remark:

> "The arbitrariness of the taxonomy structure is at once apparent in, among other things, its division of the realm of educational goals into three domains: cognitive, affective and psychomotor".[4]

They proceed to point out that these domains are not independent but indeed clearly overlap:

> "At all levels of the affective domain, affective objectives have a cognitive component and one can find affective component for cognitive objectives".[4]

Though this interdependence of the domains, at least between the cognitive and the affective ones, is recognized, the structure of the taxonomy does not allow for the systematic treatment of this interdependence. The reason is that these domain taxonomies have been developed separately on an ad hoc basis as the authors themselves explain in their preface.

Furthermore, the motor element, present in all the goals to a degree, under the form of skill, activity, etc., be it mental, emotional or physical, is not differentiated. The psychomotor domain studied later by Harrow[7] is too narrowly restricted to physical skills alone to be of much use in higher education. We propose here to extend it to include all the "active" or "motor" elements in the three domains.

3. Psychological Functions

As pointed out above, Bloom et al's taxonomy does not exploit the overlap between the psychological domains; in fact, it rather seems to be hindered by it. Yet, it is this overlap that is fundamental to establishing a systematic approach. As shown below, it allows the development of a matrix of psychological functions and, by inclusion of the "knowledge orientation", it serves to frame a matrix of educational objectives. Bloom's domains, (cognitive, affective and motor) in fact, arise naturally from what might be termed our "modes of knowing": As human beings, though we have five senses, five groups of organs through which we are in contact with "external reality" and through which sensible knowledge comes to us, it can be said that we relate to the objects of knowledge according to three modes: intellectual, emotional and active. As we have remarked elsewhere[8], "for the professional in particular, knowledge is always knowledge of what is, of what is to be done, and of how to do it in the moment of action." This, quite naturally, leads to consider the subject matter of that knowledge according to its theoretical, its applied, and its skill orientation.

The fact is that the cognitive, affective and psychomotor division of the realm of educational goals and their interrelationships recognized by Bloom et al are not as arbitrary as these authors seem to imply. Each of these divisions corresponds to fundamental modes of apprehending "the world" as the above remark suggests. Furthermore, these modes constitute the basis of the formation of the personality as understood traditionally. This can be used as a basis for elaborating a corresponding typology.

The interconnection between the cognitive, affective and motor elements of the personality have long been recognized and used in the teachings of the Eastern Christian Orthodoxy for instance, according to Mouravieff.[9] In this view, the structure of the personality, conceived descriptively, i.e. in terms of phenetic relationships between the elements of the structure rather than in terms of genotypes or of psychoanalytic considerations, is envisaged as being oriented along three great currents of psychic activity: Intellectual, emotional and motor which, roughly, correspond respectively to our thoughts or cognitive processes, to our feelings or emotional processes and to our means of action, or motor processes. Each of these groups of processes or activities is associated in a psychosomatic relation with a body location where they appear to evoke a resonance.

Of course, the somatic seat of these functions cannot be precisely located, yet, popular language, often wise and direct, vividly and descriptively, speaks of head, heart and guts in this connection. This is a rather simple and elementary but, nevertheless, profound observation. Not essential for the theory, but invaluable for self-observation, these locations are perhaps best thought of as "centers of gravity" to emphasize that, though diffused throughout, the effects of the psychological activities find themselves primarily reflected in these areas and are thus brought to the awareness of the subject (Fig. 1.a).

Such a framework provides a useful and practical model. If, to some, it may appear highly subjective, it ought to be remembered that the distinction objective/subjective is more often than not a rather subjective one and depends principally on the point of observation, i.e., quite literally, on the point of view of the observing subject. "Traditional psychology is not, in fact, based on [external] observation; it is a science of subjective experience." Remarks Coomaraswamy.(10)

Yet, grounded in a robust common sense and informed through keen psychological observation by centuries of practice, it has developed into a very fine instrument for self-observation as well as for gaining insight into others' behavior. It is in this perspective that our approach is made.

The three fundamental psychologic domains, intellectual, emotional and motor can be conceived as having a dual office of reception and manifestation: a polarization into a passive and an active aspect. The intellectual domain for instance, produces or handles ideas, combining them - an active operation - while it also registers, memorizes and reflects, a more passive activity. Similarly, the emotional domain dealing with feelings, passions and sentiments, distinguishes between their receptive and their expressive aspects. The motor domain finds itself naturally polarized into an instinctive component mostly regulating the accumulation of energy, e.g. the body autonomic functions, and a voluntary component (conditioned reflexes) which mainly governs the energy consumption (e.g. the voluntary functions of walking, handling, speaking etc...). In addition, a modicum of observation shows that each of the three main psychological domains partake of one another: one can appreciate, for instance, in any physical movement an intellectual and an emotional content giving it direction and quality respectively; a thought, in itself, can always be seen as including an element of movement and feeling, while a feeling will exhibit movement (emotion) and display a greater or lesser degree of thought. We are here dealing, of course, with a continuum, but, to clarify the analysis, we can consider that each domain divides into three, whereby two of these three parts partake of the nature of each of the other two domains or work under their influence, while the third part remains "pure" or autonomous. It is a matter of predominance where, for instance, the intellectual domain may operate relatively free from the influence of the other domains in the case of "pure" intellectual contemplation or be heavily dependent on the active domain as in a "brain-storming" activity.

Symbolically, one can represent the three domains by circles as shown on Figure 1(a). These are then divided into two parts indicating the active and passive aspects of these domains as on Figure 1(b). Figure 1(c) shows "sectors" representing the parts of each domain attuned to the other two domains. Each domain comprises, therefore, six sectors: for instance, the intellectual domain, for each of its active and passive aspects has

- a pure intellectual sector labelled II
- an intellectual-emotional sector labelled IE
- an intellectual-motor section labelled IM.

The fact that the domains partake of one another implies interactions between them. These interactions can be, in turn represented by connections linking the "pure" sectors of each domain (passive and active) to the "mixed" sectors of the other two domains as shown on Figure 2. There are, therefore, twelve links, two issuing from each of the three domains and terminating in the other two. It is this system of 18 sectors and 12 links which represents, in this perspective, the basic structure of the personality. Each sector corresponds to a characteristic group of psychological activities. For greater clarity and ease, we reorganize the scheme as a matrix and now identify the specific psychological function of each sector. (Figure 3.)

We might think of the intellectual part of the intellectual domain for instance as representing the capacity for "abstraction" whereas its motor part will be concerned with the business of "thinking", i.e. logical thought, conscious mental processes, the step by step plodding activity ordinarily associated with "figuring out." Its emotional part will, on the other hand be the province of the warmer, quicker, livelier activity usually conceived of as "intuition." In turn, the active and passive aspect of the intellectual domain can be taken to characterize the ability to synthesize and analyze, respectively. These tendencies to synthesize and analyze will naturally translate themselves within the "thinking" activity as the capacity for induction and deduction; within the intuitional activity, as the tendency towards breadth and depth respectively; and within the capacity for abstraction, as the tendency towards generalization and classification. Similar considerations of the emotional motor functions lead to the results indicated on the matrix of Figure 3. In particular, the affective domain, covering the emotional functions and governing

as it does the quality of the relationship of what is conceived as the I and the non-I differentiates, in its expressive and receptive qualities, the two fundamental attitudes of extraversity and introversity. In the first case, attention and energy flow out to objects and people, in the second, the flow is directed back to the subject. The main intellectual component of this function will be that of valuation, the introvert aspect of which will be the adoption or classification of values whereas its extrovert aspect will be concerned with elaboration or the application of these values, i.e. judgement. The emotional component of the affective domain is really our heart of heart, characterized in its active (extrovert) aspect by care and confidence giving rise to such qualities as empathy, leadership etc. In its passive (introvert) aspect it would be associated with acceptance and trust, manifesting as openness, attentiveness, sincerity, etc. For lack of a better word, we call this emotional component of the effective domain Feeling. The motor component of the affective domain, we have labelled, here again, for lack of a better word, discipline. In its extrovert aspect, it is that quality which makes us active in the service of others, thorough and productive, while in its introverted aspect, it makes us obedient, reliable and trustworthy.

With regard to the motor domain, its intellectual component will be concerned in its active (instinctive) aspect with such things as the capacity for percepts and data handling, i.e. mental awareness or alertness and its passive aspect (voluntary) with the capacity for observation. We therefore label this component of the motor domain as Perception. The emotional component of the motor function we shall call Drive. It is the more "gutsy" aspect of the confidence and acceptance qualities of the affective domain. It is characterized in its instinctive (active) and voluntary (passive) aspects as zest for life and courage respectively. The motor component of the motor domain is the realm of Dexterity. It is the area considered in detail by Harrow[7] in her taxonomy of the psychomotor domain; actively, we would include here sense and body awareness, but other functions such as the regulation of the body autonomic function can be considered as belonging to it also. In its passive (voluntary) aspect, we would consider here all the acquired psychomotor skills and conditional reflexes including handling, speaking, writing, (sports), etc....

The matrix of Figure 3 thus represents not only the 18 sectors of Figure 1.c but also their interconnections as shown on Figure 2, these interconnections being directly indicated by the relative position of the functional subdivision. Of course, one must not be carried away by all this classification, believing that this model implies that the mind is neatly divided into compartments with well-defined functions; nor should we think that the model pretends to be an analog representation of the brain or of the nervous system. It needs be emphasized here again that we are in the present case, concerned only with psychological functions of the mind and that this mind is considered as one, as a holistic entity; that the psychological functions, each one of them, is considered to take place throughout mind and therefore engages the whole mind, though different types of mental activities are conceived as having a different "center of gravity," a different predominance. The proposed scheme is one possible way of studying the psychological functions and of accounting for their interdependences, but the lines on the diagram identifying the "functions" must not be mistaken for boundaries in some mental "geography". Our purpose here is simply to show that the proposed viewpoint is a productive and in integrative one. The functions and their components thus defined do not pretend to account for all the mental realm of Man either, nor to represent intrinsic qualities of the mind. The purpose is to provide a useful operational viewpoint accounting for that part in us which is the subject of attention in education and training.

4. Taxonomy of Educational Objectives

As an illustration, we make use of the matrix of psychological functions to establish a matrix educational objectives as shown on Figure 4. It is from this last matrix that we have formulated the matrix of competences and their levels in the SHAPE program as exposed in a previous paper,[8] Figure 5.

5. Conclusion

The concept of psychological functions developed here, constitutes a link between the psychological domains recognized by Bloom and their interrelationships. It provides an integrated and logical taxonomy of educational objectives. By application to the subject matter of a professional curriculum, it generates a set of coordinated competences which can form the basis of a competence program. Such a program is now being developed at the Cooper Union School of Engineering. The concept of psychological functions also provides the basis for a study of the personality and for the elaboration of a characterology of types related to the Myers-Briggs Index. Such a typology is now being developed. It will find direct application in education, principally in assisting in the design of educational experiences best suited to enhance particular competences.

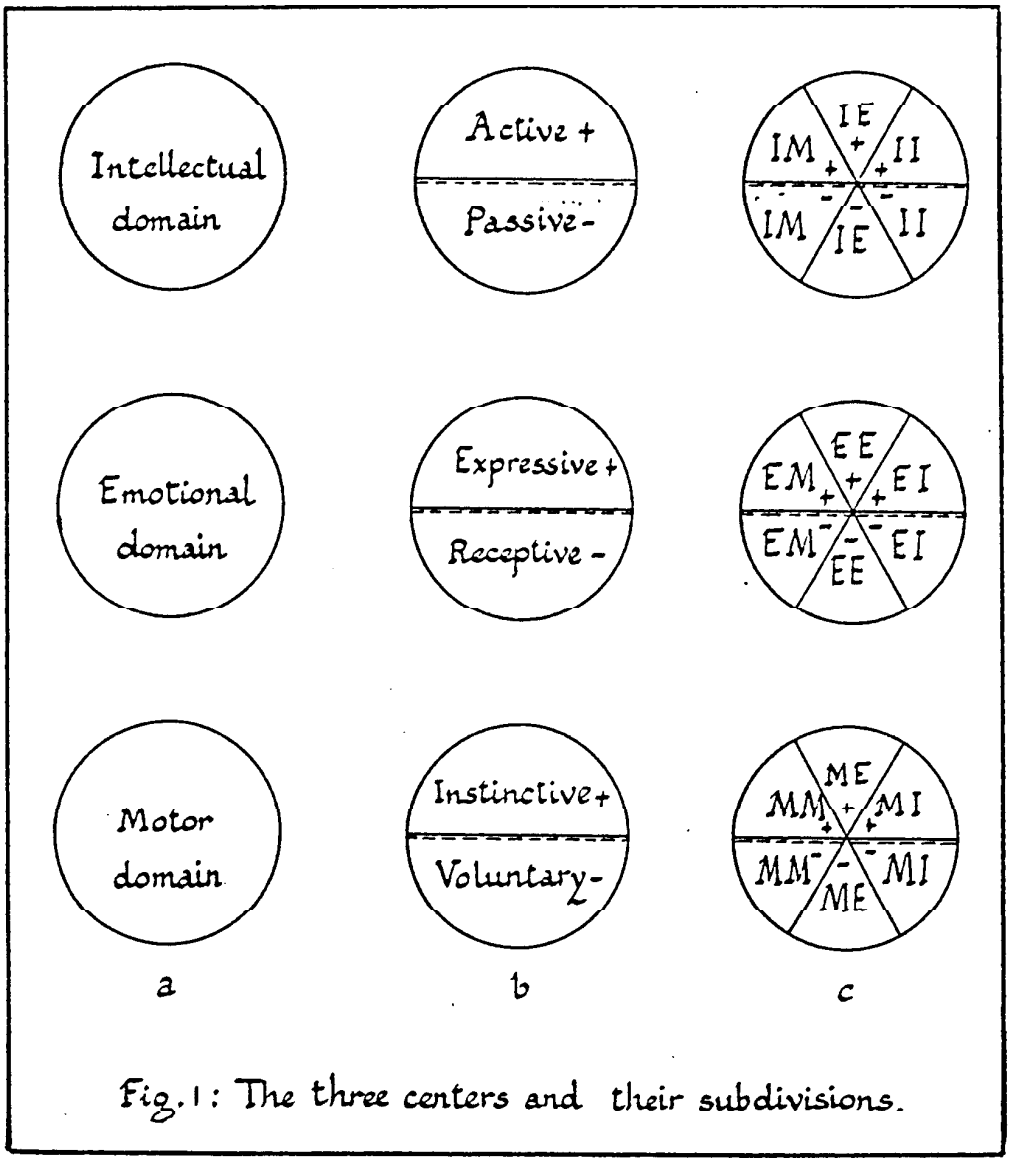

Fig. 1: The three centers and their subdivisions.

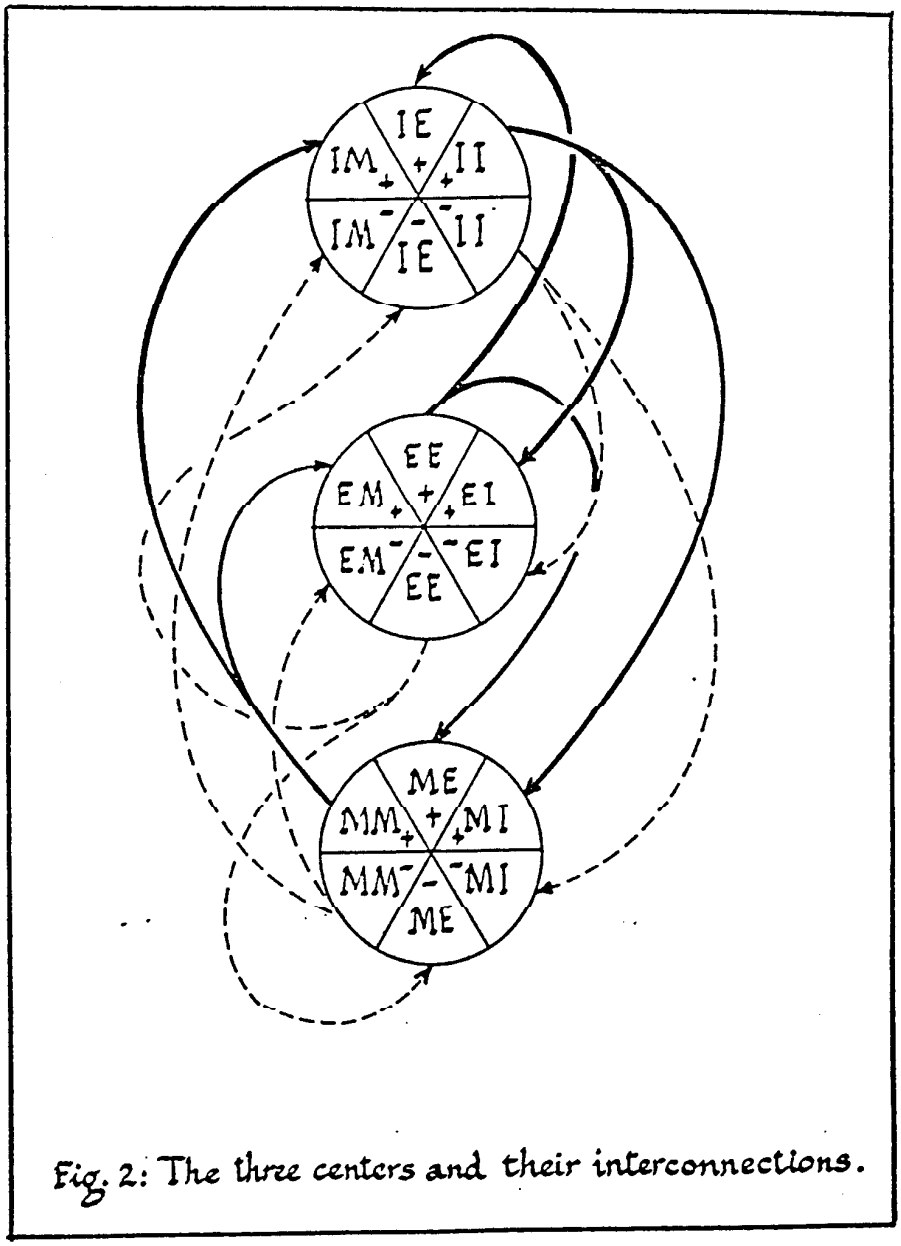

Fig. 2: The three centers and their interconnections.

DOMAIN		TENDENCY	COMPONENT OR PART OF DOMAIN		
			MOTOR	EMOTIONAL	INTELLECTUAL
	INTELLECTUAL (COGNITIVE)	Synthesis (Active)	THINKING INDUCTION	INTUITION BREADTH	ABSTRACTION GENERALISATION
		Analysis (Passive)	DEDUCTION	DEPTH	CLASSIFICATION
	EMOTIONAL (AFFECTIVE)	Extrovert (Active)	DISCIPLINE SERVICE	FEELING CONFIDENCE	VALUATION JUDGEMENT
		Introvert (Passive)	RELIABILITY	ACCEPTANCE	VALUES
	MOTOR (VOLITIONAL)	Instinctive (Active)	DEXTERITY SENSE AWARENESS	DRIVE ZEST FOR LIFE	PERCEPTION MENTAL AWARENESS
		Voluntary (Passive)	PSYCHOMOTOR SKILLS	COURAGE	OBSERVATION

Fig. 3: Matrix of Psychological Functions

MATRIX OF
EDUCATIONAL OBJECTIVES
(TAXONOMY)

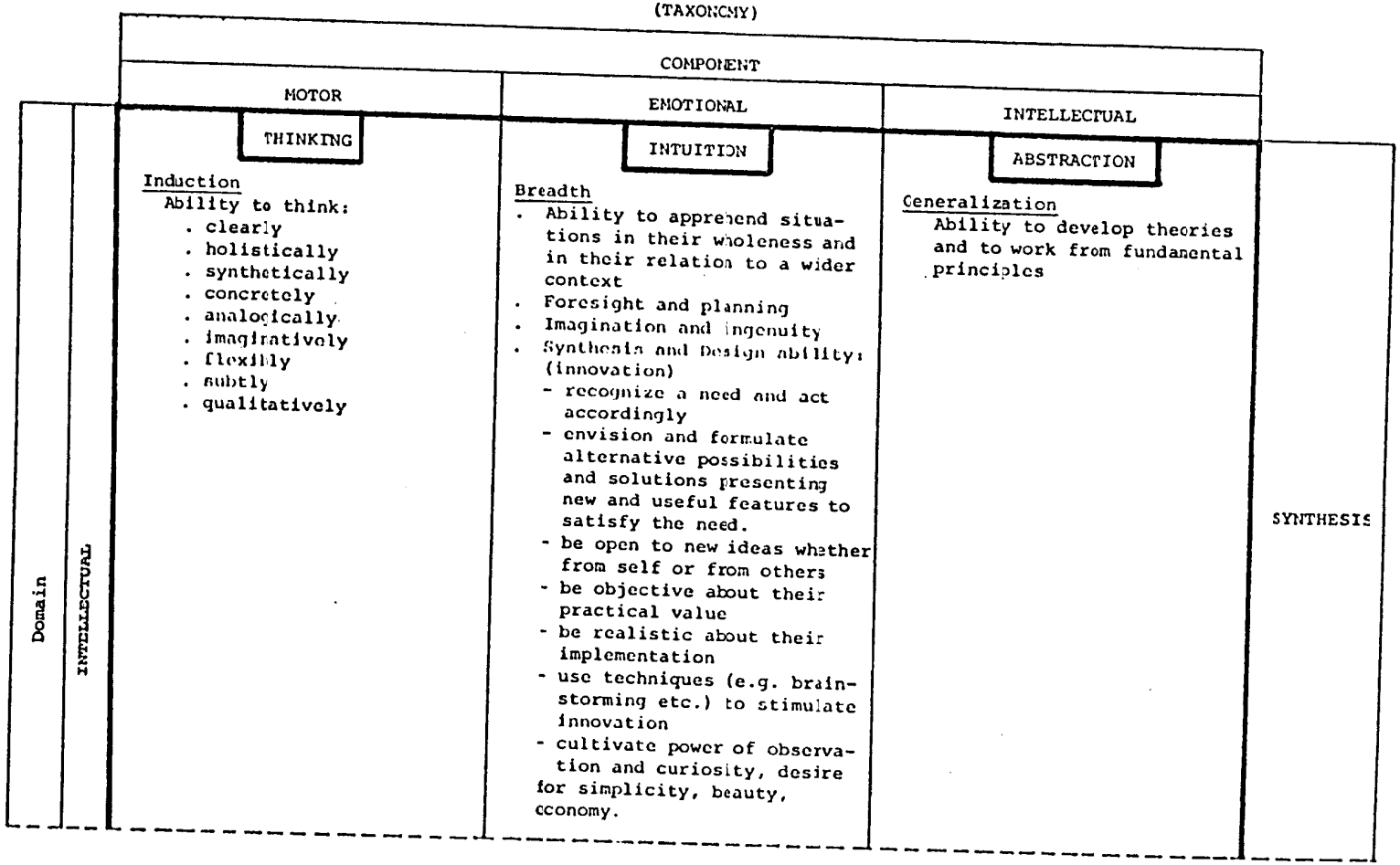

Fig. 4a: Matrix of Educational Objectives (Taxonomy)

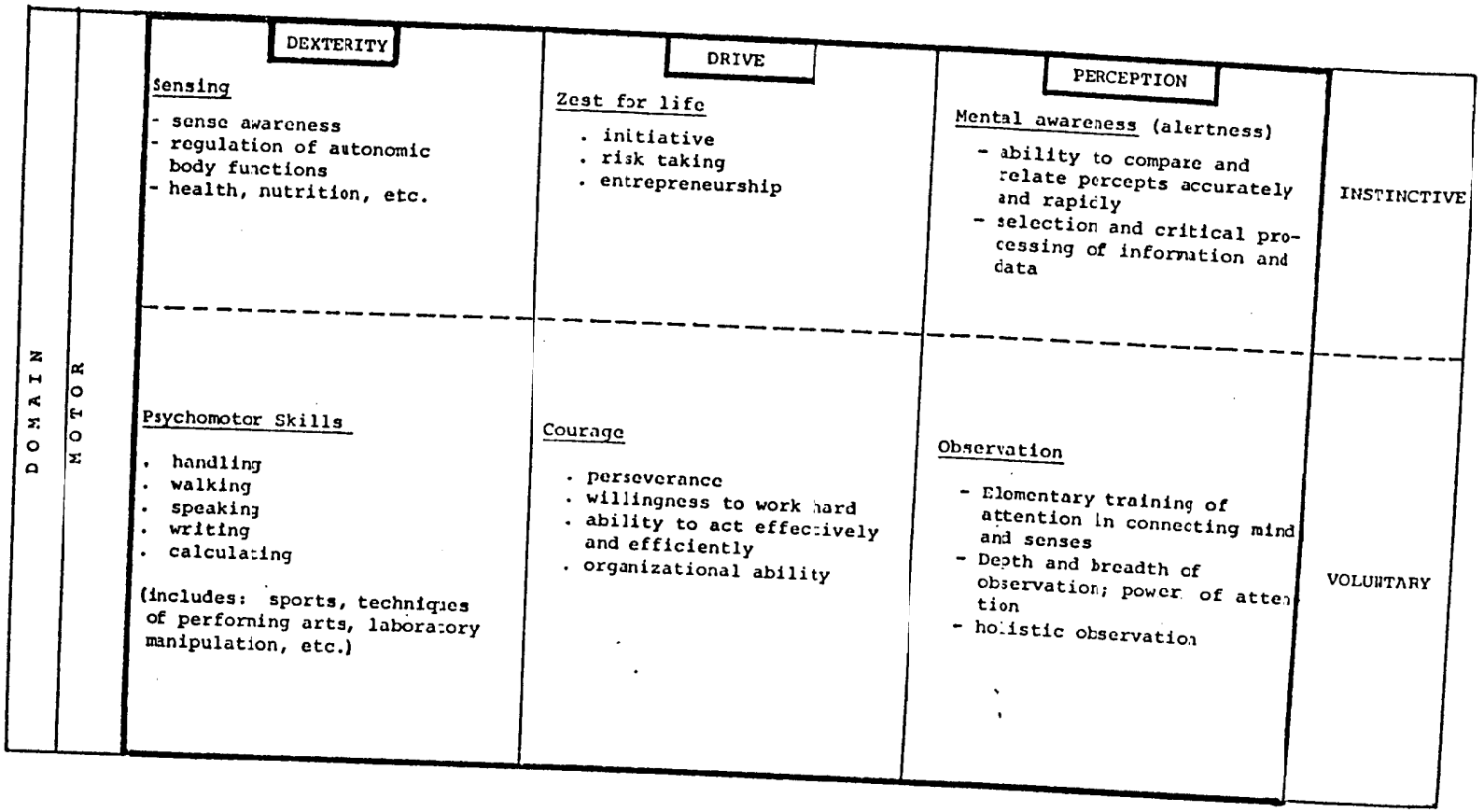
DOMAIN
MOTOR
DEXTERITY
DRIVE
PERCEPTION
Sensing
- sense awareness
- regulation of autonomic body functions
- health, nutrition, etc.
Zest for life
. initiative
. risk taking
. entrepreneurship
Mental awareness (alertness)
- ability to compare and relate percepts accurately and rapidly
- selection and critical processing of information and data
INSTINCTIVE
Psychomotor Skills
. handling
. walking
. speaking
. writing
. calculating
(includes: sports, techniques of performing arts, laboratory manipulation, etc.)
Courage
. perseverance
. willingness to work hard
. ability to act effectively and efficiently
. organizational ability
Observation
- Elementary training of attention in connecting mind and senses
- Depth and breadth of observation; power of attention
- holistic observation
VOLUNTARY

Fig. 4d

Fig. 4b

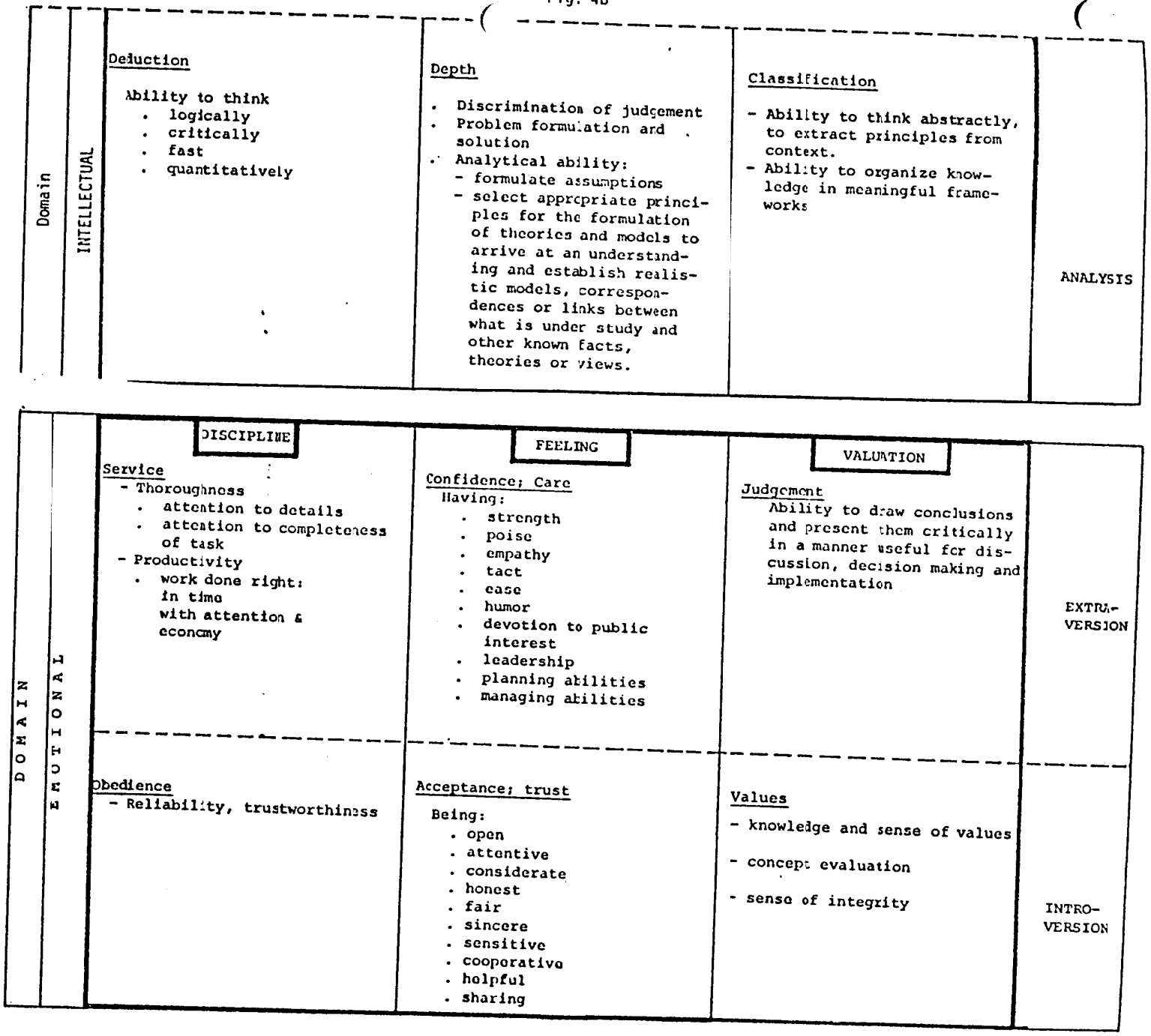
Domain
INTELLECTUAL
Deduction
Ability to think
• logically
• critically
• fast
• quantitatively
Depth
• Discrimination of judgement
• Problem formulation and solution
• Analytical ability:
- formulate assumptions
- select appropriate principles for the formulation of theories and models to arrive at an understanding and establish realistic models, correspondences or links between what is under study and other known facts, theories or views.
Classification
- Ability to think abstractly, to extract principles from context.
- Ability to organize knowledge in meaningful frameworks
ANALYSIS
DOMAIN
EMOTIONAL
DISCIPLINE
Service
- Thoroughness
• attention to details
• attention to completeness of task
- Productivity
• work done right: in time with attention & economy
FEELING
Confidence; Care
Having:
• strength
• poise
• empathy
• tact
• ease
• humor
• devotion to public interest
• leadership
• planning abilities
• managing abilities
VALUATION
Judgement
Ability to draw conclusions and present them critically in a manner useful for discussion, decision making and implementation
EXTRA-VERSION
Obedience
- Reliability, trustworthiness
Acceptance; trust
Being:
• open
• attentive
• considerate
• honest
• fair
• sincere
• sensitive
• cooperative
• helpful
• sharing
Values
- knowledge and sense of values
- concept evaluation
- sense of integrity
INTRO-VERSION

Fig. 1c

		SUBJECT MATTER ORIENTATION		
		SKILL	APPLIED	THEORETICAL
MODE OF KNOWLEDGE	COGNITIVE	COMPETENCE IN METHODOLOGIES	COMPETENCE IN PROBLEM SOLVING	COMPETENCE IN FUNDAMENTAL PRINCIPLES & CONCEPTS
	AFFECTIVE	COMPETENCE IN DISCIPLINE	COMPETENCE IN HUMAN DEVELOPMENT & RELATIONS	COMPETENCE IN VALUES
	VOLITIONAL	COMPETENCE IN BASIC SKILLS	COMPETENCE IN ACTION	COMPETENCE IN INFORMATION

Fig. 5: Matrix of Competences

Bibliography

1. Grayson, Lawrence and Biedenbach, Joseph; Ed.: Individualized Instruction in Engineering Education; ASEE Publ.

2. Popham, James W. and Lindheim, Elaine: Competency-Based Education. Engineering Education, Feb. 1978 pp 428-432.

3. MacCauley, Mary H.: Psychological Types in Engineering: Implications for Teaching. Eng. Ed. April 1976 pp 729-736.

4. (a) Bloom, Benjamin S., et al Taxonomy of Education Objectives. Handbook I: Cognitive Domain. New York: David McKay Co. Inc., 1975.

   (b) Krathwohl, David R.; Bloom, Benjamin; Masia, Bertram: Taxonomy of Educational Objectives; Handbook II: Affective Domain, New York: David McKay Co., Inc. 1974.

5. Myers, I. B.: Manual: The Myers-Briggs Type Indicator, Education Testing Service, Princeton, N. J. 1962.

6. Phenix, P.: Realms of Meaning. New York: McGraw Hill, 1964.

7. Harrow, Anita J.: A Taxonomy of the Psychomotor Domain; New York, McKay, 1977.

8. Le Mee, Jean and Rakow, Allen; Competence Definition and Assessment Plan in a Competence-Oriented Program. 1978 FIE Proceedings pp 368-381.

9. Mouravieff, Boris; Gnosis, Etude et commentaires sur la Tradition Esotérique de l'Orthodoxie Orientale v 1, 2, 3 Paris: Editions la Colombe, 1962.

10. Coomaraswamy, A.K.: Selected Papers; Metaphysics. Princeton Univ. Press, 1977.

JEAN LE MEE

Jean Le Mee is Associate Professor of Engineering at the Cooper Union School of Engineering. He was Director of the SHAPE Project (Synthesis of a Holistic Approach to Professional Education) supported by the Mellon Foundation and is now Director or the "Professional Competence Curriculum" project supported by the National Science Foundation. He teaches courses in systems and related areas at the Cooper Union. In 1975 he spent a year in Europe engaged in curriculum studies and consulting. During the academic year 1978-79 he was a senior fellow with the Department of South-East Asia Regional Studies at the University of Pennsylvania. He has published a number of papers on engineering topics, on education and a book of translation from the Sanskrit. Dr. Le Mee has served as consultant for industry and for the U.N. Presently his main research interests lie in the area of grammatical and linguistic systems and in the design of competence based curricula. He is a member of IEEE and ASEE.