A new conceptual model for finding and fostering the drives towards CEE

Marc GOOSSENS, Executive Director, European Society for Engineers & Industrialists (SEII)
Tel : + 32 24 26 32 62 – Mob : + 32 474 707 767 – Mail to : marc-goossens@skynet.be

Ellen SJOER, Researcher and Lecturer at Delft University of Technology, Director of the research group ‘Sustainable Talent Development’ at the Hague University of Applied Sciences
Tel : + 31 152 783 037 – Mob : + 31 649 69 01 91 – Mail to : e.sjoer@tudelft.nl

Bente NØRGAARD, Head of Section, Aalborg University
Tel : + 45 9940 9869 – Mob : + 45 3032 7787 – Mail to : bente@plan.aau.dk

SUMMARY

Two years ago, at the 2012 WCCEE in Valencia, the authors presented a conceptual model for learning and interacting, and they applied it to the implementation of the Knowledge Triangle and to its integration into the Triple Helix model. In this first approach of their concept, they described the paths followed by individuals within an organization and how these paths could interact, but they did not analyze the motivation driving an individual to follow a given path rather than another.

In the present paper, the authors extend their first approach and, on the basis of various fundamental works, such as Graves’ Spiral Dynamics, Schwartz’ concept of values and the 4-drive model of Lawrence & Nohria, tackle the issue of motivation. Then, they explain what induces the barriers met in university-industry cooperation in general, and in (Continuing) Engineering Education in particular, and suggest some solutions for overcoming them.

They believe that, in a fast-paced world, a proactive approach of such problems is essential, as it guarantees a ‘just-in-time’ adaptation or solution.

Short Historical Background: the M-A-U Concept (p.2)
First developments of the concept (p.2) – The almost absolute power of the models (p.4) – The exact form of the ‘helical paths’ and their interaction (p.4) – The case of organizations (p.5) – The case of civilizations (p.5) – First provisional conclusions (p.6)

Values and Motivation (p.6)
General characteristics of values (p.6) – Graves’ theory: levels of existence and Spiral Dynamics (p.8) – Schwartz’ theory of basic values (p.12) – The 4-drive model of employee motivation (p.14) – Second provisional conclusions (p.16)

Application to (Continuing) Engineering Education (p.16)
Introduction: values as a result of education (p.16) – A short historical perspective (p.17) – Three practical cases of impact on (Continuing) Engineering Education (p.18) – Soft skills in Engineering Education (p.19) – Rooting out ‘flatlanders’ in all forms and levels of education (p.19) – Is there a solution? (p.20)

Conclusions (p.21)

Keywords: Continuing Engineering Education – M-A-U concept – Spiral Dynamics – Values – Motivation – Drivers and barriers

Conference track : Day 3, Industry and University Collaboration, Session 3 (afternoon)
1. SHORT HISTORICAL BACKGROUND: THE M-A-U CONCEPT

1.a. First developments of the concept

Two years ago, at the IACEE World Conference on Continuing Engineering Education in Valencia, two of the authors of this paper presented a conceptual model for learning and interacting, and they applied it to the implementation of the Knowledge Triangle and to its integration into the Triple Helix model [1]. This concept model is based on the framework developed by the cognitive psychologist Ulrich Neisser [2], which consists – as shown in Figure 1 – of a triangular relationship between the models that we have in our brain, the exploration that we lead in a part of the world around us in order to find a satisfaction to our needs, and the available ‘objects’ that we select during that exploration and that contain some information, which in turn can – if considered useful – modify our models.

This triangular cycle represents the elementary unit of the learning process. But, going round the cycle takes some time and therefore, as shown in Figure 2, the succession of cycles takes the form of a helical path in the direction of the time, with billions of whorls in the interval that separates our death from our birth. They called it the M-A-U concept.

![Figure 1 – Neisser’s perceptual cycle](image1)

![Figure 2 – Helical path formed by the succession of cycles](image2)

But, they noticed, an individual is not alone in his world and he will have to interact with his fellow men, particularly when sharing an activity or taking interest in someone else’s activity. Except in extreme cases, that interaction takes the form of loose coupling, in the meaning defined by Karl Weick [3]. Unlike tight coupling, where both coupled elements loose their identity and some of their degrees of freedom, loose coupling preserves the identity and some evidence of the physical or logical separateness of both coupled elements.

Between two individuals, as symbolized in Figure 3, loose coupling acts as a torque that tends to align their respective axes (but there is some form of resistance, as we shall see later).
They considered that, when several people work together in a part of an organization – group or department –, the loose coupling between them, combined with the sharing of a set of common objectives and regulations, tends to give the group some characteristics of an individual: as a result, the group shows something similar to the succession of perceptual cycles.

The same reasoning remains valid when passing from the different parts of an organization to the organization itself and, further, successively to a cluster, a region, a country, a group of countries with a similar culture, and even a civilization. But, as the process is expanding, some of its features are changing: the coupling effect becomes looser and looser, the time between two successive loops grows drastically and both the cognitive concepts and the evaluating and interpreting phases become partially accessible to cognition and analysis, though forming a more and more inextricable tangle.

They then showed that the Knowledge Triangle can be obtained by the superimposition of two applications of the M-A-U concept to the University as an organization, one application concerning its educational activities, and the second application concerning its research activities. In this process, the A- and M-axes of both activities remain apparent, while their M-axes have disappeared from the representation and have become implicit (see Figure 4).

Figure 3 – Loose coupling between two individuals

Figure 4 – The Knowledge Triangle as a superimposition of two applications of the M-A-U concept
They also shortly explained in that paper how the M-A-U concept can be applied to other organizations or formal activities, such as University-Industry Cooperation and Continuing Engineering Education. Four months after the 2012 IACEE WCCEE, the authors presented another paper at the 40th SEFI Annual Conference [4], in which they applied the M-A-U concept to three practical cases linked with the Knowledge Triangle: we shall come back to that in the third part of this paper.

At that time, this concept was rather new in the authors’ mind, as they had just been developing it during the previous year. This is why we shall now bring some clarification.

1.b. The almost absolute power of the models (M)

The models that we have in our mind – and which form together our ‘Map of the World’ – have an almost absolute power, generally because they are mainly unconscious, but also, particularly, for the following reasons:

- When, in response to a need, we start an exploration activity (A) in order to find a way for satisfying that need, the explored area is, to a certain extent, delimited by our models.
- When, in this explored area, we choose – if we have the choice of course – a number of “objects” that are supposed to have the capacity of satisfying our need, that choice is dictated by our models (as is also dictated the way we shall use them).
- But, if the selected “objects” do not have the expected utility (U) – in other words, if they cannot satisfy our need – what are we going to blame for that? Certainly not our models, they are unconscious! No, we are going to blame the circumstances or some other person(s), with ‘frequent’ sentences like: “I didn’t have the choice” or “It’s XY’s fault!”.

As a result, we usually do not change our models as a result of having run through a cycle and, if NEISSER’s perceptual cycle is called the elementary unit of the learning process, it is only when we accept to learn. This is probably the explanation of what Max PLANCK said a century ago: “A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die and a new generation grows up that is familiar with it” [1], a form of Darwinism, in some sort of way.

1.c. The exact form of the ‘helical paths’ and their interaction

In the first presentation of the M-A-U concept, which is recalled above, we explained that the succession of perceptual cycles in time forms a helical path. Actually, this is an idealized description of reality, because we have many different needs and that, in order to satisfy them, we undertake different activities that are dictated by different models. Therefore, the axes of the successive loops form a broken line rather than a straight line.

---

[GOOSSENS, SJOER & NØRGAARD - # 91]
Nevertheless, in the same way that the application of various forces to a body can be described by a resultant force, the numerous segments of that broken line can be described by a global direction. The existence of such a global direction derives from the fact that the directions of the aforementioned linear segments are linked essentially to the models used in each case, that these models are progressively built in our brain during our childhood and that, once we have become an adult, they form our Map of the World, which represents the totality of our models and which can hardly be changed afterwards.

1.d. The case of organizations

We can apply a similar reasoning to organizations because, in order to work together, their executives must share, to a certain extent, the same objectives and motivations: this means that the global directions of their respective helical paths must have in common an important directional component, which can be seen as THE global direction of the helical paths of all the executives working in that company.

Such an extension of the M-A-U concept from individuals to organizations can explain a number of phenomena, such as the fact that, when taking on an engineer, companies attach practically more importance to their ‘soft skills’ than to their technical knowledge (which is, anyway, attested by their degree). Actually, his technical knowledge and know-how can be easily developed after his hiring, why his soft skills – at least, some of them – ascertain if, whether or not, the global direction of his personal helical paths is sufficiently aligned with the global direction of the helical paths of the company.

1.e. The case of civilizations

In his gigantic masterpiece ‘A Study of History’ in 12 volumes [2], the British historian Arnold TOYNBEE showed that 22 of the 23 civilizations he had studied had disappeared (the 23rd is our present Western civilization) and he attributed their disappearance to their incapacity to adapt to change. He compares the enthusiasm, the creativity and the flexibility of those who founded a civilization, with the passiveness, the conformism and the rigidity of the last representatives of that civilization. This is why he said that they died by suicide.

We think that our approach, through the M-A-U concept, is totally in agreement with TOYNBEE’s argumentation: those who founded a civilization created a new model for a group of people to live and thrive together. During its childhood, the new civilization had enough impetus and flexibility to adapt to a changing environment and expand. But, with the passing time, the people in power became unable to change a model that was becoming more and more obsolete, for the simple reason that this model was lying in their unconscious. And then came the end.

---

2 But he had the good idea to summarize his views in a single volume [5].
A recent study (2014), led by Safa MOTESHAARREI, from the National Science Foundation, and financed by NASA's Goddard Space Flight Center [6], warns us against a possible collapse of the Western Empire. Although their approach is quite different from ours and from Toynbee’s argumentation, we believe that there is no incompatibility. Nevertheless, this is not the objective of this paper.

1.f. First provisional conclusions

We have shown that the M-A-U concept, an approach that we have developed during the last three years, can explain – up to a certain point – the ‘working’ of different entities: individuals, the organizations that they build, and even the civilizations that they develop. It seems therefore that individuals project unconsciously their mental models – themselves unconscious – into their more elaborate constructions and, consequently, into the various ways through which they interact.

Of course, this M-A-U concept is purely topological. Nevertheless, all the knowledge that we have in our brain comes from electro-chemical signals that are sent to it by our five senses, and which activate a certain array of neurones forming some sort of network. Therefore, all knowledge is topological by nature.

But, before applying the concept to engineering education in general and to continuing engineering education in particular, we must take some interest in the motor – the engine – that transforms this topological concept into an active system, in other words into the drives that motivate us to act.

2. VALUES AND MOTIVATIONS

The concept of value is essential for explaining organization and change, both at personal and societal level. Values lie in the ‘M’ part of our M-A-U concept and reciprocal relations between values are at the root of our basic motivations, which underlie our attitudes and behaviours (in the ‘A’ and ‘U’ parts of our concept).

This is neither a course about values nor even a simple survey of all what has been said about them. Nevertheless, as they explain our motivations and the way we develop a global, relatively strong, direction of our successive helical paths, it is necessary to have some basic knowledge about them, particularly about CLARES’ concept of Spiral Dynamics and SCHWARTZ’ theory of values.

2.a. General characteristics of values

Here are the main general characteristics of values:
While personality traits are developed during infancy and remain particularly stable afterwards, values are learnt from culture during childhood and adolescence and remain relatively stable afterwards, though some 'adaptations' are possible.

Values express, either personally or socially, the underlying needs. They can be expressed as means (instrumental values) or as aims (final values).

Values structure our behaviour.

Values are relative: in absolute terms, no value may be said better than another one.

Values can be linked one with another, forming either an opposition or a communion.

Most theories of values adopt a conception of values that specifies six main features:

1) Values are beliefs linked inextricably to affect: when values are activated, they become infused with feeling.

2) Values refer to desirable goals that motivate action [4].

3) Values transcend specific actions and situations.

4) Values serve as standards or criteria, but their impact in everyday decisions is rarely conscious (they enter awareness when the actions or judgments one is considering have conflicting implications for different values one cherishes).

5) Values are ordered by importance relatively to one another.

6) The relative importance of multiple values guides action: before taking action, there is usually an unconscious trade-off among relevant, competing values.

There are up to now three main approaches for studying values:

1. A concept of values that is used in ‘political sciences’ : this approach is particularly well represented by the work of Ronald INGLEHART, Director of the World Values Survey. But such an approach, interesting as it might be, is not linked with our subject [9].

2. A concept of values that is considered under a historical and societal point of view: this approach was first introduced by Clare GRAVES [7] & [8], and then further developed by his disciples Ken WILBER, Don BECK, Chris COWAN and Natasha TODOROVIC ([9], [10] & [11]); it is also linked with the concept of ‘memetics’, developed by Richard DAWKINS [12]. This approach is very consistent with our M-A-U concept and this is why we shall describe it rather extensively.

3. A concept of values that is linked with ‘social psychology’: this approach has first been developed by Milton ROKEACH [13] and Lynn KAHLE [14], and then further developed by Shalom SCHWARTZ [15] & [16]. We shall also shortly describe this approach, which presents some consistency with our M-A-U concept.

---

3 See what we said in Valencia about the structuring effect of a helical path.

4 This is the M ➔ A link of our M-A-U concept.

5 This is why the many references to his work are not given here.
2.b. GRAVES’ theory: levels of existence and Spiral Dynamics

After a 30-year research career, the psychologist Clare Graves proposed a ‘Theory of Levels of Human Existence’, in which he considers that the psychology of the mature human being is an unfolding, emergent, oscillating spiralling process, marked by progressive subordination of older, lower-order systems to newer, higher-order systems, as man’s existential problems change. His theory can be summarized in the following seven key points:

1. Human nature is not static, nor is it finite: it changes as the conditions of existence change, thus forging new systems. Yet, the older systems stay with us.

2. When a new system or level is activated, we change our psychology and rules for living to adapt to those new conditions.

3. We live in a potentially open system of values with an infinite number of modes of living available to us. There is no final state to which we must all aspire.

4. An individual, a company, or an entire society can respond positively only to those managerial principles, motivational appeals, educational formulas, and legal or ethical codes that are appropriate to the current level of human existence.

5. A spiral vortex best depicts this emergence of human systems as they evolve through levels of increasing complexity. Each upward turn of the spiral marks the awakening of a more elaborated version on top of what already exists. The human spiral, then, consists of a coiled string of value systems, worldviews, and mindsets, each the product of its times and conditions. In other words, new times produce new minds.

6. In this spiralling process, mankind passes successively from an individualistic, egocentric orientation to a communitarian, social orientation, and vice versa.

7. Each new level transcends and includes all previous models, but any individual whose mind has reached a given level is convinced that the corresponding model is the best one and that the previous models are unsuitable or even completely wrong; furthermore, he is entirely unable to understand and acknowledge the models that are used by individuals who have already reached a higher level.

The main characteristics of this approach are presented in Figure 5 and in Tables 1 & 2. It may be worth pointing out that the use of colours to refer to the successive levels, the name of ‘Spiral Dynamics’, the subdivision in two tiers (subsistence and being) and the reference to memetics have been added by Graves’ disciples after his death.

---

6 Important: the choice of colours has absolutely no significance! In particular, the green of the sixth level does not refer to an ecological ideal (actually, though one may not link a political party with a given level only, it seems that the representatives of an ecologist party are mainly at the yellow level)!!

7 In order to be pragmatic and stay within the framework of our objective – the application of this approach to (Continuing) Engineering Education – we are not going to develop here the concept of the ‘MEMEs (value-attracting meta-memes).
A new conceptual model for finding and fostering the drives towards CEE

Figure 5 – The Spiral Dynamics

Table 1 – Basic description of each level of the Spiral Dynamics

<table>
<thead>
<tr>
<th>Levels and characteristics</th>
<th>The two components of each level</th>
<th>Reasons for passing to a ‘higher’ level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surrounding life conditions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Means to cope with these conditions</td>
<td></td>
</tr>
<tr>
<td>First tier: levels of subsistence</td>
<td>NH-Beige</td>
<td>A. Biological urges and drives only, dictated by nature and physical senses</td>
</tr>
<tr>
<td></td>
<td>BO-Purple</td>
<td>B. Physical world and realm of spirit beings overlap and collaborate for safety and survival traditions, customs and hero’s role apparent</td>
</tr>
<tr>
<td></td>
<td>CP-Red</td>
<td>C. Like a jungle, where the rules prevail and the weak survive; nature is an adversary to be conquered</td>
</tr>
<tr>
<td></td>
<td>DO-Blue</td>
<td>D. Controlled by obedience to a Higher Power that directs living; pursues wrong goals and eventually rewards good works and righteousness living</td>
</tr>
<tr>
<td></td>
<td>ER-Orange</td>
<td>E. Full of resources to develop and opportunities to make choices, and to bring prosperity to those with initiative and willingness to risk</td>
</tr>
<tr>
<td></td>
<td>FS-Green</td>
<td>F. The shared habitat where humanity can find peace and purpose through affiliation and appreciating the diversity</td>
</tr>
<tr>
<td>Second tier: levels of being</td>
<td>GT-Yellow</td>
<td>G. A chaotic organism with underlying order; where change is the norm and uncertainty an accessible state of being, as knowledge increases</td>
</tr>
<tr>
<td></td>
<td>NU-Turquoise</td>
<td>H. A delicately balanced system of intertwining forces in some jeopardy for humanity, in need of compassion and comprehension</td>
</tr>
<tr>
<td></td>
<td>IV-Coral</td>
<td>I. Too soon to say.</td>
</tr>
</tbody>
</table>

[GOOSSENS, SJOER & NØRGAARD - # 91]
A new conceptual model for finding and fostering the drives towards CEE

Table 2 – Main characteristics of each level of the Spiral Dynamics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>1st tier: levels of existence</th>
<th>2nd tier: levels of being</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Male</td>
<td>Male</td>
</tr>
<tr>
<td>Basic way of thinking and nature of existence</td>
<td>Adaptive, instinctive</td>
<td>Adaptive, instinctive, eclectic</td>
</tr>
<tr>
<td>Priority codes</td>
<td>Survival, small needs, food, water, shelter, sleep, security</td>
<td>Survival, psychological power, social stability, religion</td>
</tr>
<tr>
<td>Motivation</td>
<td>Physical</td>
<td>Evolutionary</td>
</tr>
<tr>
<td>Values</td>
<td>Traditions</td>
<td>Revolution</td>
</tr>
<tr>
<td>Lifestyle</td>
<td>For survival</td>
<td>For survival</td>
</tr>
<tr>
<td>Stress type</td>
<td>Vulnerability</td>
<td>For the present</td>
</tr>
<tr>
<td>Problems of existence</td>
<td>Maintaining physiological stability</td>
<td>For now</td>
</tr>
<tr>
<td>Approximate starting date</td>
<td>190,000 BC</td>
<td>For the future</td>
</tr>
<tr>
<td>Political systems and distribution of power</td>
<td>Survival classes (e.g. Hatti)</td>
<td>For the future</td>
</tr>
<tr>
<td>Economics systems and distribution of resources</td>
<td>Estates and regions</td>
<td>For the future</td>
</tr>
<tr>
<td>Present population</td>
<td>World-wide 1%</td>
<td>For the future</td>
</tr>
<tr>
<td>Present population</td>
<td>USA 0%</td>
<td>For the future</td>
</tr>
<tr>
<td>Present population</td>
<td>Europe 0%</td>
<td>For the future</td>
</tr>
<tr>
<td>Present population</td>
<td>Sub-Saharan Africa 10%</td>
<td>For the future</td>
</tr>
<tr>
<td>Present population</td>
<td>World-wide 0%</td>
<td>For the future</td>
</tr>
<tr>
<td>Present population</td>
<td>Europe 0%</td>
<td>For the future</td>
</tr>
</tbody>
</table>

Figure 6 explains how a group can pass from one level of existence to the next higher level. There are two possibilities: either an adaptation of the existing model (evolution) or an utter change of model (revolution: change of paradigm). In both cases, a crisis is necessary to induce the change. In some cases, the necessary solution cannot be found, and the group regresses to a lower level.

Figure 6 – Passing from one level of existence to the next one in the Spiral Dynamics
Figures 7 & 8 are a graphical transposition of the figures given in the lower part of Table 2. They show the relative repartition of the various levels of existence in the present world and in some parts of it (USA, Europe, Sub-Sahara Africa). Figure 7 is the repartition as the number of people (population) is concerned, while Figure 8 is the repartition in terms of power, as it is well known that some people have more power than others. These figures can explain many of the global problems that are met today in our world (for instance the fact that, globally, those who have the power have a lower level of values than those whom they are exerting this power upon), but tackling this subject is outside the scope of this paper.

**Figure 7** – Present distribution of the various levels in the population in the world and in different parts of it

**Figure 8** – Present distribution of the various levels in the power in the world and in two parts of it
2.c. SCHWARTZ’ theory of basic values

The six features of values presented in section 2a characterize all the 56 values considered by Schwartz [8]. What distinguishes one from another is the type of goal or motivation that it expresses. Schwartz’ theory of values defines ten broad values according to the motivation that underlies each of them. They are usually presented, either with the detailed values as in Figure 9a, or – more often – regrouped as in Figure 9b. The description of these ten broad values can be found in the aforementioned reference [16].

![Diagram of Schwartz' theory of values](image)

**Figure 9 – Theoretical model of relations among ten motivational types of values**

Although the theory discriminates ten values, it postulates that, at a more basic level, values form a continuum of related motivations, which gives the possibility to distinguish between four main orientations: openness to change facing conservation, and self-transcendence facing self-enhancement.

SCHWARTZ considers that values must be measured, and he has developed an instrument – SVS, for Schwartz’ Value Survey – to that effect. We shall of course not explain here the working of this instrument, which is based on a questionnaire and permits to determine what the value priorities are. The important point is that, through using this instrument for hundreds of samples in 82 countries around the world, including highly diverse geographic, cultural, linguistic, religious, age, gender and occupational groups, it appeared that people in most cultures respond to those ten types of values as distinct and that the broader value orientations captures by adjacent values are discriminated almost universally.

---

8 ROKEACH, as for him, considered only 36 values.
In order to explain that rather amazing result, Schwartz called for two additional principles, which can be explained through looking at Figure 10:

1. The first additional principle is the interests that value attainment serves. Values in the top squares of the figure (power, achievement, hedonism, stimulation and self-direction) primarily regulate how one expresses personal interests and characteristics, while values in the bottom squares (benevolence, universalism, tradition, conformity and security) primarily regulate how one relates socially to others and affects their interests.

2. The second additional principle is the relations of values to anxiety. Values in the left squares of the figure are self-protecting values (avoiding conflict, maintaining the current order or actively controlling threat), while values in the right squares express anxiety-free motivations, promoting growth, self-expansion and gain.

It may be worth pointing out that there is a pan-cultural baseline of value priorities, in other words that, with a large enough sample, we obtain the same average ranking of values independently of the cultural characteristics of the sample (of course, individual rankings can be quite different). In decreasing order of priority, this ranking is as follows:

1° Benevolence 6° Hedonism
2° Universalism 7° Achievement
3° Self-direction 8° Tradition
4° Security 9° Stimulation
5° Conformity 10° Power

Some explications can be found in the given reference [16].
Figure 10 provides an explanation of how Schwartz’ theory of values and Graves’ Spiral Dynamics can be related to each other: there is a cyclic shift between self-enhancement—which implies to control society through security, conformity to the norms and promotion of traditional values—and self-transcendence—when people think that the group is more important than the individual. The fact that there is such a pan-cultural hierarchy of values probably derives from the adaptive functions of values in maintaining societies and from our common human nature. This oscillatory shift between successive levels of existence is the consequence of a dynamic process with, as for a spring, a driving force (the need for change) and a resistant force (the resistance to change). Much more could be said about that but, once more, it would be outside the scope of this paper.

2.d. The 4-drive model of employee motivation

The 4-drive model of employee motivation (although this model is not only valid for employees) has been developed essentially by Paul LAWRENCE and Nitin NOHRIA, and has been the subject of many publications, among which we shall refer to a paper and two books ([17], [18] & [19]).

Through two major surveys and studies about overall motivation of employees in a large number of companies and service providers, LAWRENCE and NOHRIA identified four fundamental drives that underlie motivation. The degree to which they are satisfied directly affects our emotions and, by extension, our behaviour. These four drives, slightly modified by further contributions, are:

1. **The drive to acquire and to achieve:** we are all driven to acquire, not only material goods that strengthen our well-being, but also immaterial things such as experience, status, power and influence, which strengthen our feeling of achievement. This drive tends to be relativistic (we always compare with what others possess, or with what we possessed in the past), unbalanced (the same thing is always felt more important when we lose it than when we acquire it), and insatiable (we always want more).

2. **The drive to bond and to belong:** though many animals bond with their parents, kinship group or tribe, only humans extend that drive to belonging to larger collectives such as organizations, associations and nations. When met, this drive is associated with positive emotions like love and caring and, when not met, with negative ones like loneliness and anomy.

3. **The drive to comprehend, to learn and to challenge:** we want very much to understand the world around us, to explore new areas of life and satisfy curiosity. This leads us, not only to learn more about our world, but also to tackle challenges that are placed in front of us.

4. **The drive to defend and to define:** we all defend naturally ourselves, our material or immaterial acquisitions and the other beings with which we have formed a bond. This

---

9 And discussed: many question marks remain to be answered or clarified!
drive is rooted in the basic ‘fight or flight’ response common to most animals but, in humans, it goes further than a simple aggressive or defensive behaviour: we also want to create institutions that promote justice and ethics, to define clearly their goals and intentions, and to allow people, through them, to express their ideas and opinions.

According to LAWRENCE & NOHRIA, these four drives have a number of common properties:

- They are subconscious (all people want them at some level almost all of the time) and emotional (they serve to provide context to rationality: goals, intentions, purpose and motive [10]). This is why one can say that they are supported by a fifth one, the drive to feel [11].
- They are universal: they transcend age, status and culture. They evolved to help us survive and thrive in our ancestral environment. Without them, we would make wrong decisions and jeopardize our survival.
- Each of them is independent: they cannot be ordered hierarchically or substituted one for another. Therefore, a balanced personality will experience them in a balanced way.
- Drives combine multiplicatively: the more drives an opportunity or action engages, the more intensely we shall feel motivated to act. Also, if we have a deficiency in one drive, it will reinforce the other drives [12].

Basing themselves on the previous premises, NOHRIA and his collaborators have concluded that, for each of the four emotional drives that employees need to fulfil, companies have a primary organizational lever to use. Table 3 matches each drive with its corresponding lever and lists specifications a company can take to make the most of the tools at its disposal. Of course, those specifications are only useful for companies, not for other organizations, and their impact can vary from one culture to another, or even within a given culture if social constraints are different. Anyway, they can serve as a model for further studies.

Table 3 – How to fulfil the drives that motivate employees

<table>
<thead>
<tr>
<th>Drive</th>
<th>Primary organizational lever(s) of motivation</th>
<th>Corresponding actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquire &amp; achieve</td>
<td>Reward system</td>
<td>Sharply differentiate good performers from average and poor performers; Tie rewards clearly to performance; Pay as well as your competitors</td>
</tr>
<tr>
<td>Bind &amp; belong</td>
<td>Culture</td>
<td>Foster mutual dependence and interdependence among coworkers; Value collaboration and teamwork; Encourage sharing of best practices</td>
</tr>
<tr>
<td>Comprehend, learn &amp; challenge</td>
<td>Job design</td>
<td>Design jobs that have distinct and important roles in the organization; Design jobs that are meaningful and foster a sense of contribution to the organization</td>
</tr>
<tr>
<td>Define &amp; de-stress</td>
<td>Performance management and resource-allocation processes</td>
<td>Increase the transparency of all processes; Empower their teams; Build trust by being just and transparent in granting rewards, assignments and other forms of recognition</td>
</tr>
</tbody>
</table>

10 This made the famous American science fiction writer Robert A. HEINLEIN say: “Man is not a rational animal, he is an animal who tries to rationalize his emotions”.
11 Which Transactional Analysis calls the need for strokes.
12 For instance, psychopaths lack the drive to bond and to belong.
2.e. Second provisional conclusions

In our first provisional conclusions, we have shown how the M-A-U concept, a topological approach that we have developed during the last three years and which is based on a combination of NEISSER’s perceptual cycle – the elementary unit of the learning process – and of WEICK’s concept of loose coupling, can explain, not only how any individual progressively builds his knowledge and skills, but also how groups of people, small or large, proceed in the same way to build a whole set of knowledge and capabilities and forge a form of culture.

In the previous sections, we have seen, on the basis of the work of different referenced authors, how values have evolved in a spiralling way during human history, leading to a set of common values which, at a given moment of this history, are more or less shared by the whole humanity. And we have also seen how these values form the unifying thread with which our motivations are woven.

Actually, both approaches complement and confirm each other: for developing the M-A-U concept, we started from the individual behaviour and extended it to larger and larger organizations, while Spiral Dynamics was developed by Graves and his disciples starting from general considerations, and then linked with values and applied to more individual behaviours.

We can now tackle the main objective of this paper: the application of our approach to Engineering Education in general, and Continuing Engineering Education in particular.

3. APPLICATION TO (CONTINUING) ENGINEERING EDUCATION

3.a. Introduction: values as a result of education

As we have seen, life is an ever increasing and widening spiral of development, as people move through the various levels of bio-psycho-social-spiritual complexity, from one context to another. In order to do so, any individual, in order to define action (A) and evaluate its utility according to his needs (U), refers to a model, a ‘Map of the World’ (M), which has been formed in his brain during his education.

This model contains data, information and knowledge, but, more than all, it contains the individual’s values. These values will decide what information and knowledge are important for him in a given context. He acquired them through his education in the same order as they appeared in the Spiral Dynamics, beginning with the ‘beige’ (survival) in his infancy and then acquiring successively the next levels: purple, red, blue, ... Some ‘rules’ govern the acquisition and the use of values:
1. The acquisition of values slows down with age and is only possible during childhood and adolescence: once the individual has become an adult, his set of values is definite.

2. The relative importance of each value level and the maximum value level that an individual will acquire will depend on his cultural and educational environment.

3. Each individual has an overarching value level, a comfort level that he prefers to use in most circumstances because he has acquired the conviction that it is the most suitable one; this comfort level is not necessarily his maximum value level, but it cannot be far from it, as his tolerance towards other value levels decreases with their ‘distance’ from his comfort, paradigmatic level.

4. In different life contexts, an individual can ‘re-contextualize’ his views and use another, not too far away, value level. However – and this is essential – an individual cannot be at more than one level in a given area of his life.

These four rules are at the core of all human conflicts and misunderstandings: when two individuals have to work together on a given project and if, in the areas concerned by this project, they operate at a different value level, it will be impossible for them to fully understand each other. There is no escape to this problem, it exists in all life areas – including in education – and, of course, between different life areas.

One more aspect is worth being pointed out. In one of his fictional classics [20], the writer Edwin A. Abbott describes ‘Flatlanders’ as persons who are unable to recognize the vertical structure of human development. In other words, they operate at the same value level for all their activities and focus on horizontal differences, rigid categories, simplistic types, and on labels to put on people. The result is a Flatlander perspective – a one-size-fits-all approach – reflected in much areas of life today, including education.

3.b. A short historical perspective

Leaving on the side the first value level – ‘beige’ (survival sense) – where there was no ‘enterprise’ and no ‘engineer’, the evolution from the ‘purple’ level (kin spirit) to the present main levels – ‘orange’ (strive & drive) and ‘green’ (human bond) – has been accompanied by a parallel evolution of ‘engineering’, from agricultural engineering (draining marshlands and providing adequate irrigation) to what we now know: it is not necessary to describe all the intermediate steps.

At the same time, according to the already referenced authors teaching and learning styles have also evolved:

- Purple (kin spirit): teaching by repetition and learning by imitation.
- Red (power of gods): teaching by empowering and learning by conditioning.
- Blue (force of truth): teaching by imposing order and discipline and learning so as to avoid punishment.
Orange (strive and drive): teaching by building autonomy and learning for the expected success.

Green (human bond): teaching through facilitating acceptance and learning through observation.

Yellow (flexibility and flow): teaching through giving access to knowledge bases and learning through freedom to be and to discover.

3.c. Three practical cases of impact on (Continuing) Engineering Education

Now, we have seen (Figure 7) that the majority of people in different parts of the world have different comfort value levels, from ‘purple’ in sub-Sahara Africa to ‘orange’ in the USA and ‘orange/green’ in Europe. On the other hand (see Figure 8), most industrial companies operate at the ‘orange’ level. All those differences have an important impact both on Engineering Education and on Continuing Engineering Education. In order to explain it, we shall take the three practical cases that we presented two years ago at the 40th Annual Conference of SEFI in Thessalonica:

The first practical case consisted of a survey of the opinion of students of Delft Technical University about their perception of how they can contribute to the ‘Innovation’ corner of the Knowledge Triangle. Looking at the way they presented their opinion, it was quite clear that they were operating at a value level that was higher than the ‘orange’ level at which most industrial companies are operating. But, at the same time, they were not seeing that as a difference of value level, but simply as a lack of practical experience.

Before considering the second practical case, we must point out that, even if a newly graduated engineer operates with a comfort value level that is higher than the ‘orange’ level of the industrial company in which he is going to work, he will then – as we said before – ‘re-contextualize’ his views in order to do it, which means that he will always, as from that moment, operate at the ‘orange’ value level for all what concerns his work in that company or in a similar company.

The second practical case dealt with the difficulties met at Aalborg University in organizing tailor-made continuing education for engineers working in surrounding industrial SMEs. The difficulties lay both in the reluctance of university professors to indulge in such an activity and in the lack of a common understanding on what should be done from both sides’ points of view. It is quite clear, in this case, that most university professors operate at a higher – but difficult to specify – value level than the ‘orange’ value level of the engineers in industry and consider therefore that they would discredit themselves by going down to that ‘low orange value level’. On the other hand, as we said above, engineers working in industry have re-contextualized their views, consider that the ‘orange’ value level is the only one that matters in their work and that, therefore, those university professors have their head in the clouds.
The third practical case dealt with a survey, among various stakeholders, about the adequacy of doctoral studies in engineering with working in industry. The main result of the survey was that PhD graduates in engineering had difficulties in finding an adequate job in industry and were often obliged to accept a position that was lower than their actual qualification. On the other hand, most University professors consider that such a high qualification is essential for industry. Here, the difference with the ‘ordinary’ students of Delft University and with the engineers working in SMEs around Aalborg University is the following: while most engineering graduates leaving university at Bachelor or Master level can easily ‘re-contextualize’ their value level towards the ‘orange’ level of most industrial companies, the fact that some engineering students are able to gain a PhD graduation indicate that their comfort value level is higher than the value level of ‘ordinary’ students; as a result, ‘re-contextualizing’ their value level towards the ‘orange’ level of most industrial companies is impossible for most of them and, if they nevertheless accept a position in industry, they can feel very dissatisfied with it.

3.d. Soft skills in Engineering Education

For the last five or ten years, representatives of industry have more and more frequently and strongly insisted on the gap between the offer of university and the demand of industry concerning the skills of engineering graduates. But, this was not the case a half century ago. One can wonder why.

One possible explanation also lies in value levels. A half century ago, most engineering graduates had an ‘orange’ comfort value level and little adaptation was necessary for working in industry. Now, on the contrary, most engineering graduates have a ‘green’ or ‘yellow’ comfort value level and, as we said before, they have to re-contextualize towards the ‘orange’ level of most industrial companies. Our opinion is that most required soft skills, precisely, help to perform such a re-contextualization.

Of course, this is just a plausible opinion, which should need more studies to support it. But it could be worth doing it, because the movement of people and of organizations in the Spiral Dynamics cannot be stopped and is accelerating. Not only will more and more people, particularly in developed and emerging countries, reach higher value levels, but a growing number of new companies, working at a higher level than the present ‘orange’ level of most industrial companies, will spring up and develop: it is the only possibility to avoid a general collapse. Engineering Education has to be prepared for that.

3.e. Rooting out ‘flatlanders’ in all forms and levels of education

Our study has highlighted the diversity of the systems of values, not only from one part of the world to another, but also from one individual to another within the same country. It has shown, also, the impact of such diversity on the extent to which people working in different environments can understand one another.
Actually, there are two kinds of ‘flatlanders’ and, together, they probably represent more than 99.999 % of the world population:

1. The first kind of ‘flatlanders’ is composed of the ‘actual flatlanders’, those who ‘function’ only at one value level in all contextual circumstances. They are those who form what we call ‘extremists’ and ‘fundamentalists’ and, if they are not too many of them in our developed countries and very few of them in engineering education, they represent a certain danger, as they could spread rapidly, by a ‘memetic’ effect [13], with the development of mass media and of general mobility.

2. The second kind of ‘flatlanders’, representing nearly all the rest of the world population, is composed of the ‘practical flatlanders’, those who can ‘function’ at two or possibly three value levels, as they have been able to re-contextualize their comfort value level towards one or two other value level(s) in different contextual circumstances. But, they are nevertheless ‘flatlanders’ because, when they operate in a given contextual circumstance, they believe that their own value level is the only ‘good’ one and they cannot understand someone who, in the same contextual circumstance, ‘functions’ at another value level. This is the source of the all the misunderstandings and of many evils from which humanity is suffering. In (Continuing) Engineering Education, it is the source of the difficulties met in developing any form of collaboration between University and Industry, and also, as we explained above, of the gap between the actual skills of newly graduated engineers and the expectations of industry in that matter. It is the main – if not the sole – barrier that we have encountered in the practical cases we have considered in the past. It explains resistance to change and a too general lack of flexibility.

3.f. Is there a solution?

We believe that there is only one solution to that ‘big’ problem and it consists in two concomitant developments in education, particularly in Engineering Education:

1. The first development is inspired by Neisser’s perceptual cycle and our M-A-U concept. Engineers are able to understand the working of practically all the ‘machines’ that exist in our world, from the most simple ones, as a lever, to more complex ones, as a nuclear reactor. But, practically all of them do not understand the working of that wonderful little machine they have in their head – their brain – though they use it all the time from birth to death! The progresses made in cognitive sciences make now possible to learn how our brain works, and it would help them a lot – particularly in view of the second development below – to understand the enormous influence of our subconscious emotions on the supposedly rational decisions that we make.

2. The second development, as suggested for instance by Caleb ROSADO [21], would be to form engineers ( and maybe also many other professionals ) to the reality of Spiral Dynamics. It would help them to understand where people are coming from and why it is

---

13 To use Richard Dawkins’ word, but it is similar to what we called ‘loose coupling’ in our M-A-U concept.
of greater value to conflict resolution than what they simply say or do. We believe that what we said above and what could be found in the given references (and other ones) should convince all those really interested in promoting the essential role of engineers in structuring our society that such a development is necessary.

4. CONCLUSIONS

In this paper, the authors have extended the M-A-U concept they had developed and presented two years ago at the IACEE WCCEE in Valencia. They have shown that this concept is totally coherent with other approaches, essentially with Graves' theory of levels of existence and Spiral Dynamics, and with Schwartz' theory of basic values. In order to do that and convince the reader of the relevance of that common viewpoint, they had to indulge in some theoretical presentation.

Then, they have applied this common approach to (Continuing) Engineering Education and have shown that it can explain most difficulties met in that field, in relationship with the expectations and different viewpoints of industry, including three practical cases they had previously analyzed.

Going by these explanations, they have proposed a solution that should be able to solve many of the aforementioned difficulties and problems.

As the famous futurist Alvin TOFFLER said, it is time that we should change our way of learning, which implies to change, not only our way of teaching, but also our way of understanding each other. As many of the problems met in this world – hunger, water and energy supply, climate, etc – are to be solved by engineers, these ones are mainly concerned by this paradigmatic change.

But, the alternations in the Spiral Dynamics are accelerating and we live in a faster and faster paced world and we have to adopt a proactive approach of the question, instead of the reactive way that has always characterized our adaptation to a changing world. It could be the only solution to avoid serious problems in the future [14].

* * * * * * * * * * * *

14 We do not want to be catastrophist or apocalyptic, of course, but burying one’s head in the sand is not a better option!
REFERENCES


