Archives of Business Review – Vol. 8, No.10
Publication Date: October 25, 2020
DOI: 10.14738/abr.9069.
Figueiredo, J. (2020). Designing An Ethics Course In An Engineering Master Using Narrative And ANT. *Archives of Business Research, 8(10). 1-14.*

Designing An Ethics Course In An Engineering Master Using Narrative And ANT

José Figueiredo
CEG-IST, Instituto Superior Técnico,
Universidade de Lisboa

ABSTRACT

Engineers need to understand and measure the consequences of their actions, in terms of value for the organization, community, and in terms of sustainability. This simple formulation, however, hides a background of complexity that is not easy to identify. Students can develop an ethical consciousness, but their awareness is usually fragmented, that is, it is not deeply internalized. And one cannot have ethical thinking only in certain circumstances, looking only into some aspects and not the whole. What we are trying to achieve with this paper is to raise awareness to make ethical reasoning possible, to make ethics a whole system in engineering life. To guide us we use three aligned methodological approaches: Actor Network Theory (to formulate our settings and problematize goals), Bologna framework (to visit the roots of an "innovative" learning breakdown), and finally narrative (as storytelling, a constructivist way to reason and explore our reflections).

Keywords: Engineering Education, immutable mobile, obligatory passage point, border object, ANT, network of non-actor's Introduction.

INTRODUCTION

Is there a unique ethics for all persons and for all situations, in all spaces and dimensions, valid to all sides, embracing all dilemmas? As usually, good questions are apparently simple but they also rise hidden levels of complexity, a level at which answers are not easy, and surely not categorical. In our view with the lenses of Actor-Network Theory (ANT), ethics is an immutable mobile (IM) that travels through contexts and adapts without actually changing, without losing meaning, according to its basic conceptual and basic foundations (values, moral precepts, autonomy, justice, beneficence non-maleficence) [1]. An IM is something that can be interpreted in the same way in different contexts, but this doesn't mean it is completely context-independent. Immutable mobiles, as transportable things, contribute to design paths of domination when they travel through networks of negotiation interacting with different actors.

IM is something, not quite well definable, whose form and function remains stable across different contexts and places in a spatial network journey, through displacements and translations [2]. For example, an e-mail, or money, can be such a thing. Immutable mobiles act as vehicles for producing and reproducing dominant order of things {3]. However, to understand what we want to perform here, we need to briefly refer to some other central concepts used by Actor-Network Theory. We

already addressed the immutable mobile, so we now focus on boundary objects (BO) and obligatory passage points (OPP). All these concepts belong to the ANT extended world. For instance, BO has been adopted from [4], [5], and [6]. OPPs are fundamental in problematization, surely at the initial stages of our translations. Actors, identifying and formulating a problem at hand establish an (OPP) that defines the problem in their specific terms and makes them indispensables to its solution [7]. A focal actor thus establishes an OPP to "impose" [6] a view on others. The idea is that the other actors can only resolve their problems and progress by passing through the OPP. However, before passing through the OPP, they first need to modify their current interests in order to align them with those of the reference actor. These intricate of transformations, translations, negotiations and alignments will eventually contribute to network stabilization.

The OPPs are our centres of translation and IMs inscribe things, acting like a go between in a social space of OPPs, being good enough to find ways to capitalize to a centre. An IM shares the behaviour of an actor enrolling other actors, promoting change, with the behaviour of a black box, a stabilized network, for example a norm or a standard [5].

The pursuit of a goal relies on the development of negotiated partnerships that evolve according to commonly agreed-upon calculations (work), constructing meanings on top of which tacit knowledge can be consolidated. The boundary object concept was introduced by Susan Leigh Star and James Griesemer [4] (p 393) in the following terms: "Boundary objects are objects that are both plastic enough to adapt to local needs and constraints of the various parties employing them, yet robust enough to maintain common identity across sites. They are weakly structured in common use, and are strongly structured in individual-site use. They may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, the means of translations". If we perceive what is meant by IM and BO we are already able to consolidate the close relationship between these two basic concepts and ethics. In all respects, ethics is something that assures by itself, something (behaviour, practice, role, decision, judgment) that floats over the circumstances, and that can be abstract or concrete. Ethics is, like context, a very intangible actor that either retracts or imposes behaviour when dealing with what is happening.

An assertion of ethics based on the fulfilment of moral precepts does not help us acting, on the practice of acting ethically. It will only prepare us to discuss ethics, to talk about ethics. The fulfilment of moral precepts helps understanding, but doesn't contribute to doing – the final step and goal of any learning process, supreme level of tacit knowledge. In fact, dictated ethics (top down) does not constitute an operational and practical framework, a reasonable basis for practice. Ethics, like tacit knowledge, is action, it is not (most of the time it shouldn't be) an application of concepts or codes. It would be a kind of holistic sense of doing and not-doing. Ethics is an educated feeling, a way of understanding, a way of equating each action in its global context and considering all consequences of action. Ethics is a habit [8].

Aristotle classifies habits into three categories: (1) theoretical, or the retention of learning "knowing that x is so"; (2) behavioural, through which the agent achieves a rational control of emotion-permeated behaviour "knowing how to behave"; and (3) technical or learned skills "knowing how to make, or to do". This categories scale is a form of situated level for performance, as well as for knowledge. This framework forces us to (before acting) think of all the consequences

of our actions and only then return (backtrack) to the decision about the action to take. This is a reflexive process in loop, such as an action research procedure that represents something inseparably positioned at the heart of the ethical process. Ethics thus operate in four stages: identification (seeing, discovering, admitting, recognizing), formulation (problematizing and setting the problem), reflection time (understanding and analysing value, usually for all stakeholders involved) and finally a time for action (doing or not doing, and how, with which consequences) [9] argued that ethical inquiry is the use of reflective intelligence to revise our judgments in light of the consequences of acting on them.

Ethics should also be an obligatory point of passage for situated action (social, organizational, environmental, ecological, cosmic, formal, informal, singular, group, community, region, country, world...). Applying to all actor's present (identified) in the network (stakeholders), it is particularly important and crucial for engineers. This is because engineers design and develops technological artefacts. In a memetic way, if something goes wrong, an object, a thing, someone, all network behaves wrongly. In a world of mobility and dynamic relations, using communications networks and processing time, the engineer is exposed to crescent integration of information, to wider capacities of storage, as well as to increasing speeds of processing and communications, which means potentially dangerous translations, lots of them. These are two very strong reasons to develop an ethical mind.

The proliferation of communication channels as well as the ramping of technological advances in communication, the breakdown of the costs of computer memory, and the rapid progressing of processing speeds makes the ethical challenge increasingly demanding [10]. The actor who does (applies, acts), the one who creates, all those who design, and the network of mid-terms should always be involved in ethical concern. Tops of hierarchical chains are examples of actors with bigger networks (greater responsibilities, more power?) and we should demand from them ethical excellence. We all should be committed to create and maintain a culture of designing what an ethical behaviour should be and, in the other sense, a culture that is able to evaluate and check if these focal actors with more responsibility are on the right track [11].

The engineer is an actor to whom greater ethical responsibility must be demanded. Sophisticated assessment mechanisms should be adopted and applied to access this particular aspect of these actors, these doers, who can provide the best, the very good, the bad, the very drastic [12] if ethics is not part of their plan.

Our research objective can be tentatively expressed as: How to develop a constructive design [13] for an Ethics Master Course in an engineering degree using an approach to facilitate both alignment and conciliation in the engineering education broad area [14]. We begin by putting forward some ideas, clarifying some concepts, mainly ANT concepts, exploring the conciliation of wills and integrating these concepts in an articulated ethical narrative. We than use a Bolonha framework to design a new curricular unit, we interweave [14] the two frameworks and explore actions to be taken. Then we extend our ideas, trying to devise a modus operandi. Finally, we extend again our modus operandi into an action proposal. This action proposal is very simple and intends to be mainly illustrative. It is basically a narrative with tested ideas and comments that we tried to align in a whole.

WHY ETHICS IN ENGINEERING?

Engineering schools all over the world insist in two strategies that we strongly question. One is the eminence and domination of quantitative reasoning, with quantitative models, quantitative approaches, quantitative methods, completely forgetting about the qualitative mindset. And the other is the almost monopoly of problem solving. If students are good on quantitative methods and tools and they are problem solvers they are excellent. They may be excellent in the academic world, in the context of the school, but in real life this kind of practitioner can become a real dangerous engineer. In fact, the dominant scenario described encloses two errors. Quantitative is very important, but real problems happen in settings with real restrictions, fuzzy specifications, possibilities and impossibilities, impossibilities within specific socioeconomical frameworks, and so on. In real time settings, we have many wicked problems.

This means that real problems happen in a real world where specifications should come from negotiation, with real people and real things, relevant actors or relevant stakeholders, at different levels of power, and we should always be looking for the feasibility, economic viability and sustainability of our choices. Ethic is part of this process and influences the choices. Besides, there are always many options in doing things, and deciding which things to do, and how to proceed. The terms of our objectivity are never one hundred per cent clear, because reality is plural and often diverse, sometimes confusing, eventually fuzzy, always complex.

Problem solving should be considered an advanced stage of a chain, if we view an engineering process as a chain where each link depends on the previous ones. Furthermore, what problems are to be solved? What for? What is the impact of implementing a solution to these problems? Are we creating value? For whom? To adapt to a complex socio-technical space that keeps changing, problem solving should not be a first step [15]. It drives us to think and do things in mechanic ways, and often trains our students to solve the wrong problem, problems that can be completely irrelevant or problems that doesn't apply to the situation. In any case, the student is not responsible for the effectiveness of the solution, as the solution is only the result of a solving process.

In our engineering settings, ethics can be tackled with two different meanings, eventually two separate strategies with different objectives and backgrounds. One is to contribute to make students aware of ethical topics, making them more ethical engineers, and even more ethical persons. This strategy contributes to enlarge the body of knowledge on ethics, widening a systemic view of ethics in all situations and engineering settings. The other is ethics as a tool for our minds. Reflecting on ethical dilemmas we prepare ourselves to critical thinking, we naturally combine quantitative and qualitative thinking, as well as we prepare ourselves to problematize about things, formulate problems, looking at problems through different perspectives and angles, and pondering consequences of eventual solutions to these problems.

Problematizing is a problem setting, as Schön so brilliantly explained: "Problem setting is a process in which, interactively, we name the things to which we will attend and frame the context in which we will attend to them" [16]. Patterson also said "But with this emphasis on problem solving, we ignore problem setting, the process by which we define the decision to be made, the ends to be achieved, the means which may be chosen. In real world practice, problems do not present themselves to the practitioner as givens" [17].

In this second approach, ethics can be a proxy to a systemic way of thinking (quantitative, as usual, but also qualitative thinking, critical thinking) and problematizing, and we can stress one or the other of these strategies, or we can explore both when we construct and design our ethical personality and character.

Changing the perspective, but being practical, we also can "serve" an ethics course in two very general and distinctive approaches: In a curricular unity dedicated to ethics (the subject of this paper), or mingling the topic in small seminars within other curricular unities (maybe the preferable solution of them all).

Thinking ethically develops critical thinking, negotiating skills, auto-sufficiency habits and, above all, shaping our mind to combine quantitative and qualitative, rational and emotional, preparing the young engineers to be more wise and capable of reasoning along different axis, accepting different sensibilities and producing better and more sustainable decisions.

BOLOGNA APPROACH AND ANT, DESIGN AND METHODS

Rather than adopting problem solving as a model for theorizing learning processes in engineering practices and education, researchers in engineering education should view theory construction as sensemaking [18]. In our approach, valid for students, teachers, professional practitioners, and technologists we would translate theory construction into conciliation, as we need to integrate the what and the refutation of the what, that is, problem formulation (what), and problematization in ANT terms (critical thinking about the what). These two processes reshape each other, in the sense that they construct tentative realities that may trigger innovation, they 'socialize' [19] between themselves and create knowledge as Nonaka and Takeuchi explained in their celebrated book. These combined realities, constructed by this "socialization of things", or actor-networks, can be addressed as ongoing extensions and detours in pathways of evolution. We use the term socialization, proposed by Nonaka, but in an ANT perspective, we are interested in the play between hybrid actors, not only human. Hybrid can be material, immaterial, things, laws, rules, policies, artefacts, contexts, …

Hybrid actors translate (translation occurs within the actor, changing his/her interests, or in the course of the relation between the actors in the network, always in displacement within the network) and inscribe (aligned interests are inscribed in durable materials) [15]. So, alignment is a crucial purpose of the network [20]. It is through network alignment that things go stable and stability is also a condition for further change and for the perpetuation of network work (calculations, centers of calculation).

The combination of innovative thinking and learning in an engineering context, formulating problems, constructing requirements, defining specifications, designing systems [13] and practicing the integration of all these steps should explore conciliation of means and use reflective practices [16]. Socialization is a key step in the knowledge creation process [19]. It is in the core of knowledge creation, as externalization is at the closing, an output, of the same process, the beginning of another cycle. Socialization and Externalization represent two modes on the knowledge creation processes, Nonaka. The interplay and shift between these two modes nourish learning processes and promote translation swings.

In fact, we may say that technology and society are two interwoven systems that reshape each other [21]. If we look at this interplay, we are able to understand things in a different way. The attempt to conciliate these two realities is mediated by our knowledge, our filters, the way we look at things (paradigms), the way we translate our "realities", and finally the way we define our situation or context for our action (situated action). It is by using this knowledge that we can be creative, facilitate discussions, negotiations, promote translations, and contribute to aligned and stabilized developments. Besides, knowledge is cumulative, the more knowledge we have, the more knowledge we can construct, and that is the way learning progresses.

We need to design an approach to provide alignment of technology and society but for that effect we should not rely on the common and usual social network. Our approach favors the construction of actor-networks (networks of things) that interact constantly negotiating relations, with translations between hybrid actors.

Learning (the process, the abstract thing) is by itself a necessary actor in our system, in our network. But, as John Locke [22] once said, "No man's knowledge can go beyond his experience", which means that we need to address knowledge as action, and not as a repository of concepts. Locke also alerts to the fact that you learn by doing, by reflecting on what you do, the way you do it, how and why, the errors you commit. Learning is an integrative process that travels in networks, is an actor driven by purposes, and allows sensible and educated action to install in behavior and eventually to crystalize in standards (black box) [23], patterns of behavior. This "virtuous cycle of knowledge" imposes that practice brings people and things together [24], instigates this 'abstract socialization' and facilitates the construction of new knowledge that in turn improves the ability of doing things, contributing to better designs.

Actors enrolled in our network are teachers, students, developers, researchers, users, learning systems, companies, organizations, regulations, laws, tools, software's, administrative policies, policy makers, and learning processes, just to give an idea of the heterogeneity of means addressed by networks of hybrid actors.

ANT supports relations with material (relating things) and semiotic modes (working with concepts, taxonomies) without distinguishing between them. There are no either/or situations, all things are integrated and can be conciliated, all are actors in actor-networks. Ethics is an Immutable Mobile, as we already saw, but it is also a OPP, "forcing" the actors to converge on a certain goal and contribute to aligning all the actors.

METHODOLOGY

In this section, we discuss two perspectives: the generic and combined methodology (multi-methodology) used in conducting our research, supporting our inquiry, and then the methodology used to create the Bologna curricular unit. At the end, we combine both approaches and explore the creation of a curricular unity using our multi methodologies and the Bologna approach [25], [26].

We use a narrative strategy [1], [27] in an interpretive approach organized by a storytelling methodology [28]. With this narrative strategy, we have the great advantage of never fragmenting the whole into parts. Quite on the contrary, we are able to give the parts a whole. We make sense

of what is going on with the parts, people, habits, regulations, things, systems, accordances, discordances, and we do it always within our network. This narrative strategy allows a systemic approach, a contingent understanding and harmony of the whole, and enables frequent stabilizations. In addition, engineering practice is an activity in which data is often perceived without (enough, or sufficient) context, and as such, using forms of contextualization, situating our action, can represent an advantage, if not a real and important necessity. The narrative can also be a method of mediation, which, both at the level of investigation and in classes practice can be very opportune, considering the options that must be taken. These are some of the reasons why we consider this methodological/strategic approach appropriate for this investigation.

In designing a new curricular unit fulfilling the paradigmatic change from teaching to learning, the first step to agree upon is the definition of what one wants to achieve, the objectives and expected results for learning (the learning outcomes), the specific skills the learner should develop. In the context of Bologna there are distinct levels with different consequences for the cognitive degree to be achieved. Situations such as developing competences per se and, for example, learning to acquire competences, are two completely different facets of learning. Following the methodology proposed by Bologna, the process of designing a new curricular unit should not proceed with the traditional approach (centered on the teacher and on teaching). Rather, it must follow an inverse process that starts from what is to be obtained, the learning outcomes [29] and associated competencies. It is almost "reverse engineering" starting from the objectives to be achieved in relation to the academic level of the student. This process is cyclical and reinforcing [30] and should basically consist of the following steps (Program Design Based on Learning Outcomes) that articulate in a scaled manner a behavioral approach to education.

Following this approach, we should define the following list of main concerns, designed by Moon in 2003 [31] (see Figure 1):

Aims (General Purposes)
General competences to be developed
Subject specific Competences
Define overall learning outcomes
Decide how they can be assessed
Monitor results obtained by students
Iterate above steps to improve

The description of which competences should be learning outcomes, the criteria and assessment methods that should be defined related to the teaching strategies (form) are the main topics in the program. In our case, the content is explicitly developed and constructed with the students in the course of action. Following a tentative approach, and considering the evolution of the debate, the facilitator steers the discussion into important core topics, and that is the way content is constructively crafted. The cases for discussion launched in class are also foundations in this process of designing scope and defining a core set of values that explicitly materialize a base for an emerging content.

At the beginning of this process the objectives depend on the descriptors of the level at which the curricular unit is to be inserted. Like any process, this creative process must also be evolutionary,

in the sense of seeking constant improvement, with cyclical creative iterations. In fact, once the curricular module is conceived, the objectives, learning outcomes, evaluation criteria and teaching strategies, themselves already purified (that includes objectives, strategies and values), ... allows a possible stabilization of the network. See Figure 1, extracted from Moon [31]. The beginning of another cycle is always possible and often needed, as inertia shouldn't be pervasive [32]. We should exert reflection about the quality of the result obtained and always search for improvement.

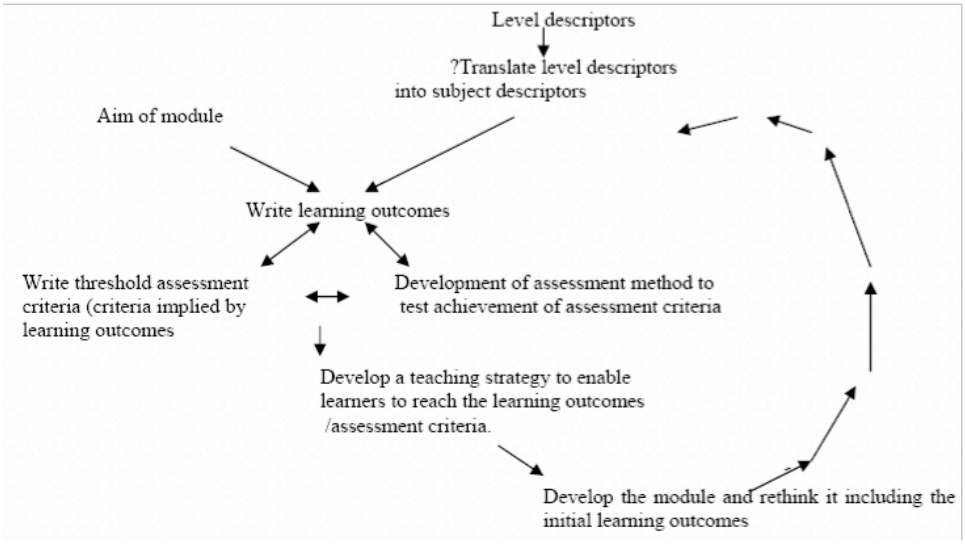


Figure 1 Basic reflective model for granting a curricular unit design (Moon, 2003) [31]

Regarding the students level, we can consider several acting levels that evolve in a hierarchy. Things can be much more elaborate, with more levels, but to explain what we consider necessary we use only two levels: declarative and procedural. Declarative knowledge relates to facts like propositions and arguments, images, and logical assessments. Procedural knowledge is more dynamic, complex, and has something to do with skills, cognitive skills (sustained attention, response inhibition, information processing, memory, and abstraction) and cognitive strategies. Contrary to what would be expected, these two forms of knowledge tend to be more distinct than interrelated [33], but we should use them both and explore the specificities of each other in order to be able to educate a systemic view.

Declarative knowledge is knowing about facts, theories, events, and artefacts. This level is about the what. Procedural knowledge is about the how, what for, knowing how to do. Procedural is related to action, doing, the ability of doing. Procedural is something that includes concurrent skills, cognitive skills and cognitive strategies, mixing reason and emotion, qualitative and quantitative. Procedural develops, explores, constructs, and exerts your tacit knowledge.

We generally accept the principle that what the students say, and what they say they know, represents their level of knowledge. In our case, with ethics, we aim to reach goals beyond the declarative level, well into the procedural level of functioning/action, that is, knowing how to do and why, with which consequences. This depends on the level at which we operate and, as such, on the descriptors of the same level. The competency building model, in our case, is open content, the students are supposed to have a critical attitude towards what is presented, and must develop a contextual reflection on the application of the knowledge they are building or have already built.

The students must also seek to get results and explore projects of their own, exploring collaborative practices. In our specific case, we stress the importance of group work, group projects, exploring the component of team organization, internal communication (within the team) and external communication, with the remaining students of the course, and even with the professors. That is why our classes have students (singular actors), groups (collective actors) and the total class, as situated community. Groups are informally formed among the students in each class, and are asked to have a sense of cohesion, like a specific tribe. Constitution of groups should change from session to session.

This also raises the awareness of the level of performance through shared practices and discussion of shared assessments. In our approach, ethics scope can extend from conceptual through personal, professional, organizational, and corporate topics. For us ethics needs to be a systemic perspective, something that invades people mind and concerns the student in all actions, concerns the student as a whole, a person in full.

What would an OPP be in our network? Something that induces actors to converge on a certain behavior, a certain practice, following a certain structural standard. It could be a strong formal ethical interpretation/practice that commits all actors in the network. We need to pass through these points in order to calculate, that means to be displaced forward in the network. And an immutable mobile (IM)? Information passes along the networks using IMs, actors whose form and function remains stable across different contexts and places, as we already saw. In their specific circulations, they influence others. And a boundary object (BO)? What would that be? Something that travels in the network and everybody recognizes but sometimes with different meanings, understanding how the various actors involved can cooperate (Hermann, 2013), despite having different and oftentimes conflicting interests.

It is our duty to identify in class possible referents for these three actors. Make them circulate in the network and design narratives that teachers can explore with their students. Doing that, we are at the core of a course that is not about content, but about form and behavior, an interrelation of both. The content is constructed along with actor's relations, and form is also molded by network stabilizations.

NETWORKS USING NON-ACTOR'S AS ACTORS OF THE NETWORK

Another thing that can be interesting about actor-networks is that we can also deal with the absence of actors, as actors in the network. We are now introducing this "new concept" of non-actors of the network. The absence of an actor can also drive action. For example, we have a beach near Lisbon (in Cascais), called Guincho, which is very well known and popular. People go there on weekends and in holydays, there are many surf championships, even the world surf championship has a leg there. The main restaurant that provided support to the beach on the south side decided to build a new section that apparently would provide better service and support to the beach. The works for this construction took more than two years and made access to the beach from this south side very difficult.

This beach is about one mile long and was frequented on the basis of two sections: south Guincho (the one we are talking about and by far most frequented), and north Guincho, more exclusive, always with less people. The difficulties of access (absence of good and comfortable access), the

absence of a toilet, the absence of a bar, the absence of showers, actors that existed before the works but now are absent, changed the turnout to this south section of the beach. Guincho north now tends to have more people. This happens because of a network of non-actors.

What would be a network of non-actor's in an ethical learning class context? Suppose you define rules and procedures to design a behavior within your class but you don't have a syllabus to fulfil, you have a perfect idea of what you want to deal with and what to do in your semester, you have a general topic, but none of this is defined with completely clear contours. None of these traditionally basic factors are taking into account here. This absence of a syllabus is the absence of an actor. Instead of following a previously defined list of topics you, as the "teacher", pay close attention to the signals and moods of your students and you shape the progressing path based on these weak symptoms. Some such symptoms are intuitive [35]. Another relevant non-actor is the teacher. In our situation, this actor doesn't exist, and, instead, we have a facilitator, someone who steers the situated community (the class) into interesting directions.

Our main concerns regard the students: teasing them into discovering new paths, motivating them to go further and use creativity, instigate them to achieve a good solution, a valued solution, that generates value to all involved. And the learning materials? are they provided by the teacher/facilitator? No, not at all, all learning materials are discovered by the students, surfing the internet, using academic databases, discovering discussion forums. The students provide the information they need, the information with which they discuss and debate, and they create knowledge in this process (Nonaka and Takeuchi, 1995). The usual top-down learning materials supplied by teachers are also non-actores in our setting, they don't exist.

Using Actor-Network Theory (ANT) you follow the actors, you have absolutely no "control" over the network, you just analyze, think, explain, and follow. However, in our perspective as engineers, not social science researchers, we try to look at actor-networks as a mean to also design, to design systems, to design communities, not just observe and comment. The previous paragraphs are only intelligible with this in mind. The difference is more than a single interpretation, it is a paradigmatic change, a different way of considering actor-networks in the making.

Another very important example of non-acting networks is the purpose of the class. The purpose of the class is to make every student follow a specific learning path, in a certain topic, within a scope that is being constructively and collectively defined. A topic related to ethics within the space of renewable energies. We stress that it is very important to construct the problem to be solved. This implies to discover an opportunity to do something, then discuss with as many stakeholders as possible, then define and detail what to do. When the problem is sufficiently defined and it is assured by the stakeholders that it is the right problem, our network works to stabilize. So, we can begin designing tentative solutions, and we design in order to support implementation. Always checking with stakeholders to validate if the prospective solution is the right solution. All this chain of aligned purposes is constructive, a constructive process, a learning process.

Each step follows a previous one only after this one is "certified". For example, when we are dealing with project management there are methodologies that make a plan end to end to the entire project. These structured methodologies have a large representation worldwide and they are probably the most used all around. But agile methodologies, with a clear tendency of ramping up

and conquer space for action, don't behave this way. Using the agile metaphor, we plan very small steps, like planning – do – check – act (using the Deming cycle), always consolidating what is being done. Our approach follows the agile metaphor. In fact, we are dealing with an agile network of actors and no actors.

CONCLUSION

Ethics value is about results, not attempts, not intentions or explanations. An introductory discipline to ethical practice for engineers must, as far as possible, be situated in this perspective. That is, the curricular unit cannot be developed around the content, but, above all, around the objectives and consequently focused on practice. The concepts, mechanisms and models applicable in the practice of reflecting about ethics should be known (content), but it is fundamental to conceive ways to organize and structure them as a framework for practice (form). Building an ethical mind is traditionally (and wrongly) organized vertically in bureaucratic units using a top down approach. For the engineer, however, it is fundamental to see this process in a different way, in a horizontal way, the way in which the engineering processes unfolds and progresses, the way engineering design and development processes evolve. The engineering act is about processes that proceed end to end, in a chain of arranged consequences, in a line of action.

Taking advantage of network effects, we are 'socializing' and creating opportunities that trigger the creation of new knowledge, facilitating thinking patterns of creativity and innovation. But for this network to be social (only with humans) is not enough. That is why we considered the "socialization" of things, instead of only people. We gain in effectiveness because many of today's constrains are either immaterial or not human centered. They are most often intangible and difficult to identify, but they are effective, and dangerous.

Learning outcomes are the result of a clear and rigorous definition of learning scope. Being comprehensive they shall include the ability to solve complex problems (with interrelated social and technological interactions) in such a way that the systemic variables are all included and the decision can reach a level that is complete (system, in its operational, social and environmental facets) [34].

In class the structure of work should favor cyclic reflection, progressive and continuous refinement, that is, after a refinement cycle, lessons learned must be incorporated and, with critical distancing, a new cycle should be executed. The cycle is agile, not with the pattern of a structured method. You define little tasks (plan), you execute them (do), you analyze if went well or not, if there were any deviations from the plan (check), and you rectify and progress (act), exemplifying the Deming Cycle already mentioned in the previous section.

We also deal with physical factors, such as the definition of the setting. We define and communicate the concern. We tentatively correct the definition of the problem. We work directly on the working conditions. We construct with the community the rules of operation. We also work on the spirit of resilience of our students, letting them know that a failure is not the end of the world and when we fail we should resume with double energy. The network behavior is constructed and defined collaboratively, with the help of all, debating and reshaping what is intended.

Contextual factors contribute to understand restrictions and constrains imposed by the situational ambience, understanding the limits of the goals and what is possible and doable. Solutions should be sustainable. Specifically, the facilitator has to contribute to the definition, design and development in the situated space of action, such as room conditions, devices that will be used in audio-visual terms, definition of group rules (valid for groups that are formed and for building the groups), community rules (valid for all groups and all students in the curricular unit). This is the way students help to focus the curricular unit in the semester. The curricular unit can thus have different contents in the same semester and in different semesters. That is, the curricular unit dynamically changes according to the students, keeping the rules, the objective, and the learning outcomes immutable (IM). The class is a space of immutable mobiles, obligatory passage points and boundary objects.

No-actor actors of the networks, as we refer, should be exposed to internalization, we need to internalize deep inside from superficial impressions, deep down from the exterior layers of knowledge to the more interior ones. We need to accumulate patterns (of behavior, situational, aesthetical) in order to be quicker in our analysis and in our progression. Only supported in patterns can our mind reason by controlled jumps and not be obliged to recognize all the little steps of simple and complex situations.

Our way of evaluating the behavior of students and groups, as we already addressed, is semi-structured. In a way, we structure a dozen of key topics that all groups should address and in the right sense (perspective), so giving a punctuation according to this alignment fact. But, in a completely different way, we also judge from intuitive aspects. Both criteria are debated within the evaluation jury. This jury is a jury of two, the teacher as facilitator and an ethic expert. The ethic expert launches dilemmas and facilitates discussions among students and among groups, projects short videos with compelling cases, and narrates cases in which ethical problems are dissected. Most of the cases and narratives are concerned with energy and engineering. Debate is usually around engineering situations related with renewable energies.

Acknowledgment

This paper was financially supported by InnoEnergy, Teacher Excellence Awards 2020

References

1. Eng, N. L., R. H. Bracewell and P. J. Clarkson, The role of narrative in evolving engineering design documentation, DESIGN 2008, Dubrovnik, Croatia, 2008
2. Hardy, C., Phillips, N., & Clegg, S., Reflexivity in organization and management theory: A study of the production of the research 'subject', Human Relations 54(5): 531–560, 2001
3. Latour, Bruno, Visualization and cognition: Thinking with eyes and hands. Knowledge and society: Studies in the sociology of culture past and present. Vol. 6, 1-40. Greenwich, CT: JAI, 1986
4. Star, Susan Leigh and James Griesemer, Institutional Ecology, `Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, Social Studies of Science, Volume: 19 issue: 3, 387-420, 1989
5. Gonçalves, Abreu and José Figueiredo How to Recognize an Immutable Mobile When You Find One, Translations on Innovation and Design. (ed.) Arthur Tatnall, Social Influences on Information and Communication Technology Innovations, Chapter 6, IGI Global, pp. 92-116, 978-1-4666-1559-5, 2012

6. Latour, B., Science in Action. How to Follow Scientists and Engineers through Society. Cambridge: Harvard University Press, 1987
7. Callon, M., Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St. Brieuc Bay, Power, Action and Belief: A New Sociology of Knowledge. J. Law (ed.), Routledge&Kegan, London, 1986
8. Aristotle, The Nicomachean Ethics. Dover Publications Inc., 1998
9. Dewey, J., The Moral Writings of John Dewey, J. Gouinlock (ed.), Buffalo, N.Y.: Prometheus Books, 1994
10. Stahl, G.K. & Tung, R., Towards a more balanced treatment of culture in international business studies: The need for positive cross-cultural scholarship, Journal of International Business Studies, 46, 391-414, 2015
11. Hamming, Richard W., The Art of Doing Science and Engineering, Learning to Learn, Gordon and Breach Science Publishers, 2005
12. Cajander, Asa, Mats Daniels, Roger McDermott, Brian Konsky, Assessing Professional Skills in Engineering Education, Australian Computer Society, Inc. This paper appeared at the 13th Australasian Computer Education Conference (ACE 2011), Perth, Australia. Conferences in Research and Practice in Information Technology (CRPIT), Vol. 114. J. Hamer and M. de Raadt, Eds
13. Bucciarelli L.L., Designing Engineers. Cambridge (Ma.): MIT Press, 1994
14. Govers Elly., An analysis of ethical considerations in programme design practice. Journal of Further and Higher Education. Volume 38, 2014 - Issue 6
15. Ohlsson, Stellan, The Problems with Problem Solving: Reflections on the Rise, Current Status, and Possible Future of a Cognitive Research Paradigm, The Journal of Problem Solving: Vol. 5 : Iss. 1 , Article 7, 2012
16. Schon, Donald, The Reflective Practitioner: How Professionals Think In Action, Basic Books, 1984
17. Patterson, Charlotte, Problem setting and problem solving: the role of evidence-based medicine, Journal of The Royal Society of Medicine, 90:304-306, 1997
18. Astley, W. Graham, Administrative Science as Socially Constructed Truth, Administrative Science Quarterly, Vol. 30, No. 4, 497-513, 1985
19. Nonaka, S. and Takeuchi, N., The Knowledge-creating Company: How Japanese Companies Create the Dynamics of Innovation, Oxford University Press, 1995
20. Delatte, N.J., Failure Case Studies and Ethics in Engineering Mechanics Courses. J.Prof.Issues Eng.Educ.Pract., 123(3), 111-116, 1997
21. Bijker, W., Hughes, T., and Pinch, T., eds., The Social Construction of Technological Systems. Cambridge, MA: MIT Press, 1987
22. Locke, John, An Essay Concerning Human Understanding, Oxford University Press, USA (original in 1690), 1979
23. Callon, Michel, Struggles and Negotiations to Define what is Problematic and what is not: The Socio- logic of Translation, In K. Knorr, R. Krohn & R. Whitley (eds.), The Social Process of Scientific Investigation, Dordecht, Holland: D. Reidel Publishing Co. 1981
24. Le Moigne, Jean Louis, Les épistémologies constructivistes, Que sais-je, Presses Universitaires de France, 1995
25. Lesley, Andres, Designing and Doing Survey Research London: Sage. 2012
26. Johnson, R. B., & Christensen, L. B., Educational research: quantitative, qualitative, and mixed approaches (5th ed.). Los Angeles, CA: Sage, 2014
27. Adams, R., & Allendoerfer, C., & Rhoulac Smith, T., & Socha, D., & Williams, D., & Yasuhara, K., Storytelling In Engineering Education Paper presented at 2007 Annual Conference & Exposition, Honolulu, Hawaii. https://peer.asee.org/2904, 2007
28. Devaney, Kevin and James Johnson, Storytelling as a Key Enabler for Systems Engineering, 27th Annual INCOSE International Symposium (IS 2017), Adelaide, Australia, July 15 - 20, 2017

29. Taylor, Rosanne Maree., Defining, constructing and assessing learning outcomes, Revue scientifique et technique (International Office of Epizootics) 28(2):779-88, 2009
30. Brundiers, K., & Wiek, A., Educating students in real-world sustainability research: Vision and implementation. Innovative Higher Education, 36, 107-124, 2011
31. Moon, Jennifer, The Module and Programme Development Handbook, London, Routledge Quarterly, Vol. 30, No. 4, 497-513, 2003
32. Goldratt, Eliyahu M., Critical Chain, North River Press, 1997
33. Gagne, E. D., Yekovich, C. W., & Yekovich, K. R., The cognitive psychology of school learning, 1993
34. Davis, Barbara Gross, Tools for Teaching, Jossey-Bass Inc., Publishers, 1993
35. Klein, Gary, Sources of Power, Cambridge Massachusetts, MIT Press, Chapter 4 – The Power of Intuition, 1998