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Theory of Objectification and Engineering Education

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Abstract. This article identifies the contributions of the forums held in 2026 on the Theory of Objectification (TO) to consider options in engineering education in the face of the Fourth Industrial Revolution or Industry 4.0. The study evaluates the applicability of this historical-cultural framework in the training of engineers proposing an alternative to traditional, transmissive, and individualistic educational models. Through an ontological approach, the transition from data and information toward the construction of real knowledge is analyzed through the pedagogical concept of joint labour. The document integrates Aldert Kamp's perspectives on interdisciplinary curricular design toward the year 2030, Klaus Schwab's views regarding stakeholder capitalism, and Nagib Callaos' concepts surrounding cybernetic humanism. Likewise, it examines the impact of technological infrastructure and Generative Artificial Intelligence (GAI), conceived here as a semiotic mediator and thinking partner capable of activating metacognitive processes in the student. In the context of developing countries like Venezuela, the need to transform the teaching of basic sciences through real problem-situations linked to the local socio-political reality is raised. Potential findings evidence the demand to migrate from an individual and punitive evaluation toward a formative and communal model. Finally, it concludes that true digital transformation in higher education does not lie in the acquisition of hardware, but rather in adopting an epistemological stance that recovers the protagonism of human activity and promotes self-regulation, solidarity, and social responsibility.

Keywords: Theory of Objectification; Industry 4.0; Joint Labour; Generative Artificial Intelligence; Curricular Redesign.

1. Introduction

The fundamental purpose of this document is to identify the contributions obtained from the presentations, debates, and proposals emanating from the 1st and 2nd Forum on the Theory of Objectification (TO), held in February and April 2026. Both academic meetings were sponsored by the Postgraduate Program in Research and Development Management (PGID), attached to the Faculty of Economic and Social Sciences of the Central University of Venezuela (UCV); the Hispano-Venezuelan Association of Engineers and Architects (AHVIA); and three commissions of the

National Academy of Engineering and Habitat of Venezuela (ANIH): the Telecommunications and Informatics Commission (comt+i), the Higher Education Commission (CES), and the Special Commission for Academic Activities in Spain (CEAE).

These forums emerged as useful activities to rethink didactics and pedagogy in the face of the multidimensional challenges imposed by the digital era and the progressive consolidation of the Fourth Industrial Revolution or Industry 4.0. During the forums, presentations were made on how knowledge is acquired, analyzing its methods and its coherence with what the student has already learned to place it alongside what is considered true or valid. The central theme revolved around rethinking the teaching-learning methodology, not merely as a mechanical transmission of knowledge and technical competencies, but as the TO proposes it: an ethical, political, and cultural project for social transformation.

The objectives of both forums focused on evaluating the functionality and applicability of the TO, a historical-cultural theory conceived by Radford and Gómez Guzmán (2023) to transform mathematical education, as well as education across different levels, including professional training in various disciplines. In particular, a university context where transmissive and individualistic models still prevail was assumed; therefore, these forums sought to study "joint labour" as an experimental model of the educational act. In this regard, an attempt was made to build an ontological framework integrating fundamental beliefs, concepts, and assumptions about the characteristics of reality, which, in addition to defining what things exist, would also attempt to understand how they relate to one another.

This framework establishes a guide that helps organize knowledge, determines the foundational core of phenomena, and shapes the vision of what it conceives as its circumstance. This document will address from an ontological framework on the nature of knowledge, passing through the analysis of the enabling technological infrastructure, to arrive at an eventual consideration of curricular redesign or the revision of the teaching-learning model necessary for the year 2030, with special attention to the reality of educational institutions in developing countries like Venezuela.

In the current circumstances, it is pertinent not only to prepare in the best possible way for the context and meaning of the Fourth Industrial Revolution or Industry 4.0, but it also seems timely to understand the impact of dominant disruptive technologies, such as Large Language Models (LLMs) and Generative Artificial Intelligence (GAI). These tools accompany us day by day to address countless requirements and serve as a thinking partner, even as a potential activator of metacognition or the ability to reason about our own thinking. In this regard, the progressive convergence between analogical and logical reasoning processes becomes essential to understand how the mind interacts with these cybernetic supports (Callaos and Horne, 2025).

It is understood that there are six dominant technologies: GAI; Autonomous Vehicles, logistics transformers, and city design; Big Data, which interprets data patterns, improves processes, and guides decision-making; the Internet of Things (IoT), where everything connected accumulates data on servers for storage and processing; the massification of robots, automation, and self-learning; and 3D printing and on-demand production. In addition to the six mentioned, many other important ones exist, such as Blockchain, to secure and protect a variety of processes and computer systems.

2. Theoretical and Ontological Framework

2.1. The TO as a Transforming Paradigm

The TO, as presented by Radford (2nd Forum 2026), is grounded in the pedagogy of Paulo Freire and conceives learning as a historical, social, and material process. The pillars reaffirmed in this second meeting are:

- Objectification and Subjectification: Inseparable processes where the student gives meaning to cultural knowledge (objectification) while constituting themselves as an ethical and critical subject (subjectification). This pedagogical link is deeply rooted in the dialectical nature of consciousness and transformative educational liberation (Radford, 2024a), turning the classroom into a living environment for knowing and becoming (Radford & Gómez Guzmán, 2023).
- Activity as Joint Labour: Learning is not a solitary invention, but a collective encounter mediated by the joint activity of teachers and students.
- Semiotic Mediation: The use of artifacts or tools (including GAI) and embodiment as means for knowledge to reveal itself to consciousness.

2.2. The Epistemological and Ontological Framework of Engineering Education

The author posits that in the current university context, a clear dialectic exists within traditional teaching models of a markedly transmissive character. This occurs within a demanding environment where an education that responds to the complexity of Industry 4.0 is urgently needed. Certainly, it was learned from the 1st Forum on TO that in the Faculty of Engineering of the Central University of Venezuela, interesting results have been obtained for years, and experience has even been accumulated with the Competency-Based Education (CBE) model.

Consequently, the present study aims to understand the reinvention of human talent, using, among other alternatives, the TO as a backbone to consider possible options that allow for the reconfiguration of teaching labour in the face of Industry 4.0. This applies both to mathematical learning and other areas within the three large engineering branches: Engineering (traditional and new disciplines), Architecture and Urbanism, and Agronomic and Forest Engineering.

Under the ontological lens, it is fundamental to begin by breaking down the triadic relationship between data, information, and knowledge. In the presentation slides and debates of the 1st Forum of the TO, it was established that data lacks intrinsic value; it is a minimal unit of registration that only acquires meaning when inserted into a system where information, by organizing and structuring such data, still remains on an external plane to the subject. The subject demands interaction with their peers for it to finally solidify as knowledge. Knowledge, according to the perspective of the TO, is not the result of passive assimilation, but a form of human activity, a process of gaining awareness of cultural systems of thought.

This distinction is critical in the era of accelerated digitalization, where the absolute ontological constitution of knowledge depends intrinsically on its structural anchoring within a sociocultural perspective (Radford, 2025). Thus, learning forces the exploration of the fine dialectic operating between historical knowledge, the act of knowing, and the manifestation of the concept within human activity (Radford, 2024b). Applying this to the learning of mathematics, the challenge for engineering training in the context of the digital era does not lie in access to data, but in the capacity to objectify mathematical and technical knowledge with the important purpose of transforming social and professional reality.

By virtue of the assumed dialectic exposed, we face the paradox of the digital society: a virtually infinite availability of information colliding with finite human time, tending toward zero, for reflective processing. This asymmetry generates a cognitive saturation which, in current teaching models, could derive in superficial and fragmented learning. Resolving complex problems, typical of the engineering field and even more so in the context of Industry 4.0, requires overcoming this paradox through the construction of spaces for "joint labour". In these spaces, interaction between students and teachers would not solely seek the transmission of standardized content, but would attempt the production of shared meanings.

In this way, the TO emerges as an option by proposing that learning is a process of becoming, where the student constitutes themselves as a subject to the extent that they interact with historical and cultural knowledge, utilizing technology—in this case, GAI—not to simplify thinking, but to empower it through its metacognitive capacity.

The set of philosophical assumptions, theoretical foundations, and conceptions of reality underlying a study forces an understanding of how knowledge is produced, validated, and comprehended to build the logic behind the epistemological framework.

This suggests that engineering education should abandon the monodisciplinary and purely technical vision that has characterized it for decades. The current demand for solutions to highly complex problems requires that the future professional, starting from a fragmented or fractured view of reality, be capable of integrating multiple dimensions of knowledge. Navigating this dense panorama introduces the necessity of incorporating complexity and complex thinking to explicitly innovate within engineering training processes (Serna & Serna, 2017), effectively redefining the relationship between technological knowledge, engineering practice, and contemporary systemic complexity during curricular design (Galland & Cura, 2012).

At the same time, Radford's TO postulates that higher education must migrate from an approach centered on the correct answer or results toward one centered on the process of knowledge objectification. This new vision is what would allow engineers not only to operate machines or develop algorithms, but also to understand the ethical and social implications of their praxis or the knowledge they apply when resolving situations and problems. In this sense, the ontological framework presented here could serve as a foundation to analyze how computer science and GAI will become the semiotic mediators defining the practice of engineering in the coming decades.

2.3. Analytical Expansion and Ontological Framework

For the postulates of Radford and Gómez Guzmán (2023), knowledge is not a static entity or a package to be transferred; on the contrary, it is a living system of ideas and forms of action historically crystallized in culture. Within this framework, data and information represent "the historical general," a potentiality of thought that lacks its own life until it is reactivated by human praxis, because it is when a person links their knowledge with an action that they understand and resolve a situation. For the TO, real knowledge emerges uniquely in the dialectical interaction between this cultural generality and "the particular sensible"—that is, the student's embodied and situated experience.

Under this perspective, or ontological lens, from which "being," existence, reality, and its fundamental structures are analyzed, the aforementioned contradiction or paradox of contemporary digital society manifests, and consequently, the resolution of complex problems in engineering. In this sense, it is required that the student cease to be an isolated recipient and become a subject who co-produces meanings in interaction with peers, with or without technological artifacts or tools.

3. Critical Analysis of the Interventions and the Panel Discussion of the 2nd Forum

3.1. Transdisciplinary and Ontological Applicability

One of the important aspects was the translation of the TO to non-mathematical disciplines. Speaker Silva Sprock A. (2nd Forum 2026) raised whether there are ontological differences when applying the TO to the Didactics of History, given that in this case, knowledge is interpretative and multi-causal. Radford's response (2nd

Forum 2026) was that no substantial differences exist, because in both cases learning is an act of "noticing" and giving meaning to pre-existing cultural systems.

3.2. Distance Education and Technology

Speaker Mosquera Padrón J. (2nd Forum 2026) consulted on the viability of grounding distance education models within the TO. The 2nd Forum revealed that while it is possible, the challenge lies in generating real joint labour that overcomes the simple "coordinated juxtaposition of individual tasks." Technology must operate as a historical-cultural semiotic artifact and not as an agent of alienation.

3.3. Engineering and Metacognition

Speaker Avella Guevara A. (2nd Forum 2026) linked the TO to its applicability in Mathematics and raised the need to do so for Industry 4.0, proposing GAI as a "thinking partner." He suggested delegating tasks to the maximum to GAI, a tool that would additionally activate metacognitive capabilities in the student, thereby freeing up time and space in the classroom for ethical debate and decision-making.

Author Nagib Callaos contributed the vision of "Cybernetic Humanism," where knowledge emerges from feedback loops between mind, society, and technology. His proposal of "twin articles" seeks to resolve the paradox between disciplinary precision and the transdisciplinary communication indispensable in contemporary education. This integration requires addressing education, research, and methodology not as isolated modules, but as an explicit transdisciplinary cybernetic whole (Callaos & Cristo, 2025), where rigorous transdisciplinary communication acts as a necessary condition to bridge the traditional fractures of monodisciplinary knowledge (Callaos, 2022).

4. Technological Infrastructure and Artificial Intelligence in Industry 4.0

4.1. Computing Infrastructure and Connectivity

The evolution of computing infrastructure or hardware and connectivity constitutes the material base enabling the Fourth Industrial Revolution or Industry 4.0. The analysis cited in the forums highlights the exponential progression of the microprocessor, from the initial 2,300 transistors to the projection of one trillion, representing one of the major conditions enabling the technical possibility for the deployment of Industry 4.0. This technological convergence is not a merely technical phenomenon; it is, in terms of the authors accompanying Kamp, Callaos, Schwab, and McKinsey, the engine driving a volatile, uncertain, complex, and ambiguous world (VUCA).

By virtue of the dialectic presented during the panel discussion of the 1st TO Forum by Nagib Callaos, digital infrastructure allows for a "cybernetic triad" where interactions between subject, object, and knowledge operate as feedback circuits. According to Schwab (2018) and McKinsey (2018), data transforms into a strategic resource and artificial intelligence becomes the axis of automation and evidence-based decision-making.

Nonetheless, the TO warns that this infrastructure must not lead to greater alienation: the ultimate point where individuals feel detached, disconnected, estranged, or dispossessed of themselves, their work, or their environment. On the contrary, the evolution of hardware must be seen as the creation of new "semiotic artifacts" that extend human cognition beyond the brain, allowing for a "sensible cognition" where the student manipulates data and visualizes complex events to objectify knowledge that was previously unattainable. Through this sensible cognition, the individual knows and gives meaning to the world via the senses, the body, and emotions, constituting a multimodal, culturally, and historically situated form of knowledge.

4.2. Artificial Intelligence as a Cross-cutting Axis and Thinking Partner

GAI positioned itself in the 1st Forum of the TO not merely as a simple resource, but as a cross-cutting axis acting as a thinking partner. Detailing the GAI ecosystem implies recognizing that tools like LLMs represent a massive digital form of "the historical general": accessible and interactive repositories of accumulated human knowledge. Here might reside a rupture between the traditional teaching model and the proposals of Kamp (2016), Callaos (2015, 2018), and Schwab (2018) under the lens of the TO. While the current model uses technology to automate passive transmission, the TO proposes integrating GAI as a cultural mediator that enhances metacognition, allowing the individual to reason about their thinking, but now from a superior intellectual level. This operational approach relies heavily on how semiotic systems function within education, where technological and digital artifacts act as fundamental mediators for the externalization of human cognition (Radford, 2013b).

This extends further into the ethical interpretation of results and decision-making in uncertain contexts. According to Callaos, this integration should favor a "cybernetic humanism," where knowledge emerges from feedback loops between mind, society, and technology, enhancing human self-regulation without compromising communal ethics. This process supports the search for the other (alterity), which is necessary for the development of being in order to construct identity, awareness, and humanity.

4.3. Regarding "Interdisciplinary," "Multidisciplinary," and "Transdisciplinary":

The categories "interdisciplinary," "multidisciplinary," and "transdisciplinary" are associated with three broader, collaborative pedagogical and methodological approaches related to education and research. The way they are approached varies depending on whether they are used to find a solution to a problem or to answer a research question. In the present study, these categories have been considered based on the works published by authors Aldert Kamp (2016) and Klaus Schwab (2018), while simultaneously grounding their conceptual frontiers through contemporary legal-philosophical definitions of epistemological boundaries (Paoli Bolio, 2019). Furthermore, their concrete application establishes a structural pillar for research-oriented training in modern engineering disciplines (Henao-Villa et al., 2017). A. Kamp studies engineering education and proposes migrating from monodisciplinary to multidisciplinary and interdisciplinary approaches, while K. Schwab proposes a more supportive, stakeholder-oriented capitalist model and utilizes multidisciplinary and transdisciplinary approaches in a different manner.

In the multidisciplinary approach, collaboration takes place across multiple disciplines or fields of knowledge. Each expert from a specific discipline works independently within their area of expertise, and at the end, the results are joined together without the intention of deeply integrating them. In the interdisciplinary approach, experts work together more closely and collaboratively; when they integrate their diverse perspectives and methods, they achieve a more comprehensive, though not yet exhaustive, understanding of the object of study.

In the transdisciplinary approach, the plan is to transcend the limitations that each discipline or area of knowledge possesses; thus, the established working teams attempt to achieve a global understanding, including the relevant aspects of each discipline but adding other cultural, ethical, and social aspects. Its result is more closely associated with reality and, in this sense, can be more useful and yield a greater impact than the previous approaches. To effectively realize this integration within professional frameworks, engineering faculties must actively design multidisciplinary approaches to address and manipulate the inherent complexity embedded in modern engineering systems (Micolini et al., 2025).

5. Curricular Redesign and Engineering for Development

5.1. The Redesign of Engineering Education for 2030

Toward the year 2030, the profile of the future professional must evolve toward a creative, ethical, and socially responsible individual. The theories of Kamp, Schwab, and Callaos coincide in that engineering education must transition from monodisciplinary thought to an interdisciplinary and fractured or "kaleidoscopic" vision. This curricular redesign implies understanding complex systems and developing capacities for lifelong learning in scenarios of instability and constant change, or VUCA environments.

Grounding this shift requires constructing a completely new engineering curriculum adapted to regional demands (Cajas, 2024), while systematically adjusting engineering education to Industry 4.0 paradigms through strategic curricular development and optimized laboratory spaces (Garcés and Peña, 2020). Consequently, modern engineering must be explicitly prepared to operate in times of heightened complexity and permanent uncertainty (Soler and Sánchez, 2020).

The objective of achieving avant-garde engineering education demands a profound re-evaluation of teaching-learning methodologies, even overcoming according to Radford and Gómez Guzmán (2023) the traditional paradigm that seems to have reduced the classroom to a space of unidirectional transfer. Under this ontological lens, Connectivism (Siemens, 2005), which coexists with traditional learning models, emerges as a necessary antecedent by recognizing that learning in the digital era is distributed across networks of human and non-human nodes. Nonetheless, by virtue of the dialectic exposed in both 2026 forums, connectivism alone appears insufficient if it is not integrated with a pedagogical structure that provides ethical and social meaning to technical interaction.

To achieve a comprehensive transition, the overarching curricular redesign must explicitly build upon the critical milestones of engineering education facing Industry 4.0 (Avella, 2026), overcoming individualistic paradigms through targeted semiotic mediation and a deep awareness of the sociocultural matrix of learning (Radford, 2013a, 2014). It is here where the TO, once again, could erect itself as the superior framework of intelligibility, proposing that learning is not the mere connection of information, but a historical-cultural process of "joint labour" In that labor, the engineering student would not only acquire a competence, but would encounter mathematical and technological knowledge through a socially situated activity.

The TO could contribute to this transition the notion that redesign is not just about updating content, but about teaching-learning methodologies or forms of subjectification. The engineer of 2030 should not be a mere technician executing formulas; on the contrary, they should be a professional capable of activating metacognitive processes to achieve the best solution at the best cost, additionally taking advantage of GAI's possibility to reason about their own thinking. According to Kamp, this requires integrated learning that combines creativity, technology, and social responsibility. This comprehensive vision matches the integration of engineering within broader science-technology-society (STS) educational prisms, which reinforces the critical humanistic dimension of technical training (García-Carmona, 2023).

To achieve this, higher education should, according to Radford's TO (2026), abandon "punitive evaluation" and individualism and migrate toward a "communal evaluation" that values both the appropriation of technical knowledge and alterity, or the development of "being-with-others." For its part, the comprehensive training proposed by Callaos underlines that engineering is, ultimately, a creative and human act oriented toward social development.

5.2. Engineering for Development: The Context of Venezuela

The reinvention of human talent acquires specific nuances in developing countries and, very particularly, in the Venezuelan reality addressed in both forums. In Venezuela, engineering training faces the challenge of reconciling the communal ethics of the TO with engineering disciplines conditioned by standardized curricula and institutional pressures. The analysis highlights that the mathematics block in Venezuelan engineering faculties may have traditionally operated as a transmissive-receptive academic filter according to the 1st TO Forum (2026).

The proposal of conducting the two forums for Venezuela consisted of seeking options for the "reinvention of talent" through the design of real problem-situations that could return engineering mathematics, and eventually other subjects, to their socio-political matrix. A Venezuelan engineer should not calculate integrals just to pass, but learn with them to optimize and resolve processes that directly impact their environment, such as the design of energy networks or habitat structures and facilities. In the framework of engineering education, this implies that methodologies must migrate from the mechanical resolution of algorithms toward the exploration of highly complex problem-situations.

The underlying logic suggests that knowledge is not something one "possesses," but something one "inhabits" through praxis. In this sense, the "joint labour" proposed by Radford (2020) and analyzed during the 1st and 2nd Forums pointed out that an ethic of solidarity and responsibility toward the other is demanded. Thus, learning ceases to be an act of individualistic accumulation to transform into a collective project where the teacher and the student co-produce meanings, utilizing available technologies as mediators that extend the capacity for reflection and action upon reality's situations and problems.

5.3. Toward a Technological Humanism in Engineering

This process of metacognitive activation would be the core of "joint labour" in the digital era. The TO postulates that learning occurs when the subject recognizes themselves in the work of culture; in this case, GAI would represent the crystallization of centuries of mathematical and engineering knowledge. However, for this interaction not to turn into alienation, didactics must foster what Callaos describes as the "self-regulation of being." The engineer must develop a critical sensitivity to discern between information processed by an algorithm and the skill and wisdom necessary for its ethical application. Under this ontological lens, GAI at no point replaces the teacher; on the contrary, it repositions them as an architect of learning experiences who uses technology to make visible reasoning processes that previously remained hidden in the student's mind.

The national reality of Venezuela, characterized by the need for innovative solutions in the face of limited resources, could find a transforming binary in the TO and GAI. The training of human talent should be oriented toward a "cybernetic humanism" that prioritizes the resolution of concrete reality problems, utilizing GAI to close infrastructure and knowledge gaps. In this technological framework, the formal conceptualization and operational deployment of cognitive and agentic digital twins establishes an ideal path to ground this transformation inside the engineering classrooms (Silva Sprock & Silva Sprock, 2026). Engineering for development is not just a matter of technical efficiency, but a social commitment that requires professionals capable of working collectively, with an ethic of alterity and with an inescapable responsibility for the impact of their decisions.

6. Comparative Analysis of the Forums and Closing Reflections

6.1. Dimensions of the Forums on the TO

The systematization of the debates and presentations from both academic meetings allows for the structuring of a comprehensive analytical framework centered on three fundamental dimensions for the reconfiguration of engineering education: evaluation, the nature of learning, and the impact on the local context. By contrasting the 1st Forum (focused on foundational and theoretical justification) with the 2nd Forum (oriented toward praxis, transdisciplinarity, and structural difficulties), the epistemological and operational tensions entailed in adopting the Theory of Objectification in contemporary higher education become evident.

- Evaluation Dimension: During the 1st Forum, the imperative need to migrate toward an evaluation model that prioritizes and qualitatively values the student's process of gaining awareness and evolution was established as a theoretical postulate, distancing itself from the traditional behaviorist approach centered exclusively on the result or the correct answer. However, the analysis of the 2nd Forum translated this postulate into harsh institutional reality, identifying a marked structural difficulty. A dialectical clash exists between the communal and supportive ethics promoted by the TO (where growth is measured collectively) and the normative, punitive, and individual frameworks demanded in a standardized manner by official university accreditation agencies.
- Learning Dimension: From a conceptual perspective, the 1st Forum defined learning through the lens of the TO as a collective, ethical, and material encounter with pre-existing cultural knowledge, in contrast to theories that reduce it to an isolated cognitive assimilation. In the 2nd Forum, this definition was subjected to critical examination regarding technological and digital mediation. The panel discussion yielded a core warning for distance and hybrid education models: there is a latent risk that the use of platforms and computing tools might generate merely a "coordinated juxtaposition of individual tasks," fragmenting interaction and undermining the true concept of collective and face-to-face "joint labour".
- Local Context Dimension: The territorial relevance of the research was initially addressed in the 1st Forum through a diagnosis of the crisis and the urgency of reconfiguring and reinventing human talent within engineering faculties in Venezuela to face Industry 4.0. For the 2nd Forum, this concern was transformed into a concrete, situated methodological proposal for Venezuelan curricular design. It was proposed that the ideal way to break away from traditional transmissive models is the design and implementation of real and complex "problem-situations" based on the national socio-political environment, ensuring that traditionally abstract

subjects used as academic filters—such as the mathematics block—return their technical utility directly to the service and optimization of the country's social development needs.

By contrasting the 1st Forum with the 2nd Forum, the epistemological and operational tensions entailed in adopting the Theory of Objectification in higher education become evident (Table 1).

Table 1 Comparative Analysis between the 1st Forum and the 2nd Forum on TO.

Dimension	1st Forum (Foundation)	2nd Forum (Praxis and Difficulty)
Evaluation	Proposes the need for an evaluation that values the process	Identifies a structural difficulty between the communal ethics of the TO and the punitive/individual metrics of accreditation agencies
Learning	Defines learning as a collective encounter with cultural knowledge	Warns about the risk that group work mediated by technology might only be a juxtaposition of tasks and not real "joint labour"
Local Context	Analyzes the Venezuelan reality from the perspective of reinventing human talent	Proposes the design of real problem-situations to return mathematics to its socio-political matrix within the national context

6.2. Closing and Prospective Reflections

Methodological redesign should consider the integration of GAI not as a substitute for human thought, but as a companion that allows for the externalization of low-level cognitive processes to give way to metacognition and high-order reflection. The TO maintains that tools, from the slide rule to latest-generation GAIs or language models, are "semiotic artifacts" carrying history and cultural intent. Therefore, engineering education in 2030 should focus on the student's ability to dialogue critically with these ancient and modern artifacts.

Connectivism would now provide the network infrastructure and relationships between knowledge sources; additionally, the TO would now provide the necessary human depth so that this network is not a simple data mesh, but a fabric of wills oriented toward solving the problems of Venezuelan and global reality.

In conclusion, the TO could offer a robust and necessary framework to rethink engineering education, not as the simple acquisition of technical competencies, but as a potential project for human development and collective emancipation. The prospective value of this document for engineering in Venezuela would reside in its ability to integrate Generative Artificial Intelligence as a new semiotic tool that, far from alienating the student, would empower them by activating their metacognitive capacity and their critical encounter with knowledge and with the other.

Engineering training should empower the student and future engineer's self-regulation and metacognition, thereby allowing them to understand how GAI and a good computing setup could activate or extend their own cognition. For this reason, it is imperative to approach GAI not as a disruptive entity that displaces human intellect, but as a semiotic tool and companion of unprecedented capabilities. In this way, human talent would be prepared for "co-creation" with GAI, always maintaining the primacy of human judgment and social sensitivity. The new profile of the 2030 engineer could look something like this: a professional with a solid technical foundation, but also with a reflective capacity and a communal ethic that allows them to lead digital transformation with a human and transcendent purpose.

Finally, it is imperative to recognize that the implementation of these new methodologies would find its greatest enemy in the rigid structure of traditional university faculties and professors. The transformation toward a model based on the TO requires a rupture with punitive and individual evaluation, and—something even more uphill—the acceptance of communal and formative evaluation as valid and ethical. The student no longer just solves the problem, but, by virtue of technological mediation, is forced to think about their own thinking, validating, questioning, and adjusting what the GAI models propose.

By virtue of what was presented in the working sessions of both forums, engineering education must transcend the monodisciplinary vision to embrace true interdisciplinarity, where mathematics is not a filter for exclusion, but the language that allows for the objectification of the laws of nature and technique in favor of social development. This methodological change is the precondition for human talent to face the challenges of Industry 4.0 with a critical, ethical, and deeply human vision. It is not simply a matter of adding new courses on AI or Big Data, but of restructuring and adapting the curriculum so that the student can develop the mental agility necessary to navigate highly uncertain (VUCA) environments.

According to the contributions of both forums, the professional would no longer be solely an isolated "problem solver," but a critical node forming part of a social innovation network. On the other hand, technological infrastructure (sensors, digital twins, 5G/6G connectivity) would act as a system of semiotic mediation allowing the engineer to visualize and manipulate complexity in ways previously unthinkable.

The true digital transformation of engineering faculties would not reside in the acquisition of latest-generation hardware, but in the adoption of an epistemological posture that restores the protagonism of human activity. The TO would provide the necessary scaffolding for technology to be a vehicle of emancipation and not subordination.

As final questions for the academic community, it is worth asking: How will we guarantee that the technological mediation of GAI does not end up deepening the student's disconnection from reasoning with their own thought? In what way can a truly communal evaluation be epistemologically justified before accreditation entities that still demand standardized performance metrics? The success of this transformation will depend on the educational community's capacity to embrace its dialectical nature and resist the fragmentary pressures of the dominant system, forging classrooms that are true spaces for collective work and social transformation.

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