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Leonardo da Vinci: Lean Educator or Lean Sensei?

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Abstract. The inspiration behind the research conducted in this conference paper roots back to the 6th European Lean Educator Conference (ELEC 2019) held in Milan. Named “The Lean Educator and Practitioner Mashup”, the conference was meant to explore the latest academics and industrial contribution to lean education, embracing the figure of Leonardo da Vinci as a conceptual leitmotif.

Both formal and informal events were paramount in the inspirational process leading to this research, highlighting some relations between lean thinking principles and the character of Leonardo da Vinci.

In this regard, analogies have been analysed to study if and how Leonardo’s tools, theories and techniques could describe him as one of the contemporary figures of the Lean Educator or Lean Sensei.

The focus of the research was on Leonardo’s tendency to outline the method and process through which his genius developed and manifested, to point out similarities and differences with the contemporary lean thinking and practice and to compare his figure with the one of a Lean Educator first and of the Lean Sensei afterwards.

Keywords: Leonardo da Vinci, Lean thinking, Lean Educator, Lean Sensei.

1 Introduction on lean thinking and Leonardo da Vinci – LEANardo

The inspiration behind the research led in this work roots back to November 2019, during the 6th European Lean Educator Conference (ELEC 2019) held in Milan. Named “The Lean Educator and Practitioner Mashup”, the conference was meant to explore the latest academics and industrial contribution to lean education, embracing the figure of Leonardo da Vinci as a conceptual leitmotif, in celebration of the 500th anniversary of his death.

Several influent academics and professionals in lean management took the stage to share latest studies and experiences led in this context. Speech after speech, it was built

an enriching and stimulating environment, enhanced by more convivial meetings around the city in order to deepen interesting aspects about the genius of Leonardo da Vinci.

Both formal and informal events were key in the inspirational process leading to this research, highlighting some relations between the lean thinking principles and the character of Leonardo da Vinci.

In this regard, analogies have been analysed in order to study if and how Leonardo's tools, theories and techniques could describe him as one of the contemporary figures of the Lean Educator or Lean Sensei.

The research was first general and concerned insights about principles and practices related to lean thinking and their relevance with Leonardo da Vinci. Just in a second moment, the focus was shifted towards Leonardo's tendency to outline the process through which his genius developed and manifested, to point out similarities and differences with the contemporary lean thinking and practice and to compare his figure with the one of a Lean Educator first and of the Lean Sensei afterwards.

To answer these questions, it was first conducted a literature review regarding lean thinking and practice to highlight the relevance of the five lean principles and the most common traits and tools to lean thinking. Followingly, another literature review was carried out, to understand the possible contributions that Leonardo's method and attitude towards life could have had, unconsciously or not, on lean thinking and practice, bringing to life the concept of LEANardo, followingly defined more in detail.

The first work of literature on lean thinking and practice produced several insights, which will be presented in a brief overview followingly.

As a matter of fact, Toyota represents in the common imaginary the best application of lean thinking, the place where everything started. For this reason, its production system has been first studied and then replicated all over the world thanks to the formalization by Womack and Jones of The Five Lean Principles, representing important pillars to be accurately followed in the implementation of Lean practices [1,2].

Basically, Womack and Jones tried to convey that it is implicit in the interaction of all these principles that the never-ending improvement process it is aimed at with lean thinking can be summarized in a continuous pursuit for perfection, which is represented by a continuous boost for value, exposing hidden Muda in the value stream [3].

To do it, some tools and techniques can be used in a lean thinking perspective, both related to the TPS (along with TPD, TQM and Hoshin Kanri [4]) and more oriented to Product Development as *Set-based Concurrent Engineering* [3-5]. Among others:

- The 5S, used to eliminate *Muda* and improve discipline and standards [1,2],
- JIT (*Just In Time*), about producing just what needed at a specific time [1,2,6],
- *Kanban*, a tool through which the JIT is made possible [1,2],
- *Kaizen*, related to the concept of continuous improvement [1,2],
- *Zero Defects*, dedicated to the elimination of waste and defective parts [1,2,6],
- *Andon*, a control device reporting the status of a machine, line or process [7].

2 Context and Background

This paragraph will be mainly a literature research based on Leonardo da Vinci's method and tools, to highlight his "lean attitude" ante litteram through a comparison between The Five Lean Principles and *The Seven Da Vincian principles* [8].

This translates, in a second moment, into the research of the traits of a Lean Educator and a Lean Sensei in Leonardo's way of approaching life.

2.1 The Seven Da Vincian Principles

The Seven Da Vincian Principles, formalized by Gelb in the homonymous book, are considered the pillars of Leonardo's methodology and attitude towards life [8]. The objective of this analysis is actually to give an idea of his major and most common traits, the ones who made him the recognized genius that is known today, in order to make afterwards some reflections about his affinities with lean thinking and practice.

Given that, it is now time to introduce the seven principles:

1. *Curiosità* (Curiosity), curious approach towards life and research for continuous learning,
2. *Dimostrazione* (Demonstration), propension to test knowledge through experience and commitment, together with the willingness to learn from mistakes,
3. *Sensazione* (Sensation), experience the world through the five senses,
4. *Sfumato*, willingness to embrace ambiguity and paradox,

5. Arte e Scienza (Art and Science), continuous balance between art and science, logic and imagination,
6. Corporalità (Corporality), propension towards grace and ambidexterity,
7. Connessione (Connection), awareness of the importance of interconnections among all things and phenomena [8].

Curiosità can be defined as Leonardo's desire to know more about the world surrounding him, its dynamics and processes. He was extremely fascinated by nature and passionate in his research for truth and beauty. This attitude towards life "fueled the wellspring of his genius throughout his adult life, as he was able to transmute his passion into inquisitiveness" [8]. This continuous desire to learn is the cause of the depth of his studies and of the range of the topics considered.

The second principle is related to the concept of Dimostrazione, i.e., the human propension to absorb the most out of an experience. As a matter of fact, "Leonardo's practical orientation, penetrating intelligence, curiosity and independent spirit led him to question much of the accepted theory and dogma of his time" [8]. This is one of the reasons why he was so ahead of time, he was driven by experience, which was the first tool he used to question the status quo and common knowledge. The learning process was based on experience and new knowledge was created a mistake upon another.

The third principle, Sensazione, is strictly related to the second one, as the best way to make experience is through the five senses, especially sight. "*Saper vedere* (knowing how to see) was one of Leonardo's mottoes and the cornerstone of his artistic and scientific work" [8]. By improving his senses, he meant to improve his mind and the experiences accordingly.

Sfumato, literally "going up in smoke", is related to the concept of paradox and unknown. "Keeping your mind open in the face of uncertainty is the single most powerful secret of unleashing your creative potential. And the principle of sfumato is the key to that openness" [8,9]. Accordingly, paradox was a common trait in his research for the truth, as learning more and more about everything, he was dragged deeper into ambiguity and towards the unknown.

Arte e Scienza is the principle expressing his inborn dichotomy. Art and Science were two traits influencing each other, but that had to be continuously balanced. For this reason, he is labelled by Gelb "the supreme whole-brain thinker", able to see the

world in all its facets and to find connections among them to understand its intrinsic dynamics [8].

The principle of Corporalità is related to the Latin saying “Mens sana in corpore sano”. Giorgio Vasari, artist and art historian of the same period of Leonardo, can be helpful in this regard reporting about “his great physical beauty and more than infinite grace in every action. His great personal strength was joined to dexterity” [8,10]. This is reflected in his obsession for the human body and interest in anatomy.

Finally, the seventh and last principle, Connessione, is probably the one that better gives a measure of Leonardo’s genius. He recognized an intrinsic relation among all things and phenomena of the world surrounding him and found in these connections a way to create new knowledge out of their interactions. Gelb says that “one secret of Leonardo’s unparalleled creativity is his lifelong practice of combining and connecting disparate elements to form new patterns” [8].

2.2 Lean Sensei vs Lean Educator

Before discussing the concept of LEANardo more in detail, analyzing the common traits of lean thinking and Leonardo’s way, it is necessary to better define what a lean educator and a lean sensei is. As a matter of fact, this research aims at taking unusual and unique insights on Leonardo da Vinci in relation to his lean attitude towards his research and creation processes.

The Cambridge Academic Content Dictionary defines an educator as “a person whose work is teaching others, or one who is an authority on methods or theories of teaching” [11]. Moreover, according to Doscatsch, a general educator is “one who teaches or educates others with no indication of mentoring or working with preservice or fellow teachers” [12]. Therefore, a lean educator can be defined as an authority on methods or theories of teaching, who educates their students with no indication of mentoring, applying the lean methods depicted through the five lean principles. This figure, then, is defined by their pronounced attitudes towards dedicating into the shaping of others’ education, through a direct approach.

On the other hand, a lean sensei “is not a title you can take for yourself. It is given to you as a sign of respect from the people who want to learn from you because they

recognize your mastery, such as it is. This mastery requires a blend of theoretical knowledge, practical skills, and good judgement from experience, as well as a genuine intention to help – even when the lessons can be on the brutal side” [13].

So, the lean sensei is not internally moved by the same motivations of a lean educator, he is basically claimed to convey his mastery and knowledge by people recognizing his authority and who are eager to learn [14].

3 Discussion – Is Leonardo a Lean Educator or a Lean Sensei?

3.1 Analogies: the concept of LEANardo

In the previous paragraph, it was shown what can be concisely called “Leonardo’s way”, considered as an attempt to universally describe his method and attitude towards life. While reading it, it’s impossible not to catch some analogies with the Five Lean Principles. Such analogies will be now better shown in this paragraph; so, some considerations will be drawn to give a measure of how cutting-edge and innovative he was in this topic, and to give an explanation to the concept of LEANardo.

To accurately apply Lean Thinking and Practice, attention must be paid to the specification of value, that has to be defined in the customer’s perspective, so a product (or good or service) is valuable when it is capable to satisfy customers’ needs and these are willing to pay for it. In the same extent, Leonardo for most of his life worked for commissioners, usually important patrons of the major cities, and had to satisfy their desires. His customers had expectations that had to be met in order to keep benefiting of their protection and sponsorship, even if he didn’t believe in what he was asked to do, or his genius would have suggested him to dedicate to other projects [15]. Basically, everything revolved around the customers and their needs, however he was not willing to renounce to projects he was very passionate about and sometimes persuaded his customers, satisfying needs they didn’t actually have.

Another analogy can be found in Leonardo’s tendency to make several sketches of concepts he wanted to develop. For instance, Figure 1 shows his attention in the development of models for chains, his concept is enriched and improved at every attempt in

order to draw on paper exactly what he had in mind, seeking perfection in the execution [16].

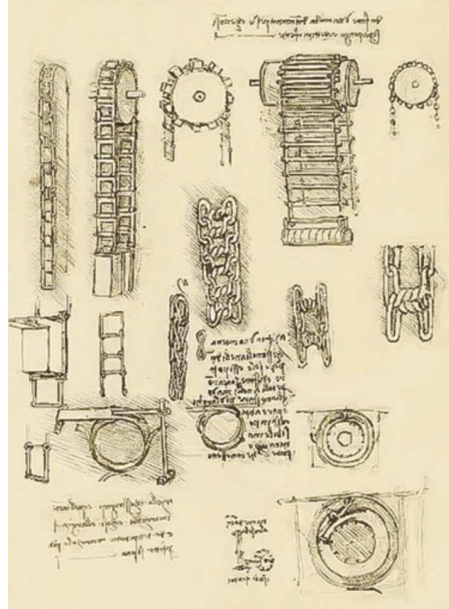


Fig. 1. Models for chains from Leonardo da Vinci (details) [16]

This vision is strictly connected to the lean concept of *Kaizen*, which is related to a research of perfection through continuous improvements. Moreover, sketches in Figure 1 don't have to be intended just as ways to visualize and improve a concept, but also as a way to test it both as a whole and at components level, investigating different alternatives in terms of mechanics, connections or materials. This could be interpreted as an evidence for another analogy: his propensity for Rapid Prototyping, typical of Lean Product Development applications. This concept has already been relatively addressed by Tarelko in his work "Leonardo da Vinci: precursor of engineering design" and by Sampaio in "Historical evolution of technical drawings in engineering", where it is discussed Leonardo's tendency to study all components in detail, evaluating different alternatives to understand, through models on paper, which was the best suitable for his purposes [17,18]. In this way, the testing phase for his concepts was diluted throughout the all design, the two phases were conducted in parallel and their results influenced each other, in an ancestral and simplified version of *Set-based Concurrent Engineering*.

The last thing to be said regarding his sketches, is that he used to write notes on the side. Notes were about everything that could come to his mind while thinking of his concept, so some lines are reminders regarding how to develop the physical prototype once the concept was defined, others were about details that shouldn't have been forgotten, or about insights for other possible works [17]. This was basically what in Lean Thinking and Practice is now called *Job instruction and Standardization*, it is to say defining strict guidelines to be followed by whomever is in charge of doing the job, once he is carefully trained for it. In the same extent, Leonardo described the procedure step by step, in order to be clear and make it simple.

In addition to this, Leonardo's projects were conceived in a lean "pull" logic. As a matter of fact, in Lean Thinking and Practice, activities must be organized in a "pull" logic, so you realize an activity just when the downstream process requires it. In the same way, Leonardo's projects derived from a demand to satisfy, both internal (for instance his desire to fly in the sky) or external (works of military engineering).

In any case, his projects were driven by experience. As a matter of fact, as he was an illegitimate son, he couldn't be instructed as every child in the upper middle-class of the time, he never studied Latin or Greek, so he had no chance to read all the classical and technical literature of previous times. For this reason, he focused on experience, without relying much on theory, he developed his own necessary encyclopedia through what he was able to experience in his life. He didn't learn by spending hours studying literature, he rather learned by doing, a mistake upon another, understanding what hadn't worked and why [N8]. The analogy with the lean concepts of *Learn by doing* and *Make mistake faster* goes without saying.

Moreover, as just stated previously, Leonardo constantly felt the urgency to know more about the world, in a process of continuous learning driven by experience and commitment. These concepts are basically the pillars of lean thinking and practice, which finds its strength in the commitment that people are expected to put in their work, which is conceived as a continuous circle of learning to create new knowledge.

However, it is in this context that one of the analogies driving this work of thesis arises. As a matter of fact, Leonardo's learning process was totalizing and embracing different fields, so what made him so ahead of time was his strong multidisciplinary,

it is to say his interest in the most disparate fields, reflecting in his achievements in quite every domain of human knowledge.

In the same extent, *Set-based Concurrent Engineering* promotes the development of multidisciplinary in project teams, in a powerful attempt of denial for *silos-thinking*, in order to create synergistic knowledge [3].

Finally, to wrap up, LEANardo is basically a concise way to express everything that has been figured out during the development of this literature research, it is the result of an accurate analysis of literature that highlighted the relevance of the indirect influence of Leonardo da Vinci on lean thinking, graphically summarized again in Table 1.

Table 1. Analogies between *Leonardo's way* and Lean Thinking and Practice in keywords

Analogies in Keywords	
Leonardo's Way	Lean Thinking and Practice
His projects had to meet commissioners' requirements in order to keep their sponsorship.	Value defined in the customer's perspective. A product (or good or service) is valuable if it satisfies customers' needs.
Customer-centric approach	Customer is the starting point of the process
Several sketches to continuously improve his concepts	<i>Kaizen</i> : seeking perfection through continuous improvement
Several sketches to perform testing of components during the design	<i>Rapid Prototyping</i> in <i>Set-based Concurrent Engineering</i> : Test - Design - Build
Process described step by step through notes	<i>Job Instruction and Standardization</i>
Projects arise from a demand to satisfy	Lean "pull" logic
Learn through direct experience and a mistake upon another	<i>Learn by doing</i> <i>Make mistake faster</i>
Multidisciplinarity Interdisciplinarity	Denial for <i>silos-thinking</i> in <i>Set-based concurrent Engineering</i>

3.2 Lean Educator or Lean Sensei?

Given all the points previously discussed, Leonardo da Vinci as a lean educator could be considered as a forced analogy. As a matter of fact, he was a lean educator

just potentially, he seldomly expressed and transmitted his potential directly to his contemporaries. Future generations throughout the centuries learned from Leonardo's attitude and method, but always indirectly and according to their interests.

For this reason, more than an educator, he could be considered as a lean sensei. As a matter of fact, this figure is more appropriate to describe Leonardo's figure and the authority that it constituted all over the centuries. Indeed, as previously mentioned, this title "is given to you as a sign of respect from the people who want to learn from you because they recognize your mastery, such as it is. This mastery requires a blend of theoretical knowledge, practical skills, and good judgement from experience, as well as a genuine intention to help – even when the lessons can be on the brutal side" [13].

4 Conclusions

The main purpose of this work was to analyse the method and attitude towards life of Leonardo da Vinci, in order to depict the analogies detected through the literature with lean thinking and lean education.

In this regard, all the analogies were schematized and studied to prove if Leonardo da Vinci can be defined a lean educator first and a lean sensei afterwards.

The results show that considering Leonardo da Vinci as a lean educator could be not totally pertinent, as he rarely got in contact with students or directed transmitted his knowledge to his contemporaries. He has been regarded as a genius since ever, as an unreachable figure you can only learn from. His authority is undeniable, for this reason he can be regarded more as a lean sensei towards the centuries.

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