DESIGNERS FUTUREPROOF SKILLSET? AN ABILITY AND SKILLS ANALYSIS FOR THE NEAR-TERM TRANSITION TOWARDS WORKING WITH AI.

Eleny Meiborg, BDes
Rosamelia Ribeiro, PhD

(1) Universidade Tecnológica Federal do Paraná

e-mail: emeiborg@alunos.utfpr.edu.br

(2) Universidade Tecnológica Federal do Paraná

e-mail: rosamelia@utfpr.edu.br

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This paper presents a preliminary analysis between abilities and skills needed by designers for the transition towards the impact of upcoming technologies in the labour market, especially the ones related with Artificial Intelligence, by giving a solid background of the technology and in consequence tries to prepare designers for future job requirements.

1. Introduction

The imminent growth in cheap computing power and the ubiquity of the mobile internet worldwide have already impacted many existing labour markets, yet the trajectory of change regarding Artificial Intelligence (AI) on employment and skills has, thus far, raised a polarized discussion between those who see unlimited possibilities regarding improved productivity and those that foresee a massive displacement of jobs (WEF, 2016). Historically, in the previous industrial revolutions, such disruptive change has taken decades to happen, now, given this new pace and scale of disruption, brought by the Fourth Industrial Revolution (SCHWAB, 2016), an anticipatory planning and reskilling is in order.

In this paper, a preliminary analysis of designers' abilities and skills was made in comparison with Artificial Intelligence capabilities. Through such analysis the aim was to try and provide a path for designers to prepare for this transition as well as to prepare for a possible displacement in the foreseeable future. Another important factor about

this work is to also provide some level of understanding about the technology and its role in the upcoming scenario, preparing the designer for both ends of the previous discussion.

2. Methodology

The present analysis initiated as an empirical investigation of recent literature, regarding the future of work, more specifically reviewing the literature on the upcoming demand for work-related skills. Through observation of the demand it was possible to associate the field of Design and Artificial Intelligence, where their correlation was given due to a worldly trend to be seen further as a forecast, where all occupations are to be affected by emerging technologies.

For the development of the analysis, a clarification of the nature of design and methods of designing was explored towards sequentially identifying designers' abilities, as well as an investigation about the realm of Artificial Intelligence, where it started and what is the technology about, also in order to identify AI's capabilities.

3.Designers' Abilities

To start and comprehend what designers are capable of it is of great importance to understand the nature behind what designers do. Nigel Cross (2006) presents a pragmatic view of the activity, by stating that the most essential thing the designer does is to provide, for those who will produce the desired proposal presented by the client, a description of what the design should be like, aiming therefore in the *communication* of a specific design proposal. Behind this simplistic view a multi-facetted and multi-levelled thinking happens along the process of a design project, and inside the generation of design proposals exist a whole range of criteria and requirements to satisfy the client's brief. This process usually follows a design methodology, where to some length can be very different from one another depending on the project, but they only differ in their levels of details rather than in fundamental concepts, so in other words they adopt some unifying principles, proposed by Gedenryd (1998) as *separation, logical order, planning, product-process symmetry*. Respectively, the four principles outlined by Gedenryd (1998) follows a consecutive order, where one is an elaboration of those before it, drawing out their consequences and filling in their details to be characterized as follows:

Separation: The separation of the design process into distinct phases, with each individual activity being performed in isolation from the others.

Logical order: The specification of an explicit order in which to perform these different activities.

Planning: The pre-specification of an order in which to perform the activities within a phase.

Product-process symmetry: The plan being organized so as to make the structure of the design process reflect the structure of the sub-components of the resulting design product.

An example of perhaps the most important type of separation divides the design process into three major phases: analyzing the problem, synthesizing a solution, and evaluating the outcome (GEDENRYD, 1998). This separation is considered to be the basic model of a design method, upon which many writers

agree, where analysis creates the decomposition structure of the artifact, and synthesis is to follow as a "structured decomposition" with successive refinement, while evaluation comes with testing, to see whether designers indeed have reached the correct solution (JONES, 1970, p.63; GEDENRYD, 1998, p.21).

When applying a design method, a designer should be able to handle tasks where key abilities must be set in place. Carrol (1993) presents a general view of design ability, being the "variations over individuals" in the level of design task difficulty at which, when all conditions appear favorable, individuals perform successfully on a design brief", but Arvola (2002) points out that this definition forgets that the difficulty of a design task will always vary according with the background and repertoire of the designer, meaning that any measure of design ability in the sense of potential to present performance on a task can be regarded as a measurement of achievement; of how well something has been learned.

Despite the levels of knowledge of the designer, eight main abilities have been pointed as crucial to designing, and Yukhina (2007, p.6) in alignment with Cross (2006, p.20) presented such abilities as:

1. Solve ill-defined (wicked) problems;
2. Produce novel and unexpected solutions;
3. Use nonverbal, graphic/ spatial media as means of problem-solving;
4. Apply Imagination and constructive forethought to practical problems;
5. Adopt solution-focusing strategies;
6. Employ abductive, productive and appositional thinking;
7. Work with several design solutions in parallel to understand problem-solving space;
8. Tolerate uncertainty and work with incomplete information.

When analyzing these designers' abilities, three groups of separate factors can alter the design task, and according to Arvola (2002) these groups are: some relating to the design situation, others to methods of designing, explained earlier, while the rest deal with design goals.

4. Artificial Intelligence Capabilities

Artificial Intelligence is not something new, Alan Turing's pioneer question "can a machine imitate human intelligence?" raised discussions about it in the 1950's, most specially at a Dartmouth College workshop, presenting automata theory, neural nets and the study of intelligence (RUSSEL; NORVIG, 2010, p.17; AGGARWAL, 2018).

AI research began in many fields, from neuroscience, mathematics, engineering to computer science, making it hard to find a single definition that is universally accepted by professionals, some define it as a computerized system that exhibits behavior commonly deemed as intelligent, while others define AI as "a system capable of rationally solving complex problems or taking appropriate actions to achieve its goals in whatever real-world circumstances it encounters" (NTSC, 2016). This broad background and many seminal works about AI helped generate the development of its most important sub-fields (Figure 1), still in progress today (AGGARWAL, 2018).

Figure 1: Important sub-fields of AI as of 1982.
 Source: Aggarwal (2018).

When working with AI, designers will always be in collaboration with programmers or/and engineers, meaning that designers will rely upon them to develop novel applications, while designers do not necessarily need to understand all of the mathematical details associated with Artificial Intelligence, it is very important to understand its underlying properties and constraints (HEBRON, 2016).

Therefore, in an attempt to bring clarity to the

complex and confusing subject of AI, Burgess (2017) presents a non-technical meta-view of what AI tries to achieve by *capturing information, determine what is happening and understand why is it happening*.

Noting that when *capturing information*, designers must first comprehend data and also its power, that is, data is becoming an integral part of almost every product, service and system (BERGER, 2018). Mainly, there are two types of data, structured and unstructured, the first being any data that is managed by a standard database management system (DBMS), where inside such system are keys, records, attributes and indexes, and the second kind of data is all the data not found in a standard DBMS (INMON, 2014). But Inmon (2014) also presents a less confusing way to comprehend the previous classification, by approaching data through its repetition; data that occurs frequently, repetitive data, found in a record that appears very similar to data in every other record is analogous to structured data – while nonrepetitive data has a unique occurrence in terms of content, therefore its record is different from the others, but similarities can be found in content, size or structure with other records, that way it is possible to analyze such data inside a collection, therefore analogous to unstructured data.

To use such data, according to Burgess (2017), AI presents eight capabilities: *Image Recognition, Speech Recognition, Search, Data Analysis Clustering, Natural Language Understanding, Optimization, Prediction and Understanding*; that should be used to perform inside a determined application. Figure 2 is a representation of such capabilities and their correspondent applications being used in businesses today, where the only exception is *Understanding*, that was purposefully placed by Burgess (2017) to demonstrate what AI is still not currently capable of executing.

Figure 2: The AI Capabilities and Applications.
Source: Author(s) based on Burgess (2016).

This current applications in AI, alongside with robotics, are continuing what other automation technologies have done in the past: using machines and computers to substitute for human labour in a widening range of tasks and industrial processes (ACEMUGLO; RESTREPO, 2018). This kind of automation, computer-controlled, is called computerization and its outcomes in the labour market are well-established in the literature, documenting the decline of employment in routine intensive occupations – with tasks following explicit procedures that can easily be performed by sophisticated algorithms (FREY; OSBORNE, 2013). The question is: How susceptible is Design to computerization? Frey & Osborne (2013) answers this question when it regards to Artificial Intelligence, their research is based on expanding the premises about the tasks that computer-controlled equipment can be expected to perform, and more, they ranked the estimated probability of computerization for 702 detailed occupations and the Designer was placed in three different categories, presented from least to most computerizable as; Fashion Designers with 21% chance of computerization (89 position in rank), Interior Designers with 22% (93) and Industrial Designers with 37% (119). Which meant that, from the 702, the designer occupation is not very susceptible to this type of automation but it doesn't mean that some processes involving the design won't be, and one example of computerization of processes closely related with designers was during the 1980s, when a desktop publishing software automated some of the tasks of setting type for

publication, so before that, designers would draw a page design and send it to typesetters and compositors to produce pasted up pages, which means that designers using computers substituted for typesetters (BESSEN, 2016).

However, this was only an example, recent developments in the technology is making it possible to automate knowledge-worker tasks, something that has long been regarded as impossible or impractical for machines to perform, and due to some achievements, such as human-level speech and image recognition, AI can now process a larger amount of data and inform accurate decision-making (WEF, 2016 & 2018). What brought a serious discussion regarding the future of employment worldwide, and several reports have been converging in topics when it comes to this subject, with highlight to a forecast from the World Economic Forum (2016).

5. Forecast

As entire industries adjust, most occupations are undergoing a fundamental transformation, the patterns of consumption, production and employment created by the impending change brought by emerging technologies pose major challenges, requiring proactive adaptation by corporations, governments and individuals (WEF, 2016).

The Future of Jobs Report (WEF, 2016) is a first step in becoming specific about the changes and challenges at hand, viewing the new trends of the shared economy alongside with technology growth not only in artificial intelligence but also genetics, 3D printing, nanotechnology, biotechnology and robotics, which are all building on and amplifying one another.

The report presents some workforce strategies and timeframes for change in varied sectors of the industry where the specifications can be used to anticipate and prepare for future job requirements, bringing a general comprehension that 65% of the respondents' industries are pursuing to invest in reskilling current employees, and the biggest barrier, with 51% of respondents declaring to be insufficient understanding about this disruptive changes.

Another critical factor to be considered is the mismatch between technology and skills - between the requirements of new technologies and tasks and skills of the workforce, that should aim efforts at closing those skills gaps, by grounding in a solid understanding of a country's or industry's skills base today and of the changing future skills requirements (ACEMOGLU; RESTREPO, 2018; WEF, 2016). Also, this mismatch is resulting in major recruitment challenges and talent shortages, a pattern already evident in the report results and set to get worse over the next five years (WEF, 2016).

The World Economic Forum (2016) also surveyed industries to provide the demand for core work-related skills by 2015-2020 with share of jobs requiring skills family as part of their core skill set in percentage (Figure 3 and figure 4), describing in figure 3 the share of skills for the given categories where the *dark blue* part of the stacked bars represents the demand expected to *remain stable*, the *grey* part of the stacked bar represents the *demand today* but for which demand *will be on the decline* by the year 2020, and the *bright blue* part of the bar represents the *anticipation* of the demand by the year 2020. Accordingly, the *dark blue and grey* parts of the bar chart combined represent the industry's *current overall skills demand* profile while the *bright blue and dark blue* parts of the bar chart combined represent *overall skills demand* in the industry as expected *for the year 2020*.

Figure 3: Change in demand for core work-related skills, 2015-2020, all industries.

Source: World Economic Forum (2016).

Skills family	Current	2020
Complex Problem Solving Skills	36	36
Social Skills	20	19
Process Skills	18	18
Systems Skills	16	17
Resource Management Skills	14	13
Technical Skills	14	12
Cognitive Abilities	11	15
Content Skills	10	10
Physical Abilities	5	4

Figure 4: Demand for skills in overall industries, 2015 and 2020, in %.

Source: World Economic Forum (2016).

The overall interpretation of the demand is that a wide range of occupations will require a higher degree of cognitive abilities, such as creativity, logical reasoning and problem sensitivity as part of their core skill set, where more than half (52%) of all jobs expected to require these cognitive abilities don't quite use them today, or use them only to a much smaller extent. Also, in 2020, more than one third (36%) of all jobs will require complex problem-solving as one of their core skills, however such skills will become somewhat less important in heavily technical industries, in which automation will take a bigger part of these complex tasks (WEF, 2016). The skills family with the most stable demand across all jobs requiring these skills today or in the future are technical skills: nearly half (44%) of all jobs requiring these skills today will have a stable need for them in the coming years. On the other hand, social skills such as persuasion, emotional intelligence and teaching others will be in higher demand across industries, more than narrow technical skills, such as programming or equipment operation and control (WEF, 2016). One with the decline in importance will be physical abilities (27% decline) compared to less than 1 in 20 jobs (4%) that will have them as core requirement.

On account of such numbers, the interpretation of the demand helps to suggest that perhaps designers must begin to improve their cognitive abilities,

which is higher in demand, followed by complex problem-solving, social and technical skills. Also, the demand will provide a basis for the comparative analysis between designers' abilities and Artificial Intelligence capabilities.

6. Capabilities and Skills Analysis

This section details the 35 core set skills presented in the forecast within the skills families, found in figure 3 and 4, due to their relevance as widely used work-related skills and abilities, that have been empirically derived from today's most-frequently cited skills and abilities across all occupations and job families (WEF, 2016). Their definitions, represented in table 1, will be used for the comparison between designers and artificial intelligence, where the WEF (2016) separates them into three groups, *Abilities*, *Basic Skills* and *Cross-Functional Skills*¹. The first group contains the *Cognitive* and *Physical Abilities*, the second *Content* and *Process Skills* and the third *Complex Problem-Solving*, *Resource Management*, *Social*, *Systems* and *Technical Skills*.

ABILITIES	
Cognitive Abilities	
<i>Cognitive Flexibility</i>	The ability to generate or use different sets of rules for combining or grouping things in different ways.
<i>Creativity</i>	The ability to come up with unusual or clever ideas about a given topic or situation, or to develop creative ways to solve a problem.
<i>Logical Reasoning</i>	The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events) and/or to apply general rules to specific problems to produce answers that make sense.
<i>Problem Sensitivity</i>	The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.
<i>Mathematical Reasoning</i>	The ability to choose the right mathematical methods or formulas to solve a problem.

¹Cross-Functional Skills needs both technical, social and analytical skills (WEF, 2016).

<i>Visualization</i>	The ability to imagine how something will look after it is moved around or when its parts are moved or rearranged.
Physical Abilities	
<i>Manual Dexterity and Precision</i>	The ability to make precisely coordinated movements to grasp, manipulate or assemble objects.
<i>Physical Strength</i>	The ability to exert maximum muscle force to lift, push, pull, or carry objects.
BASIC SKILLS	
Content Skills	
<i>Active Learning</i>	Understanding the implications of new information for both current and future problem-solving and decision-making.
<i>Oral Expression</i>	Talking to others to convey information effectively.
<i>Reading Comprehension</i>	Understanding written sentences and paragraphs in work-related documents.
<i>Written Expression</i>	Communicating effectively in writing as appropriate for the needs of the audience.
<i>Information and Communication Technology (ICT) Literacy</i>	Using digital technology, communications tools, and networks to access, manage, integrate, evaluate and create information.
Process Skills	
<i>Active Listening</i>	Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate and not interrupting at inappropriate times.
<i>Critical Thinking</i>	Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
<i>Monitoring Self and Others</i>	Monitoring/assessing performance of yourself, other individuals or organizations to make improvements or take corrective action.
CROSS-FUNCTIONAL SKILLS	
Complex Problem-Solving Skills	
<i>Complex Problem Solving</i>	Developed capacities used to solve novel, ill-defined problems in complex, real-world settings.

Resource Management Skills	
<i>Management of Financial Resources</i>	Determining how money will be spent to get the work done, and accounting for these expenditures.
<i>Management of Material Resources</i>	Obtaining and seeing to the appropriate use of equipment, facilities and materials needed to do certain work.
<i>People Management</i>	Motivating, developing and directing people as they work, identifying the best people for the job.
<i>Time Management</i>	Managing one's own time and the time of others.
Social Skills	
<i>Coordinating with Others</i>	Adjusting actions in relation to others' actions.
<i>Emotional Intelligence</i>	Being aware of others' reactions and understanding why they react as they do.
<i>Negotiation</i>	Bringing others together and trying to reconcile differences.
<i>Persuasion</i>	Persuading others to change their minds or behavior.
<i>Service Orientation</i>	Actively looking for ways to help people.
<i>Training and Teaching Others</i>	Teaching others how to do something.
System Skills	
<i>Judgement and Decision Making</i>	Considering the relative costs and benefits of potential actions to choose the most appropriate one.
<i>Systems Analysis</i>	Determining how a system should work and how changes in conditions, operations and the environment will affect outcomes.
Technical Skills	
<i>Equipment Maintenance and Repair</i>	Performing routine maintenance on equipment and determining when and what kind of maintenance is needed and/or repairing machines or systems using the needed tools.
<i>Equipment Operation and Control</i>	Watching gauges, dials or other indicators to make sure a machine is working properly; controlling operations of equipment or systems.
<i>Programming</i>	Writing computer programs for various purposes.

<i>Quality Control</i>	Conducting tests and inspections of products, services or processes to evaluate quality or performance.
<i>Technology and User Experience Design</i>	Generating or adapting equipment and technology to serve user needs.
<i>Troubleshooting</i>	Determining causes of operating errors and deciding what to do about it.

Table 1: Definition of core work-related skills.
Source: Author(s) based on the World Economic Forum (2016).

With the definitions, it becomes possible to identify, within the 35 abilities and skills, the presence of the designers' abilities and the AI capabilities presented earlier. The comparison analysis of the identified skills and abilities can be found in table 2, where the check (✓) symbol represents the skill/ability found within each group, and the X to represent the skill/ability not found inside each group.

SKILLS AND ABILITIES COMPARISON		
ABILITY/SKILL	DESIGNERS	ARTIFICIAL INTELLIGENCE
Cognitive Abilities		
Cognitive Flexibility	✓	X
Creativity	✓	X
Logical Reasoning	✓	✓
Problem Sensitivity	✓	✓
Mathematical Reasoning	X	✓
Visualization	✓	X
Physical Abilities		
Manual Dexterity and Precision	✓	X
Physical Strength	✓	X
Content Skills		
Active Learning	✓	✓*
Oral Expression	✓	✓

Reading Comprehension	✓	✓
Written Expression	✓	✓
Information and Communication Technology (ICT) Literacy	✓	✓
Process Skills		
Active Listening	✓	✓
Critical Thinking	✓	X
Monitoring Self and Others	✓	✓
Complex Problem-Solving Skills		
Complex Problem Solving	✓	✓
Resource Management Skills		
Management of Financial Resources	✓	X
Management of Material Resources	✓	✓*
People Management	✓	X
Time Management	✓	✓
Social Skills		
Coordinating with Others	✓	X
Emotional Intelligence	✓	✓*
Negotiation	✓	X
Persuasion	✓	X
Service Orientation	✓	✓
Training and Teaching Others	✓	X
System Skills		
Judgement and Decision Making	✓	✓
Systems Analysis	✓	X
Technical Skills		

Equipment Maintenance and Repair	X	X
Equipment Operation and Control	X	✓*
Programming	X	✓
Quality Control	✓	X
Technology and User Experience Design	✓	X
Troubleshooting	✓	✓

Table 2: Skills and Abilities Comparison.

Source: Author(s).

The comparison analysis shows that, regarding the designers, they lack on *Mathematical Reasoning*, *Equipment Maintenance and Repair*, *Equipment Operation and Control* and *Programming*. While artificial intelligence is in shortage of *Cognitive Flexibility*, *Creativity*, *Visualization*, *Physical Abilities*, *Critical Thinking*, *Management of Financial Resources*, *People Management*, *Coordinating with Others*, *Negotiation*, *Persuasion*, *Training and Teaching Others*, *Systems Analysis*, *Equipment Maintenance and Repair*, *Quality Control* and *Technology and User Experience Design*.

The abilities/skills with the asterisk (*) are not detailed in the previous section regarding AI capabilities because they usually are a combination of processes such as Robotic Process Automation (RPA) with AI, where such combinations of software and hardware capabilities are key enablers of AI (BURGESS, 2017). So, to justify the existence of such abilities/skills, in the comparison, an explanation will be provided, starting with *Active Learning*, that exists inside *Reinforcement Learning*, found in the *optimization* capability, that examines how an agent(AI) can learn from success and failure, from reward and punishment; where the agent starts with *passive learning*, that is, it has a fixed policy and a task to learn utilities of states, what involves learning a model of the environment it was placed, then comes *active learning*, where the agent must also learn what to do, exploring as much as possible of its environment in order to learn how to behave in it (BURGESS, 2017 & RUSSEL; NORVIG, 2010). Thus, to some extent AI possess *active learning*, but not as advanced as the designers

because it needs human help for improvement when its given a reward or punishment. Now, for *Management of Material Resources and Equipment Operation and Control*, both in combination with RPA, are according to Burgess (2017) the case where AI can work autonomously on infrastructure components, that is triggered by system alerts, so the robots can access almost any other system, with no disruption or changes required to those underlying systems where RPA in this scenario can be considered a ‘meta-manager’ that sits across all the monitoring and management systems. By doing so, AI is optimizing logistics and distribution of inventory in warehouses and stores; with real-time going from allocation of resources to manufacturing processes; optimizing the blend and timing of raw materials in refining and optimizing labour staffing and resource allocation (BURGESS, 2017). And lastly *Emotional Intelligence*, that is a combination of *Natural Language Understanding (Syntactic, semantic and sentiment analysis)* with a range of new hardware devices, providing users with mechanisms for communicating with machines through the endlessly expressive capabilities of the human body, with devices such as the Microsoft Kinect (HEBRON, 2016).

Finishing the analysis, Designers perhaps, can focus on abilities/skills that they possess and AI doesn’t, that according to the demand, are *Cognitive Flexibility, Creativity, Visualization, Coordinating with Others, Negotiation, Persuasion, Training and Teaching Others, Quality Control and Technology and User Experience Design*.

Furthermore, because cognitive abilities were highlighted as the biggest future demand, it is reasonable to learn about specific cognitive abilities, the one’s which are domain-related to design, and are found in Yukhina’s (2007) research, presented as *Visual Spatial, Learning and Memory, Production, General Reasoning and Factor-Analytical Reasoning* (figure 5).

Designers’ Cognitive Abilities

Visual Spatial

- Manipulating Spatial Relations
- Spatial Scanning
- Gestalt or Closure Flexibility
- Spatial Orientation
- Spatial Visualization

Learning and Memory

- Associative Memory
- Visual Memory
- Perceptual Speed

Production

- Association Fluency
- Sensitivity to Problems
- Originality/Creativity
- Figural Fluency
- Figural Flexibility

General Reasoning

- Logical Reasoning
- Learning Abilities
- Imagery
- Meaningful and Free Recall Memory
- Length Estimation
- Perceiving Gestalt or Closures

Factor-Analytical Reasoning

- Communication
- Inductive Reasoning
- Abductive Reasoning

Figure 5: Designers Cognitive Abilities
Source: Author(s) based on Yukhina (2007).

According to Yukhina (2007) the *visual-spatial* and ideational (*production*) abilities have long been recognized as having a major importance within academic performances, but since most students enter higher education with little experience, a large part of the responsibility to teach and develop those various abilities and skills falls down to education that is concerned with showing new ways of seeing, thinking and doing.

7. Conclusions

To undergo the transformations presented by the culmination of emerging technologies merging the physical, digital and biological domains, designers alongside with other occupations (areas of expertise) will need to invest in reskilling; acquire or invest in skills to prevent for job displacement - even though it was pointed out that the design profession is not very susceptible to job automation the demand of the forecast presents a real concern to act upon. Another point to be aware of is, designers must learn to work in collaboration with programmers and/or engineers and vice-versa, and although the AI capabilities shown are a form of insertion to the knowledge it would be wise for designers to continue seeking the knowledge about AI in order to strengthen and improve collaborations, as a form of

broadening the opportunities for creation of novel and unexpected solutions to existing problems.

Regarding the skills analysis, a suggestion for the professionals of the area is to use this analysis to compare with one's own abilities and skills and try to identify and improve the possible skill gap between the future demand and the current skill set.

Also, another concern should be about education in the design academic curriculum, that is responsible for teaching the needed abilities to perform design tasks, so with this imminent change of scenario, it is possible to assume that universities will have major roles in directing future designers towards working with these new technologies and hopefully the design education would benefit from this investigative analysis.

Finally, the relevance of this paper is significant to the field because the investigation seeks to demonstrate Artificial intelligence from the point of view of designers, that differs from programmers and engineers, allowing for a more human-centered approach. Nevertheless, this paper provides preliminary results of a work in progress, where its future applications are still undetermined.

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