Module 3

Design and mathematics: The Turing machine case.

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REFERENCED DOCUMENTS

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1	2020-1-UK01-KA201-078934		IPinSTEAM Proposal
2			

APPLICABLE DOCUMENTS

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1. Title of the Module

1.1 Learning Outcomes

In this module, we are going to learn what a design is and what can be its uses related to mathematics, statistics, and big data. However, before going into the concepts mentioned above, we must know what a design is, as well as other fundamental aspects related to this concept.

After completing this module, you will be able to:

- Understand what legal protection is used for in industrial designs.
- How the use of industrial designs affects our daily lives and their application in mathematics.
- What are the practical applications in the Turing Machine, its many modifications and the opinion of experts on this subject.

Estimated seat time: 2 hours

1.2 Main Content

1.2.1 Terms and Definitions

First and foremost, we must understand what industrial design is to proceed with this discussion. An industrial design is defined in the field of Industrial Property as the look or decoration of a product or component of it that distinguishes it aesthetically from others without taking into consideration any of its technical or functional qualities. This is a wide term that includes both factory-made and handmade items.

Industrial designs are usually divided into three product types:

- Three-dimensional objects, such as furniture, shoes or the ornamentation mentioned above.
- A combination of the above, i.e., a mixture of three-dimensional objects with two-dimensional ornamentation.
- Architectural structures, scenery, the specific design of a shop or restaurant, a book cover, a website, or a shop window, among others.

Now that we have explained a little about this topic, we must address the International Classification for industrial designs. This is **the Locarno Classification**.

The Locarno Classification, established by the Locarno Agreement (1968), is an international classification used for the purposes of the registration of industrial designs. The current edition of the Classification is published on the Internet.

The Locarno Agreement established a Committee of Experts on which each contracting country is represented and empowered this Committee to make amendments or additions to the original list of classes and subclasses, to establish the alphabetical list and the explanatory notes. They are also responsible for amending or supplementing each of the three parts of the Classification. This classification is for administrative purposes only. However, this classification is of interest to us as the **EUIPO**, the European Union Intellectual Property Office, is also governed by this classification.

On the other hand, we also must be clear about what a Community Design is since it is also carried out in all the Member States of the European Union.

A registered Community design confers on its holder the exclusive right to use it in all Member States of the European Union and prevents use by third parties without his consent.

In the event of any future enlargement of the European Union, the validity of any registered or applied for Community design will be automatically extended to the new enlarged territory of the EU, without the need to file an application or pay any fee. Applications can be filed directly with the EUIPO. The registered Community Design is initially protected for a period of five years, renewable for further periods of five years up to a maximum of 25 years from the date of application.

The International Design is part of a system of International Design Registration for countries that are members of the Hague Agreement comprising the 1934, 1960, and 1999 Geneva Acts. The application of the 1934 Act has been suspended since 1 January 2010.

The Hague Agreement achieves the simplification and unification of a series of formalities such as formal examination and publication, to obtain in each of the designated countries a registration with the same rights and obligations as if it were a national design.

It is also noteworthy that an International Design Register is easier to manage than several national designs, both in the case of renewal and in the case of changes of ownership or representative. Designs can be protected abroad through an international design or through a community design.

Focusing more on the issue at hand, to register a design, two basic qualities are required: novelty, i.e., that there is no identical design available to the public at the date of registration, and uniqueness, i.e., that the impression generated by the garment on the public differs from that generated by any other design.

However, as we have seen in the previous modules, linking these disciplines is an almost impossible task. Therefore, we are going to take an example with the Turing Machine in the following section to explain the minimal links between both teachings.

1.2.2 Theory behind the IP implementation

To explain the theory behind IP implementation, as in previous modules, we have had to use examples (hypothetical or not) to establish common links. In this case, we have selected an example that could be affected by IP focused on the registration of industrial designs, mainly for two reasons. Firstly, it is a machine that is fundamental to the development of science and, in this case, was created by a mathematician. The other reason is that this, at first sight, simple machine has undergone many modifications at the level of design and manufacture which, in a hypothetical case, could also be affected by Intellectual Property. The example selected is that of the Turing Machine.

First, if there is one thing we need to know, it is what a Turing machine is. A Turing machine is a device that manipulates symbols on a strip of tape according to a table of rules. Despite its simplicity, a Turing machine can be adapted to simulate the logic of any computer algorithm and is particularly useful in explaining the functions of a CPU within a computer.

It was originally defined by the English mathematician Alan Turing as an "automatic machine" in 1936 in the journal Proceedings of the London Mathematical Society. It is not designed as a practical computing technology, but as a hypothetical device representing a computing machine.

Now, we ask ourselves the following question: what is the relationship between the Turing Machine and the registration of industrial designs? Now, we ask ourselves the following question: what is the relationship between the Turing Machine and the registration of industrial designs? Currently, the Turing Machine is not a device that is registered as an industrial design, but due to its characteristics, it could be registered. However, should it?

One of the main reasons why the Turing Machine could not be registered is because, oh, surprise! being something related to Mathematics, it should be considered as public domain and not as something that belongs to private property. However, this machine, which was originally created around the 1930s, was not registered as such at the time. Over the years, this machine has undergone many modifications, and other machines with the same name, but different functions, have been created. It is now that the debate is taking place. On the one hand, it is a machine that belongs to the public domain and, according to some tutorials on YouTube, you can even build one at home. However, although it is a machine that is apparently easy to build, it has undergone several modifications over time, so it would not make sense that, since it is a completely necessary machine in computing, there would not be economic retribution for this.

The Turing machine mathematically models a machine that operates mechanically on a tape. On this tape are symbols that the machine can read and write, one at a time, using a tape reader/writer head. The operation is completely determined by a finite set of elementary instructions. Turing imagines not a mechanism, but a person he calls the "computer", who slavishly executes these deterministic mechanical rules.

More precisely, a Turing machine consists of:

- A **tape** that is divided into cells, side by side. Each cell contains a symbol from some finite alphabet.
- A **head** that can read and write symbols on the tape and move the tape left and right one (and only one) cell at a time.
- A **state register** that stores the state of the Turing machine, one of the finite states.
- A finite **table of instructions** (occasionally called an action table or transition function).

Every part of the machine - its state and collections of symbols - and its actions - printing, erasing, tape movement - is finite, discrete, and distinguishable; it is the potentially unlimited amount of tape that gives it an unlimited amount of storage space.

Now, let's discuss the different types of Turing Machines that there have been and there are. This is also a way of ordering the original machine and all its modifications. The 5 most significant modifications of the Turing Machine are:

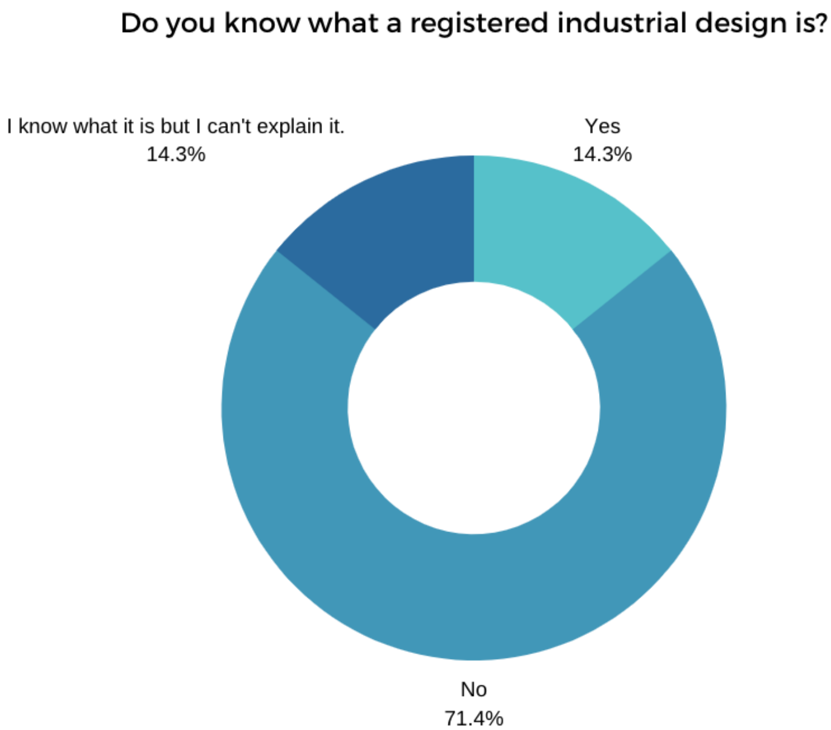
- Turing machine with **standby motion**
- Turing machine with **infinite tape on both sides**
- Turing machine with **multitrack tape**
- **Multi-tape** Turing machine
- **Multidimensional** Turing Machine

Listing these modifications of the Turing Machine is neither more nor less than to illustrate the great difference between the primitive idea of the machine, and how little by little, it has been changing according to the needs of its users. Faced with such a thing, we will always be left with the question of whether what is really ethical, or moral is that, although this machine is part of the public domain, both the author of the machine and the authors who were making modifications to it, should have an economic benefit for their work, in this case, for the implementation of new designs, more beneficial for the machine and therefore, for everyone.

1.2.3 Practical examples

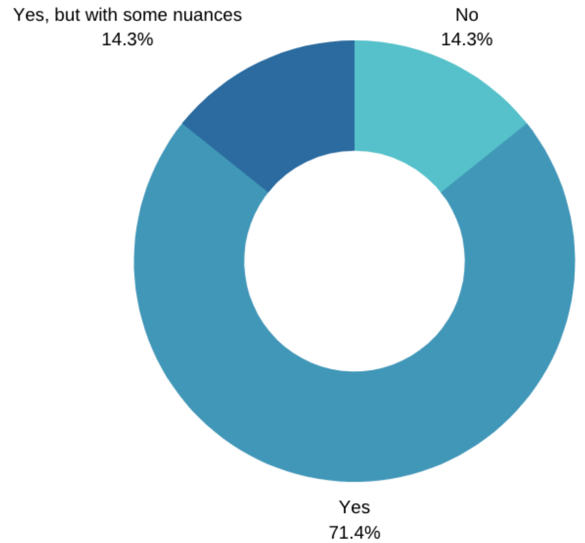
As we have seen throughout this module, the implementation of these two disciplines is more complicated than it seems, which is why, for the practical examples section, a survey has been carried out with mathematicians from several Spanish universities so that, as far as possible, they can provide a more specific vision of this subject.

In the first question, **it** asked a simple question but important for the continuation of the survey, which was whether they knew what a registered industrial design is. The majority doesn't know what is (71.4%) and of those who do (28.6%), only half knows how to explain it.

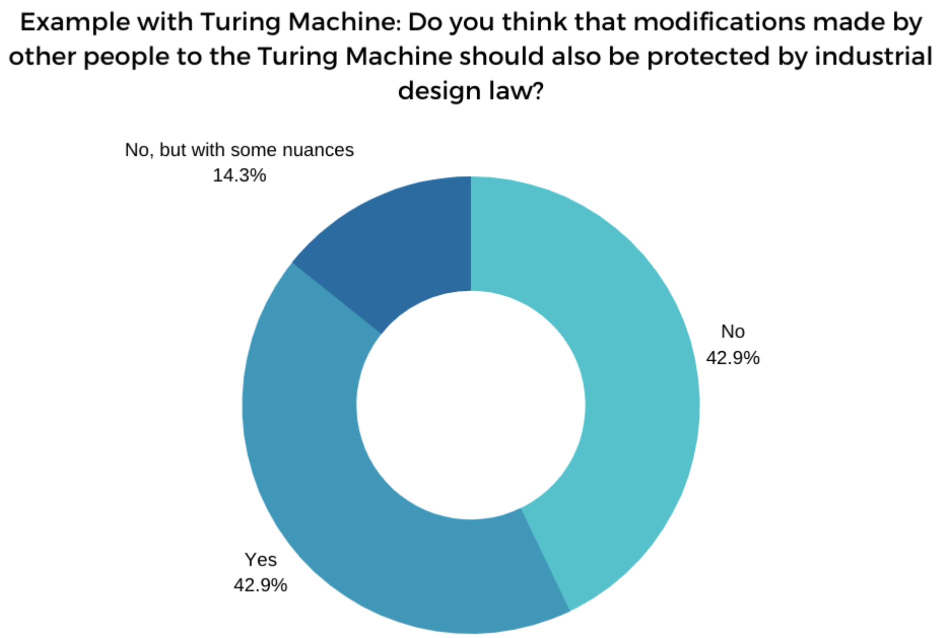


The mathematicians interviewed were then asked a further question about what improvements could be made in the mathematics and design relationship. In general, the community surveyed would agree that there should be some form of financial remuneration for the creators of operations, theorems or algorithms used in registered designs.

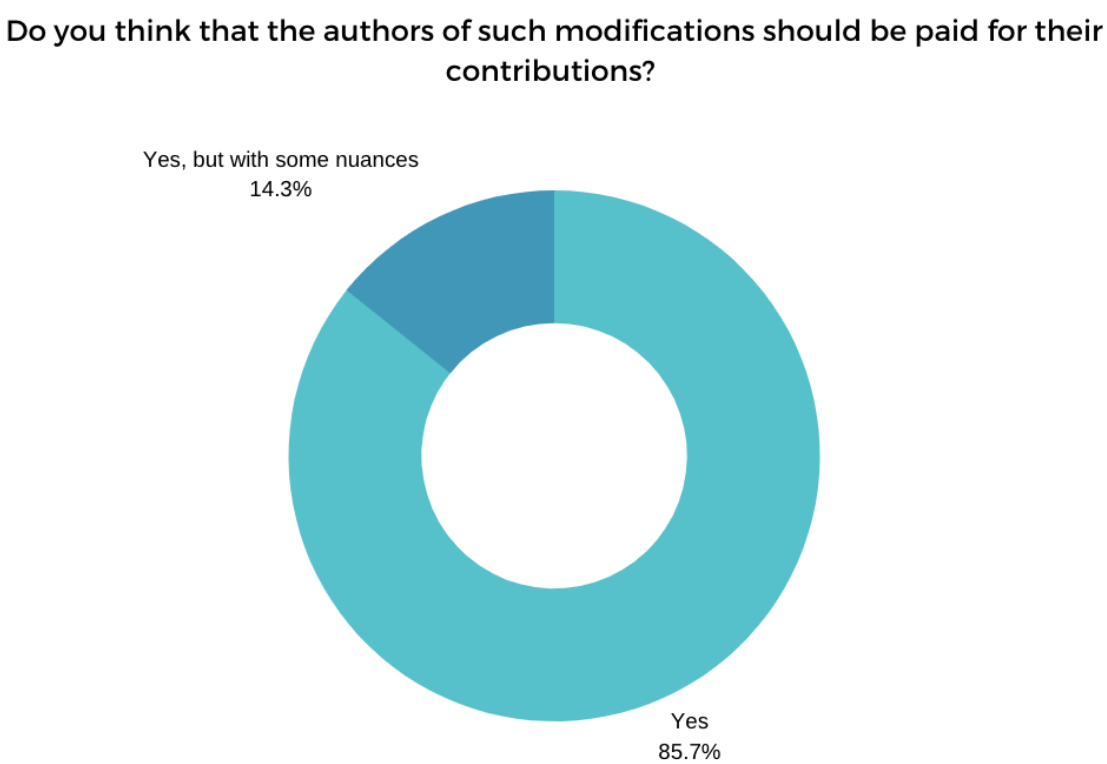
To make an industrial design, whether registered or not, X procedures and/or mathematical operations are needed, do you think there should be a remuneration for the creators of this or these procedures?



Then, the example of the Turing Machine was introduced. This system was developed by the English mathematician Alan Turing, and at the time, it was used to decrypt Nazi Germany's messages during the Second World War, implemented in his machine called *Enigma*. In addition, this machine lays the foundations of modern computing since it is considered by some as the first computer. By introducing this example, we ask whether subsequent modifications made to this machine should be protected as an industrial design. A part of the opinion is against, while a little less than half would be in favor of implementing such a type of legislation.



Finally, in relation to the previous question about the Turing machine, respondents were asked whether they believe that modifications should be remunerated to their creators. Practically all respondents agreed that they did.



1.2.4 Case studies

This module was carried out among several mathematics graduates from the University of Valencia, the Autonomous University of Madrid, and the University of Valladolid. In the following, we will explain in more detail the above statistics on the relationship between mathematics and design.

Firstly, the question was addressed as to whether the experts asked in the questionnaire would agree that the design of a Turing Machine should be protected and must pay for its use and reproduction. On this question, a large majority of the interviewees would not agree. Some argue that free access to these mathematical procedures allows and facilitates a greater development of mathematics as a science, and that therefore, this type of services should not be protected, or at least, should not cost the consumer money.

Other people are also against it, but offer another argument, for example, that the idea could be registered, in this case, not as a design but as a patent, but that the design would remain free form, so that anyone who can reproduce it or propose modifications to it can do so, as is the case now.

On the other hand, some of the interviewees argue that the design of the Machine should not be shared as it is a cryptosystem. They add that, normally in these cases, there must be an entity with sufficient power to be interested in the invention and to finance it, given that if these types of cryptosystems are made public, they would lose their real usefulness.

There is another type of opinion, perhaps of a more moral and reflective nature, which offers us a way of thinking from which we should also learn. Mathematics, as well as being a science, is a branch of knowledge. By turning knowledge into a commodity, it becomes an object of speculation subject to the interests of the market. This person takes a stand against this mainly because of a moral dilemma, as he is against the commodification of knowledge. However, this same person considers that in this case, as in the case of the modifications to the Turing Machine, the work of the research team in question should be acknowledged in an essential way.

On the other hand, as far as funding in general is concerned, while the vast majority agree that a possible economic benefit without affecting the legislative nature of the Turing Machine, one of the respondents considers that, instead of a private and personal benefit, it should be given as funding for further documentation and research work.

1.3 Knowledge Assessment

Quiz-like assessment based on the main content. Please mark the correct answer with bold when required. Include 10 questions for your module. Increase gradually the level of difficulty.

Question 1: Industrial designs are a very important part of intellectual property.
[True] [False]

Question 2: Industrial designs are usually divided into three product types
[True] [False]

Question 3: How many major modifications has the Turing Machine undergone since its creation?
[5] [6] [more than 10]

Question 4: Can a Turing Machine be registered as a design?
[No, in any case]
[Neither the machine itself nor its many modifications can be registered.]
[Only at the United States]
[All of the above are correct]

Question 5: Who does the Turin Machine belong to?
[It is part of the public domain]
[It is private property]
[It belongs to Alan Turing]

Question 6: Are there tutorials on YouTube to build your own Turing Machine?
[Yes, and you can build it in your own home]
[Yes, but you need a very precise material, and it is not usually done]
[Yes, but it is more often used for academic projects]
[All of the above are correct]

Question 7: The Turing Machine, being a free design, anyone can create modifications on it.
[True] [False]

Question 8 (matching): Match the terms with their definitions.
Turing machine: Mathematical model of a hypothetical computing machine which can use a predefined set of rules to determine a result from a set of input variables.
Design: The art or process of designing manufactured products.
Enigma: It was a machine used by the Germans to encrypt their communications.
Mathematics: the abstract science of number, quantity, and space, either as abstract concepts

Question 9: Match the parts of the Turing Machine with its description.
Tape: is divided into cells, side by side. Each cell contains a symbol from some finite alphabet.
Head: can read and write symbols on the tape and move the tape left and right one.
State register: stores the state of the Turing machine, one of the finite states.
Table of instructions: occasionally called an action table or transition function.

1.4 Skills Assessment

For a better implementation of the skills assessment, the following exercise is proposed, which is closely related to critical thinking and has a strong moral charge on the subject we have dealt with throughout the module.

Regarding industrial design registration and mathematics, we have seen that they are disciplines that feed off each other and need each other, but they are not complementary. Although design needs mathematics, the latter is not usually patented, but the question we should be asking is, should it be patented?

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In the face of this reflection, multiple alternatives can be put forward. In the first place, we can think of something that can repay the efforts of the mathematical community and all the possible applications that they have provided us with and that form part of our daily lives. However, we must be aware that in this guild, there is no sense of ownership as such, in which merits are attributed to these people, so perhaps meddling in a field that does not belong to us is not the most appropriate thing to do.

Therefore the proposed activity is to reflect on the expert opinion expressed in the practical examples and case studies, and according to one's individual or collective values and objectives.

In the end, it is about choosing the best option as a society, which one can be more beneficial for everyone and, ultimately, which one is fairer and more realistic to implement.

2. References

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