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POSTPONING DEEP DOCUMENTATION TO GENERATE INNOVATIVE SOLUTIONS

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Abstract: *Ensuring the competitiveness of products and technologies requires addressing innovation activities. The didactic work of the authors of this paper has led to the observation that, under certain circumstances, a deep documentation activity when aiming to identify innovative solutions can turn into a psychological obstacle in terms of generating innovative solutions in a given time. One way to reduce such a consequence of deep documentation can be to postpone it, that is, resort to extensive documentation only after identifying at least one supposedly innovative solution. However, one cannot give up on deep documentation, which is necessary to validate the innovative nature of the identified solution and the possibilities of its use. Postponing deep documentation can be applied when there is a certain level of professional knowledge. Arguments and explanations have been formulated according to which, at least in certain situations, a postponement of deep documentation may be indicated.*
Keywords: *creative design, innovative solution, minimum level of knowledge, documentation activity, postponing deep documentation.*

1. INTRODUCTION

Integrated engineering is considered to correspond to a holistic approach to the stages of design, development, and implementation of complex engineering systems and solutions [1, 2]. It is also accepted that integrated engineering aims to take into account all stages corresponding to the life cycle of a product, starting from the conception of the product and ending with its removal from use [3].

One of the essential components of such an approach is *innovation*, applied in all the stages mentioned above. The last decades have highlighted the search, by researchers, for solutions to increase the probability of reaching innovative solutions to solve engineering problems. In this way, it has been possible to identify methods to stimulate scientific and technical creativity, but also to highlight the need to ensure a working atmosphere favorable to the maximum manifestation of creativity [4-6].

The development of a product requires a design stage and, for reasons of ensuring the competitiveness of the products, it is necessary to highlight the need to use innovative solutions for the product created, as a result of *creative design*.

According to an opinion expressed relatively long ago, the main stages likely to lead to a new or improved product are *preparation*, *incubation*, *illumination*, and *verification* [7-9]. In turn, the preparation stage implies the existence of *an information substage*, within which an innovative person will seek information about the problem that concerns him [7, 10, 11].

The information takes place simultaneously or before the innovative person already proceeds to sketch some first solutions to solve the problem that concerns him. From this point of view, an experienced designer who has sufficient knowledge in the field of the problem to be solved can proceed directly to sketching some first solutions.

If the designer is less experienced or is a beginner designer (as is the case with a student), a documentation activity is necessary, through which it becomes possible to accumulate more or less detailed information about the problem to be solved and about the possible solutions to this problem, previously identified by other people.

The previous didactic activity carried out by the authors of this work highlighted the fact that there are situations in which deep documentation in the field of the problem to be solved can turn into a real obstacle for the beginner or less experienced designer.

Less confident in his possibilities and especially when faced with high-performance solutions developed by other researchers, such a designer may experience a state of inhibition, no longer being able to understand and accept that there could be other solutions, perhaps even better than those identified through the documentation activity.

For such a reason and based on their teaching activity, the authors of this paper believe that it is sometimes possible to obtain an innovative solution by postponing in-depth documentation, and some arguments in this regard are presented in the following chapters of the paper.

The objective pursued by the research whose results were included in this article was to present a hypothesis according to which, in certain circumstances, a postponement of in-depth documentation can facilitate the identification of innovative technical solutions.

2. FAVORABLE CIRCUMSTANCES FOR A CREATIVE PROCESS OF IDENTIFYING AN INNOVATIVE SOLUTION

In the various technical subjects taught throughout their university careers, situations arose in which students were asked to identify, as far as possible, innovative solutions to solve technical problems.

In such situations, it was sometimes found that students who were not always very successful in terms of academic results (i.e., without very good results obtained in colloquia or exams) were able to reach original solutions to the technical problems they were facing.

If the accumulation of a large volume of knowledge was not the initial cause of this manifestation of technical creativity, it meant that another factor or a group of factors was what facilitated the manifestation, by the respective students, of broader technical creativity.

As teachers, we asked ourselves what these factors would be capable of favoring a more plenary manifestation of technical creativity. We thus found, first of all, that the students in question were part of that category of people who did not give very much credit to the absolute validity of the technical and scientific information accumulated within the various university subjects.

They considered this information to be valid at a given time and that this information could be perfected/improved, including through their contribution.

Secondly, as previously mentioned, these students were not always among the students with the best professional results (with the highest obtained grades in colloquia and exams). This could mean that the knowledge they had did not manifest itself as a brake on the generation of new or improved knowledge.

In such circumstances, the question was formulated whether a very large volume of knowledge in a certain field does not turn, at least for some people in the technical field, into a real obstacle to understanding that, in addition to the known solutions (solutions highlighted during the various teaching activities), other solutions are also possible, some of these latter solutions being even more advantageous than the known ones.

Thus, the idea of avoiding the transformation of a large and profound volume of specialized knowledge into a real obstacle to a fuller manifestation of creativity was outlined.

The previous observation was particularly valid in the case of those people who started from the teaching activities belonging to a certain university subject with the premise that the set of knowledge specific to that object is completely and definitively established, that it is closed and can no longer be developed.

Of course, a certain responsibility in this direction also falls on the teachers who, through the content of the teaching activities supported, generated the feeling of completely

systematized knowledge that was no longer possible to develop.

3. THE NEED FOR A MINIMUM VOLUME OF PROFESSIONAL KNOWLEDGE FOR THE MANIFESTATION OF TECHNICAL CREATIVITY

It cannot be denied that the manifestation of technical creativity is based on a minimum volume of technical knowledge through the appropriate handling of which innovative technical solutions can be reached. People who do not have a minimum volume of technical knowledge in the field in which they work and in which they try to contribute by proposing improvements cannot be creative, from a technical point of view.

In these conditions, the question was raised of assessing the extent to which postponing in-depth documentation, when seeking to identify a technical solution, could not contribute to ensuring better conditions for a fuller manifestation of technical creativity.

As mentioned, it is accepted, in principle, that one of the first stages of identifying an innovative solution to a technical problem is the documentation activity, to establish what results other researchers have reached to a possible solution for solving that technical problem. By taking into account the teaching experience of the authors of this work, it can be noted that the presence of the deep documentation stage at the beginning of the process of solving a technical problem does not always effectively lead to results characterized by a certain level of innovation.

Thus, it was appreciated that one of the factors that can affect the process of identifying new solutions is the volume of professional knowledge of the person involved in such a process. This factor can manifest itself in a positive direction (which would mean that a large volume of professional knowledge could facilitate the creative process), but, in some situations, it can determine negative effects. Let us note that the volume of professional knowledge can be included in the group of cognitive-intellectual factors, but it can turn, in

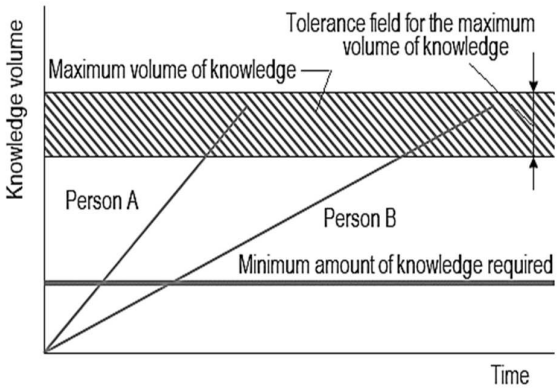

Fig. 1. The existence of certain levels of knowledge between which a full manifestation of technical creativity is possible.

certain circumstances, into a psychological obstacle to the identification of creative technical solutions.

It is thus accepted that, for effective involvement in the creative process, it is necessary for the person who wants this to have at least a minimum level of professional knowledge, to understand the problem he or she intends to solve (Fig. 1).

On the other hand, some specialists believe that there is also a maximum volume of professional knowledge which, if it is considered to have reached maximum development and that it can no longer continue/evolve. Such a situation could turn into an obstacle to the full manifestation of technical creativity.

It is necessary to emphasize that a large volume of professional knowledge turns into a psychological obstacle only when this volume of knowledge seems to be no longer susceptible to development or evolution, being therefore considered as a closed volume that can no longer be developed in the future.

To act against the effects of such a psychological obstacle, it is necessary to explain to students that, in general, no system of knowledge can be appreciated as a definitively closed system and that can no longer be developed.

Once new methods and material means of research are identified, it is expected that the system of knowledge in question can also be supplemented with new professional or scientific knowledge. This can be referred to as

a so-called spiral of knowledge development [12-16], according to which, as new research tools are used, new or improved solutions can be reached to known solutions.

This means that, in practice, it is generally not acceptable to have knowledge systems that are definitively closed, that is, those that cannot be developed anymore.

According to the knowledge spiral model, it is considered that there is *tacit knowledge*, including skills, intuitions, and beliefs, and *explicit knowledge*, which incorporates knowledge that can be communicated and documented, from the categories of data, rules, and procedures. It is appreciated that the generation of new knowledge occurs by transforming tacit knowledge into explicit knowledge or vice versa or by combining the two categories of knowledge in distinct ways.

The knowledge spiral model is considered to imply the existence of four ways of converting knowledge, namely through socialization, externalization, combination, and internalization.

On the other hand, according to the graphic representation in Figure 1, it can be assumed that once a minimum volume of professional knowledge is exceeded, it is expected that the owner of that volume of knowledge can be involved in the process of generating new technical solutions.

However, it is possible that, if the person concerned acts in the direction of advancing in technical documentation activities, before having somewhat outlined his solution to the problem he is facing, the information accumulated through additional documentation may turn into a kind of psychological obstacle, preventing the person in question from foreseeing the possibility of the existence of other solutions to the problem, therefore including solutions susceptible to patenting.

One of the authors of this paper felt such an obstacle when, in the reading room of the invention office, he found that for the problem that concerned him, there were a large number of approaches and solutions, including from representatives of prestigious companies in the investigated field. In such a situation, the question arose whether, only through his means and efforts, the specialist could reach solutions characterized by a certain level of innovation.

4. POSTPONING DEEP DOCUMENTATION

From the teaching experience of the authors of this paper, it was found that in the case of technical problems submitted for resolution by students, some of them were able to reach innovative solutions in a relatively short time, without undertaking additional documentation activities, through an original combination and efficient exploitation of the knowledge they had at the time or during the period in which they became aware of the technical problem whose solution was requested.

Under such conditions, the idea of postponing in-depth documentation in the field of the problem to be solved arose, that is, of first investing some efforts in the direction of at least a partial resolution of the technical problem, calling only on the professional knowledge available at that time. Of course, for essential technical aspects regarding the technical problem to be solved, it may be necessary to carry out additional documentation activities, but it is recommended that, for this stage, only general works (dictionaries, encyclopedias, popularization works) be accessed and consulted, which do not provide too detailed information regarding the ways of solving the technical problem and which only target the principles that could underlie the solution of the problem addressed.

Some examples in which postponing the deep documentation proved useful are briefly mentioned below.

Thus, given the need to select topics for his diploma thesis, student G. Cioban opted to address, within work, the possibility of calibration of conical gear milling heads shaped in a circular arc on a universal lathe [17]. From the specialized literature available at that time, it was found that calibration processes could only be performed on chamfering lathes.

Having advanced practical skills, student G. Cioban set out to transfer some of the possibilities of the calibration lathe to a universal lathe. Without resorting to deep documentation in the field addressed, but

investing efforts in understanding the functioning of a specialized calibration lathe, student G. Cioban thus sketched the first version of a device that could perform calibration of the cutting tools included in the milling heads of curved conical teeth on a universal lathe. Later, together with other teachers, the student finalized the imagined solution, becoming the first author of a patented invention relating to a beveling device on a lathe [17]. In this way, carrying out the calibration process on universal lathes was appreciated as an innovative technical solution.

In the context of course activities in a manufacturing technology university matter from an evening study program, a teacher presented the possibility (not mentioned in the specialized literature available at the time) of obtaining conical teeth shaped in an arc of a circle on universal milling machines. Until that time, it was known that teeth of the mentioned category could only be made on specialized machine tools. Student M. Olan, who worked in a machine manufacturing company as a milling machine operator, found the idea interesting. In a few days, without conducting deep research and using his professional knowledge, student M. Olan formulated the first idea about a device adaptable to a universal milling machine tool and which would provide conditions for obtaining a conical gear shaped in a circular arc. Later, the solution proposed by student M. Olan would be patented [18], the student is listed as the first author of the invention proposal.

As previously mentioned, throughout the teaching activities carried out in higher technical education, the authors of this paper have also observed other situations in which postponing in-depth documentation allowed students to identify innovative solutions. For such situations, students were registered as first authors of invention proposals that later met the patenting conditions [17-22].

This identification was carried out without having previously resorted to specific aspects of deep documentation in the field of the problem addressed, but was facilitated by the existence of basic knowledge belonging to the respective field.

It is worth mentioning that in all situations in which the identification of innovative solutions by students was observed, the existence of practical skills of the students involved was found, sometimes accumulated by completing professional training courses.

A situation in which involvement in deep documentation could have harmed the possibilities of identifying innovative solutions was the one in which one of the authors of this article participated.

Thus, having formulated a research topic regarding the identification of devices that would contribute to expanding the technological possibilities of electrical discharge machining equipment, one of the authors of this paper went to the lecture room of the State Office for Inventions and Trademarks of Bucharest and consulted there several existing inventions in the field addressed. The variety and complexity of some of the accessed solutions, developed in economically developed countries, initially manifested itself as a real psychological obstacle in the attempt to identify innovative technical solutions. Knowledge of the existence of such an effect, however, allowed, subsequently, the difficulties of such a situation to be overcome and to identify device solutions whose originality was confirmed by their patenting.

The aforementioned aspects should not be considered a plea against the use of the so-called deep documentation.

After outlining his solution, the specialist must resort to deep documentation, to verify the possible originality of the solution identified by him or to continue the search for an innovative solution. To the extent that the first in-depth documentation does not confirm the originality and superiority of one's solution, the specialist can resume the efforts to search for an improved solution compared to the one previously established, resorting to a new postponement of the in-depth documentation, which he could resume later, after the possible identification of a solution appreciated as presenting aspects of innovation.

Starting from such a statement, the graphic representation in Figure 2 was conceived, corresponding to a block diagram in which some

of the first stages of a creative process are highlighted.

From Figure 2 it can be seen that deep documentation is not eliminated. It is necessary, however, to have a deep documentation stage, through which, together with the actual design activities, the disadvantages related to the possible impact on the feasibility of the project, of the technical accuracy, and the risk of a redundant innovation are significantly diminished. What was wanted to be highlighted through the content of this article was the fact that postponing deep documentation could facilitate a faster and more unhindered identification of an innovative solution.

Approaching the deep documentation stage and the actual design stage of the solution that may have been identified by postponing deep documentation will reduce the risks that are likely to develop when the advantages assumed to correspond to the previously identified solution will not be confirmed. In the latter case, it is necessary to resume the activities of identifying a new or improved innovative solution.

A question can also be formulated regarding who and how should contribute to the establishment of the minimum volume of professional knowledge that would facilitate the future specialist to fully manifest his technical creativity.

Such an action must be undertaken by the school and by the faculty that has training responsibilities in a technical field. Teachers must take into account the knowledge of pupils and students of the principles underlying the

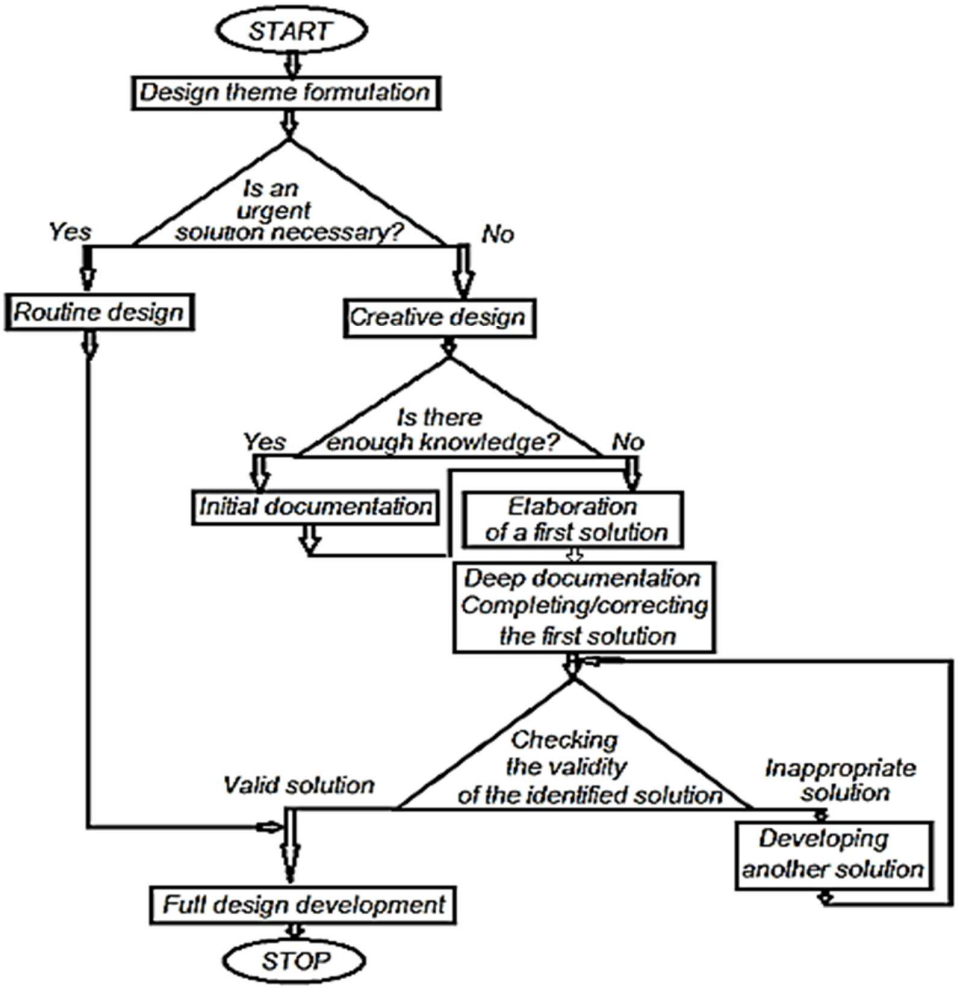

Fig. 2. Inclusion of the deep documentation stage after the development of a first solution.

functioning of some technical solutions. They could also offer solutions to solve some technical problems, but they should take into account that the knowledge of these solutions does not turn into psychological obstacles. In this regard, one could resort to emphasizing the fact that the technical solutions presented corresponded to a certain period of the evolution of human society and that, of course, they can be improved, including through their contribution. Teachers must also contribute to increasing the confidence of pupils and students in their abilities to reach, through their efforts, innovative and therefore patentable solutions. At the same time, teachers must contribute to the emergence of the desire to contribute to the generation of innovative technical solutions, through examples of people who have contributed, at relatively young ages, to the generation and promotion of ideas that have been patented or have enjoyed positive appreciation.

Returning to the concept of *creative design*, it also considers that the trained and well-prepared specialist can resort to a postponement of deep documentation, first trying to reach innovative solutions only with the knowledge he has at a given moment. Some of the well-prepared specialists know and apply the principle of postponing deep documentation without being aware of this fact.

As in the case of a previous example, if such a specialist considers that he does not have sufficient basic knowledge, he could consult the general technical works, continuing the activity of generating his solution and only later, after outlining such a solution, resort to deep documentation, to verify the possible originality and superiority of the solution outlined before deep documentation.

Let us note that a postponement action is also provided in the stages of applying the method of stimulating the manifestation of creativity called *brainstorming*. Within this method, the critical evaluation process of the identified solutions is postponed, in order not to create an obstacle capable of hindering the process of reaching an innovative technical solution, through the premature action of critical factors.

There are also known methods that use different possibilities capable of helping the innovative designer to get outside the routine thinking model (*routine design*), appreciating that only in this way will it be possible to reach one or more innovative solutions more quickly. For example, within the TRIZ method, the explicit aim is to identify, in the problem to be solved, those contradictions by the removal of which can accelerate the creative solution of the problem addressed [7, 23-25].

As previously mentioned, the teaching experience of the authors of this paper confirmed, at least in some situations, the validity of using the principle of postponing deep documentation.

There were thus situations in which, using the professional knowledge they had and practically without resorting to documentation activities, the students were able to identify innovative solutions.

Subsequently, after submitting some invention proposals to the representative authority, it was found that the proposed solutions met the conditions of patentability, with patents being obtained for such solutions.

5. SURPRISING SITUATIONS WHEN LACK OF KNOWLEDGE IS AN ADVANTAGE

The previous arguments are not intended to be a plea for lack of professional knowledge, but, as indicated in the literature consulted, there are situations in which lack of knowledge seems to have been an advantage [26-28].

Thus, throughout the evolution of science in general, opinions can also be mentioned in which ignorance can be appreciated as an advantage. An opinion in this sense was expressed by the Romanian professor of geophysics and hydrology Constantin Crânganu [26].

The Romanian researcher supports his observations by referring to the philosophy of ignorance as a source of wisdom promoted by the ancient Taoist philosophy and, respectively, the concept of the veil of ignorance, promoted by the American liberal philosopher John Rawls.

A ChatGPT query revealed that lack of knowledge can be an advantage in the following situations [27]:

1. The need to promote unconventional ways of thinking;
2. Stimulating curiosity;
3. Eliminating or diminishing the influence of professional prejudices, according to which certain problems are solved only in a certain way;
4. Promoting motivation to learn;
5. An increased possibility of making connections between knowledge belonging to different fields.

As examples of situations in which the lack of knowledge seems to have manifested itself as an advantage, the artificial intelligence website mentions the case of Steve Jobs, who does not seem to have had advanced programming knowledge, but had an original interpretation regarding the design and use of solutions offered by intuition.

A second example starts from the originality of the solutions sometimes offered by children; they are not affected by the presence of rules.

Let us accept that an observation similar to the last aspect mentioned in the previous paragraph is specific to the use of the so-called *technique of the laymen*, that is, of questioning people who do not have advanced knowledge in a certain field when the aim is to identify an innovative solution to solve a certain problem.

Interestingly, according to the title of a forum-type website, "with enough profanity, you can accomplish anything" [27].

6. CONCLUSIONS

The evolution of human society has shown that it is important to look for ways to facilitate the process of identifying new technical solutions. It is known, in this direction, that one of the stages of a creative process that must be approached immediately after formulating the innovation theme is that of materializing a documentation activity in the field of the innovation theme. The teaching experience of the authors of this paper led to the idea that, if the specialist has a minimum level of knowledge in the field of the technical problem to be solved, he could proceed directly to the search for an innovative solution, and only after identifying such a solution should he resort to a deep documentation activity, which would allow the verification and eventual application in practice of the solution or solutions considered innovative. In this way, the potentially inhibiting influence that a large volume of information on previously identified solutions to the problem at hand could exert on the human psyche could be avoided. If the specialist finds that he does not have sufficient knowledge in the field of the addressed problem, he could resort to consulting general works that would help him clarify the principles valid for the solution sought. Only after identifying a solution considered innovative could the specialist resort to so-called deep documentation, which would allow for verification of the patentability of this solution and its eventual application in practice. The teaching experience of the authors of the paper confirmed the validity of the principle of postponing deep documentation when the students had the minimum amount of professional knowledge that would allow them to start the creative process of gradually outlining an improved solution. In the context of future research on the topic addressed in this paper, a challenge could be to organize a larger-scale experiment with two groups of students, some of whom would resort to deep research and others would not. Under such conditions, it would be possible to more clearly separate the extent to which postponing deep research would prove effective in identifying innovative technical solutions.

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Amânarea documentării profunde pentru generarea unor soluții inovative

Asigurarea competitivității produselor și tehnologiilor necesită abordarea activităților de inovare. Activitatea didactică a autorilor acestei lucrări a condus la observația conform căreia, în anumite circumstanțe, o activitate de documentare profundă, atunci când se urmărește identificarea soluțiilor inovative, se poate transforma într-un obstacol psihologic în ceea ce privește conturarea soluțiilor inovative într-un timp dat. O modalitate de a diminua o astfel de consecință a documentării profunde poate fi amânarea acesteia, adică recurgerea la o documentare extinsă numai după identificarea a cel puțin unei soluții presupus inovative. Cu toate acestea, nu se poate renunța la documentarea profundă, care este necesară pentru a valida natura inovative a soluției identificate și posibilitățile de utilizare a acesteia. Amânarea documentării profunde poate fi aplicată atunci când există un anumit nivel de cunoștințe profesionale. Au fost formulate argumente și explicații conform cărora, cel puțin în anumite situații, poate fi indicată o amânare a documentării profunde.

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