Intelligent Communication, Specific to the Engineering of Materials, under the Conditions of Ensuring the Circular Economy and Technological Digitization

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Abstract. The paper presents the problem of meeting the conditions imposed by the circular economy with direct references to a field of materials engineering, the manufacture of castings. The study has several motivations, one related to the analysis of the ways in which the development of the circular economy can be achieved by a company producing castings. The second one is to establish the partnerships that are necessary in order to materialize the conditions in the castings industry. The third motivation, based on the analyzes carried out at the level of the first two, aims at calibrating the communication for the actors that contribute to the realization of the circularity desideratum in the industrialization of the cast products in the new conditionings of the digitization instruments. To structure an action methodology in the direction of intelligent communication, specific to materials engineering, the paper is structured as follows: the conditions and values to which the circular economy is reported, the engineering design elements of solutions for a circular economy, communication partnerships, analysis of development measures of the circular economy in partnerships and the results of the analysis of the expected activities and partnerships.

1. Introduction

From the perspective of socio-economic behaviors, often imposed institutionally, there is an increasing need for communication for many areas served by engineering. One of the most interesting is that of natural resources, especially that of materials that support the materialization of functional coverage by designing products and services. Their transformation into industrial developments of great diversity, at the level of an increasingly complex economy, requires a fundamental change in the way traditional engineering is practiced. Therefore, one of the most dynamic changes has been in the fields of materials engineering, making a necessary distinction between what it means and what materials science represents.

Therefore, engineering is related to the design of the truth established in a certain space of developments, defined by existing conditions and existing partnerships in the design, operation and use of products and services necessary to achieve functionalities very well defined by market requirements and regulated by competent authorities.
In order to understand more deeply and exactly the involvement of engineering in the fields it serves, it is important to carry out an analysis on the following levels: assessment of the existing situation, analysis of public policies, knowledge of the regulatory framework, deepening and detailing technical and procedural solutions, responsible involvement in understanding financial instruments and mechanisms, establishing the impact of developed solutions on socio-economic developments. Therefore, it is essential to follow - at the level of communication - the aspects analyzed in order for the solutions offered to be in line with the requirements imposed at multidisciplinary level.

To properly calibrate the necessary communication in materials engineering, it is important to make an analysis on the following aspects: the conditions to which materials are subjected, the requirements of the fields served, the actors of the activities carried out or the beneficiaries of specific activities. The reasoning to be made, given the specifics of the paper, is achieved by imposing two conditions, one related to ensuring the participation of materials engineering in the particular development of the circular economy and the second which aims to use the tools of the most dynamic field of moment, that of the digitization of the activities included at the level of the present industries in the current socio-economic framework.

Therefore, even if there is a very well defined specialization at the level of university training, that of materials engineering, it is appreciated that the practice in this field requires having a good communication with the representatives of the categories involved in existing multidisciplinary processes.

The present paper, in addition to its scientific objective, is intended to be a plea for an opening of materials engineering to new socio-economic developments and a recognition of a profound differentiation between materials engineering and materials science. At least in Romania, materials engineering has emerged as a transformation of the old metallurgical specializations, which in turn have emerged as a differentiator, required by new industrial developments, by the fundamental specializations particularly to chemistry and physics. Reducing engineering only to the requirements of chemistry or other fundamental disciplines is not appreciated as favorable in today’s course of technological developments and the requirements of transforming products and services into industrial objects.

2. The conditions and values at which the circular economy is reported

For the practical enforcement of the principles of the circular economy, it is important that materials engineering should find ways to communicate the conditions considered in the design of a shaped material, a product or a service, namely:

- safety conditions in ensuring the functionalities, which ensure the behavior of the material at the demands imposed by the accomplishment of the required functionalities or the safety in operation at the imposed demands;
- processability conditions, ensuring a certain geometric shape at a certain dimensional accuracy and a morphological structure of the material;
- conditions for increasing the duration of exploitation, by ensuring a sustainability corresponding to the socio-economic requirements;
- environmentally friendly conditions, by ensuring measures concerning the manufacturing, processing or operation part in an environmentally friendly relationship;
- disposal conditions at the end of the life cycle, by ensuring a material, energetic and environmental recovery of the materials from the products to be disposed of or by ensuring an intelligent degradability at the end of the life cycle.

If the first three conditionings were present at the level of the general-practicing engineer until the 1990s, the references being made regarding the existing situation in Romania, the last three decades imposed a reformulation of engineering, by adding the other three groups of conditionings, private, as a major responsibility for sustainable development. This maturity manifests itself today in the form of the circular economy, which is represented as "a principle of economic organization that aims to systematically reduce the amount of raw materials and energy throughout a life cycle of a product or
service and at all levels of the organization of society, in order to ensure the protection of biodiversity and the proper development of individuals” [1].

For the exact understanding of the conditions, with the motivation to build a tailor-made communication, the following are the values to which the circular economy refers through the material value of products and services, related by the overall consumption of materials in the atmosphere or from the stock of inorganic materials.

Given the need for efficient communication on the potential of materials included in the manufacturing process of castings, in the desire to use them efficiently, the indicator of “material intensity” is used, which is the total mass of raw materials needed to make a product. The concept was developed by the Wuppertal Institute, which, in approaching the “material intensity” indicator, defined five categories of flows: "abiotic raw materials, which are non-renewable raw materials such as minerals (aggregates, sand, ore of various metals, etc.) or fossil fuels, which are the result of drilling or extraction activities and are consumed indirectly in the manufacturing process of a product (e.g. for one tonne of steel not only one tonne of minerals is consumed); biotic raw materials, which are renewable and which represent the biomass consumed, whether or not obtained from agricultural or forestry activities; earthworks, determined by the activities of agricultural production, forestry, construction works, etc.; water consumed in the manufacture of a product; the air used, used either for combustion or for chemical transformation" [2].

Using a synthesis of the intensity of the materials made by Nicholas Roussat and adopting it for materials that enter the process of elaboration of a ton of cast iron, we have the situation presented in Table 1 [3]. The calculation is approximate, based on a calculation of the average annual consumption in a cast iron foundry for a period of seven years, between 2012-2018.

| Component          | Consumption at ton of cast iron, [t] | Abiotic material | Water | Air | t/ amount of component |
|--------------------|-------------------------------------|-----------------|-------|-----|-----------------------|
| Old cast iron      | 0.593                               | 4.744           | 44.475| 0.385|                      |
| Scrap metal        | 0.394                               | 3.677           | 32.264| 0.304|                      |
| Turnings           | 0.049                               | 0.456           | 4.013 | 0.038|                      |
| Sand               | 0.325                               | 0.715           | 0.682 | 0.013|                      |
| Recirculated material | 0.195                           | 1.817           | 15.97 | 0.151|                      |
| Chromite sand      | 0.009                               | 0.031           | 0.029 | 0.001|                      |
| Hardener           | 0.049                               | 0.412           | 0.352 | 0.137|                      |
| Refractory paint   | 0.019                               | 0.133           | 0.129 | 0.002|                      |
| Metal shot blasters| 0.011                               | 0.136           | 1.485 | 0.030|                      |
| Total/ton of good parts | 1.644                       | 12.174          | 99.399| 2.061|                      |

From the point of view of communication and awareness of the actors present in the manufacturing process of castings, the data calculated on the basis of “material intensity” are significant. Thus, it can be estimated that for a ton of cast parts delivered, 1,644 tons are consumed directly, and at the level of biotic materials we have an extraction of resources in an equivalent of 12,174 tons of raw materials, a specific consumption of 99,399 tons of water and a use of 2,061 tons of air. Basically, if the principles of recirculation and recycling were not used as instruments of the circular economy, this would be the real consumption in relation to the use of natural potential.

At the same time, at the level of partnerships that can be created through industrial symbiosis, these consumptions can be the basis for the use of the non-useful part that results in the manufacturing process, especially used sand, which is generated in a quantity of 324 kg/t and slag in an amount of 34 kg/t Their use would substantially reduce the quantities that are extracted from nature for use for various lucrative purposes.
Therefore, the example given and the definition used show that materials engineering provides the tools and reasoning necessary to materialize the circular economy.

3. Engineering design elements of solutions for the circular economy

The following is a methodology for determining the elements of intelligent construction of the circular economy, with a careful focus on a specific field of materials engineering. In a particular approach, we called this process "circular economy engineering" [4], which came to be introduced as a specialty in the master studies. Starting from the structure of the mentioned discipline, we adapt a methodology for building solutions for the circular economy at the level of a field of materials engineering, that of the manufacture of castings. It presents the following stages: the selection of favorable public policy elements, their transposition in the construction of the circular economy and the determination of the necessary solutions to ensure circularity.

Following the proposed methodology, that of following the institutional formulations, we notice that in the European Union there was a serious analysis on the mechanisms to support the circular economy. At the level of a public policy document, "the notion is defined by ensuring an efficient economy in the use of resources, imposing an objective of maximizing economic growth and limiting the pressure on resources" [5].

Without going into the details of the institutional presentations, moving to the second stage of the proposed methodology, the favorable policy elements are presented grouped on the following categories of analysis, Figure 1: technical-scientific, technical-productive, technical-economic and innovative construction.

In the first category, that of technical-scientific analyzes, the defining elements of engineering are taken into account, those of design in order to ensure the principles of ensuring the circular economy, of which we mention the following, with a schematic presentation in Figure 2: light loading, ensuring sustainability, efficiency in the use of resources, substitution of hazardous or deficient materials, ecological conception from the perspective of exploitation, intelligent management of the neutral parts generated throughout the life of materials, products or services.

In the second category, that of technical-productive analyzes, the following specific actions were retained: audit of productive activities from the perspective of how to ensure waste management activities; imposing technological infrastructure efficiently in terms of consumption of material and energy resources; choosing environmentally friendly materials at the level of technological processes; organization of technological flows with a view to ensuring good waste management.

In the third category, that of technical-economic analysis, the following specific actions were retained: ensuring an open market for the sale of raw materials generated following recycling; repositioning of maintenance and repair services on the market, development of end-of-life product collection systems; supporting industrial symbiosis to make the by-products market a reality in a significant way; the development of new methods of consumption, which stimulate the rental, lending, exchange of services or sharing of products, as alternatives to their individual ownership; unlocking specific investments; elimination of environmentally harmful subsidies; progressive taxation of the consumption of material and energy resources.

In the fourth category, that of innovative solutions, it is emphasized that action must be taken at the following levels: technological, organizational, social and vocational training.

4. Communication partnerships

Starting from the necessary conditions, from the values to which the reporting is made and from the elements of the engineering design of the solutions for the circular economy, we notice that in order to establish the communication modalities it is necessary to establish the necessary partnerships to transform a field or activities according to the principles of circular economy.
Figure 1. Categories of analysis in order to promote the circular economy.

From the analysis made, we establish that the process of transforming materials engineering, especially the manufacture of castings, to the requirements of the circular economy can not be achieved only by the participation of specialists in one field, requiring the involvement of several specializations. This can be a valid assessment, first of all, for those who organize engineering training
systems - at the level of industrial developments the process is much faster - with the desire to streamline activities in the global market. The castings industry can be an example in this direction, by the fact that at the “world foundry congresses”, which take place every two years, they addressed issues of multidisciplinary action, in which partnerships took place between parts manufacturers, foundries, suppliers of raw materials, beneficiaries from various fields, representatives of the scientific environment, technological research and academia. As a justification for the diversity of partnerships, but also for imposing the circular economy in the manufacture of castings, there are some aspects related to the congresses in Bilbao, in 2014, and in Krakow, in 2018. Thus, for the first congress mentioned the keywords made reference to energy, environment, market trends, demands and innovation, and the following issues were addressed: advanced engineering, robotics and automation, environmental protection and sustainable development, energy efficiency and rapid prototyping. One of the works of the authors, in the aforementioned congress, constitutes the support of a “method of evaluation of the tendencies of the manufacture of the castings in relation to the principles of development of the circular economy.” [6].

**Figure 2.** Materials engineering actions to support the circular economy.

5. The analysis of measures for the development of circular economy in partnership system

In order to establish the measures and actions to be undertaken at the level of a technological process for obtaining the castings from the perspective of achieving the objectives of the circular economy, the following procedure was performed: dividing the process into phases, stages and activities; establishing the necessary measures; intuition of the necessary partnerships.

At the level of the process division, the following phases were taken into account: 1. Analysis of specific information; 2. Analysis of manufacturing readiness in terms of available technologies and technological infrastructure; 3. Analysis of the casting process; 4. Analysis of the results of the manufacturing process; 5. Analysis of exploitation and disposal at the end of the life cycle; 6. Analysis of other phases that contribute to the realization of castings; 7. Analysis of the whole process from the perspective of fulfilling the conditions for ensuring the circular economy.
Each phase is divided into several stages, take for example the structure of the second, third and seventh phase. Thus, the “analysis of the preparation of the manufacture from the point of view of the necessary technologies and infrastructure” (phase 2) presents the following stages: 2.1. analysis of the constructive conception; 2.2. technological design analysis; 2.3. manufacturing preparation analysis; and the “analysis of the manufacturing process” (phase 3) presents the following stages: 3.1. direct activities; 3.2. indirect activities, and for the “analysis of the whole process from the perspective of fulfilling the conditions for ensuring the circular economy” (phase 7) the following stages are presented: 7.1. pollution monitoring; 7.2. recording and interpretation of specific material and energy consumption; 7.3. recording specific energy consumption per unit of product; 7.4. recording other consumptions per unit of product; 7.5. waste management in relation to the product unit; 7.6. management of recirculated material introduced in the production process and reporting to the product unit; 7.7. the management of the recirculated material introduced within the technological process by reference to the product unit; 7.8. the management of the by-products generated within the technological process in relation to the product unit; 7.9. energy management recovered at the level of the technological process in relation to the product unit; 7.10. the management of other resources consumed at the level of the technological process and their reporting on the product unit.

The present stages are divided into main activities of the technological process, for example, several details are presented. Thus, the “analysis of technological design” (stage 2.2) presents the following specific activities: 2.2.1. general analysis of the casting technology depending on the nature of the alloy, the type of technology and the constructive features of the required functionalities (wall thickness, overall dimensions and dimensional differences to be ensured); 2.2.2. power system analysis and optimization; 2.2.3. analysis and optimization of solidification by correlating the masonry and / or cooling system with the constructive design typologies; 2.2.4. analysis of the cooling process and constructive optimization from the point of view of the stresses that form in the castings; 2.2.5. constructive-technological optimization with the composition of the alloy, the characteristics of the shape and the casting conditions; and “indirect activities” (stage 3.2) have the following specific activities: 3.2.1. the flow of transport and handling of materials entering the production circuit; 3.2.2. the flow of use of protective equipment and materials; 3.2.3. the flow necessary to ensure the utilities of the technological process; 3.2.4. the flow of activities for ensuring the maintenance of technological equipment; 3.2.5. the flow of current and general technological cleaning activities; 3.2.6. the flow of integrated and sustainable management activities of productive waste and other similar household waste; 3.2.7. other indirect flows present within the technological flow; so that at the level of “waste management by reference to the product unit” (stage 7.5) the following activities are present: 7.5.1. waste management generated during elaboration; 7.5.2. waste management generated at the realization of forms; 7.5.3. waste management generated at casting; 7.5.4. waste management generated at cleaning and finishing, 7.5.5. waste management generated in the heat treatment phase; 7.5.6. waste management for painting and surface coating operations; 7.5.7. waste management for roughing and processing; 7.5.8. waste management in operations other than those specified.

Starting from the presentation of the activities, in Table 2 are presented, in a selective way, intuitively, the necessary partnerships in order to fulfill the proposed objectives and to find the best ways to communicate.

Table 2. Activities supporting the circular economy together with the partners required for the specified activities (selective presentation).

| Code | Activity | Measures | Partnerships |
|------|----------|----------|-------------|
| 2.2.1. | General analysis of the casting technology depending on the nature of the alloy, the type of technology and the constructive features of | Development of computer programs for technological design in order to optimize material and energy consumption, adoption of technologies and infrastructure necessary for the established objectives. They can be | Specialists in the field of informatics, mathematics, materials physics, chemistry, circular economy, modeling of physico-chemical processes and those of a |
| Code   | Activity                                                                 | Measures                                                                                                                                                                                                 | Partnerships                                                                 |
|--------|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|
|        | the required functionalities (wall thickness, overall dimensions and dimensional differences to be ensured) | positioned on various levels of use, covering the typology of processes, alloys and the level of technological equipment. Within the mentioned instruments, it is necessary, taking into account the objectives of ensuring the circular economy, the development of IT structures aimed at managing the life cycle of the process, environmental protection and sustainable development measures. | metallurgical nature. They will work with specialists in various fields for which cast parts are delivered and with those specialized in the practices of casting various alloys, etc. |
| 2.2.2. | Power system analysis and optimization                                      | Supporting computer programs for computer-aided design of power systems, which, based on the models created, are to achieve an optimization of specific consumption. At the same time, it will be followed from the beginning of the technological design activity of the management modalities in order to recirculate the detached power supply networks from the part level. The transition from traditional to computer-aided design aims to achieve effects on the mentioned optimizations, even if often an interaction between the two systems is necessary. | Specialists in mathematics, hydraulics, thermotechnics, especially in the phenomena of heat transfer in liquid, solid and gaseous phase, in mass transfer. Specialists in the field of modeling physical phenomena specific to the development of technological processes. Specialists in the field of informatics, with experience in the field of industrial activities, etc. |
| 2.2.5. | Constructive technological optimization with alloy composition, shape characteristics and casting conditions | Promoting computer-aided operational design software, the process of obtaining castings, usable in the offices of study and current technological analysis. | Specialists in computer-aided programming, adapted to the design of technological processes, etc. |
| 3.1.1. | Alloy processing flow                                                      | Designing, developing and following the elaboration processes on the principles of the circular economy; reduction of material and energy consumption; calculation of rechargeable or recycled material with a high share of rechargeable material; avoiding materials that alter the heritage of recycled material; avoidance of the use of dangerous substances; establishing flows for obtaining by-products from the general useless structure within the manufacturing process; generating flows for reuse and recycling of used materials or products, etc. | Specialists in the field of metallurgy, logistics, physics, chemistry, use of hazardous substances, obtaining construction materials, making shaped products used in the area of public works, etc. |
| 3.2.1. | The flow of transport and handling of materials entering the production circuit | Optimizing transport and handling flows, in order to reduce specific consumption. Materialization directly at the level of production costs of these activities. Development of recycling activities for infrastructure used at the end of the life cycle, and for consumables regeneration and recycling activities. | Specialists in the field of logistics, organization of material flows, means of transport, life cycle analysis, management of consumables used in transport, etc. |
| 4.2.2. | The non-useful part turned                                                 | Collaborative realization of studies for | Specialists in construction |
6. The results of the analysis of the expected activities and partnerships

In order to establish the specificity of the communication, it is important to evaluate the process partners, namely the actions that are subsumed to the functionalities of the market economy from the perspective of materials engineering, by respecting the conditions related to ensuring circularities. The analysis of the partnerships shows that the process of ensuring circularity is carried out together with another very important one, that of digitalization within the fourth industrial revolution “Industry 4.0”. Therefore, it can be appreciated that the engineering of the manufacture of castings is and will be strongly marked by powerful knowledge in terms of achieving an environmentally friendly production through the use of computer systems and infrastructure.

Given this trend, it is appreciated the importance of creating an IT platform for industries served by materials engineering, as a tool for positioning towards the socio-economic environment, i.e. producers, suppliers and beneficiaries to the requirements of the circular economy. To these components are added, given the existence and need for institutionalized conditioning, also the public authorities and global structures acting at the financial, economic and sustainable development level.

Being aware that the problem posed is an interdisciplinary one, or more precisely a multidisciplinary one, it can be seen that at the level of communication an engineering approach is needed to provide the essential data in having a proper picture of the goal. With this motivation in

| Code | Activity | Measures | Partnerships |
|------|----------|----------|--------------|
|      | into a by-product | the inclusion of a large part of the non-useful part in the by-product category, by respecting the existing institutional regulations. | materials, public works, chemistry, materials testing, case law on the use of material resources, etc. |
| 6.2.2. | Analysis of transport activities | Management on the principles of the circular economy of internal and external transport activities: internalization of transport activities at the level of manufacturing costs of castings; optimization of circuits and raw materials and finished products; use of ecological means of transport; regeneration and recycling of consumables used in the means of transport; reduction of material and energy costs of transport and handling per unit of product. | Specialists in the organization of industrial transport, in the logistics of materials specific to obtaining castings, maintenance of internal or external means of transport, management of specific consumables in transport, etc. |
| 7.1.1. | Air pollution | Complex management of atmospheric polluting activities specific to manufacturing processes: activity monitoring measures; adoption of environmentally friendly technologies; introduction of depollution equipment; seeking solutions based on the principles of circular economy of pulverulent materials retained in depollution activities. | Specialists in physics, chemistry, meteorology, air pollution management, infrastructure specific to depollution facilities, etc. |
| 7.5.1. | Management of waste generated during processing | Approaching the elaboration process on the principle of inputs and outputs, paying special attention to reducing losses through handling, reducing the neutral part generated, looking for solutions to ensure recirculation and those related to the imposition of the resulting by-products. | Specialists in the field of metallurgy, electrical installations, automation, physico-chemical analysis, chemistry of refractory materials, etc. |
mind, we consider that the engineer specialized in materials engineering is necessary to penetrate the constitutive mechanisms and use of the virtual image, which gives him the possibility to perform an analysis of the manufacturing process from this perspective. This can offer the possibility of establishing a strong interpretative basis, of solid positioning for the specific actions of the “smart economy” and for the analysis of a phenomenon, present at the moment, that of defining a multidimensional truth and its use in identifying “false information” as such.

In order to achieve the proposed objective, it is necessary for the communication to emphasize the importance of the following activities:

- critical analysis of the conditions and indicators specific to the circular economy from the perspective of technological solutions;
- evaluation of the systemic modalities of virtual communication, in order to adopt the variant usable within the materials engineering;
- critical engineering analysis of manufacturing systems from the perspective of the circular economy and the use of its constituent elements.

7. Structuring the architecture of a collaborative platform by transposing the circular economy at the level of the manufacture of castings

The design of the structure of the collaborative platform architecture took into account the ways and conditions that virtual communication, through its specific tools, can integrate the principles of the circular economy, through the mutations and effects produced in the castings industry. For this, through the analysis made to the actors present in Romania at the level of cast parts, the following elements were pursued: the elements of interest of the circular economy that transpire from the virtual image of organizations, the ways to migrate to new business models based on information access and economic circularity; the influence of the principles of the circular economy in the design and manufacture of castings, which involve the use of tools specific to virtual communication.

Given the objective of the paper, the studies focused on the analysis of the major elements that determine the new economic models in the casting industry, models that correlate virtual communication, specific manufacturing and the circular economy. In this sense, a detailed analysis was performed on the following levels: external communication through presentation sites, the structure of manufacturing processes, the presence of elements subscribed to the circular economy.

In the analysis of the first level, that of communication, starting from the fact that the main objective of IT platforms is to facilitate the interconnectivity of economic actors, we noticed, for the analyzed situation, that of Romanian producers’ sites, the need to improve communication between the protagonists of this field, especially the facilitation of the relationship between them, according to the interests they have, with priority in meeting the demand with the supply. Such an approach involves, however, planning strategic paths by developing a "communication plan" for this purpose, a document focused on messages and communication objectives, materialized in the virtual image.

Thus, from this perspective, the following elements were proposed at the level of restructuring the virtual image: elaboration of a general picture on the virtual communication mode in the economic sector of castings, analysis and validation of the types of virtual messages conveyed, capturing the ways in which the communication objectives of the economic actors in the manufacture of castings are affected in the communication process. They materialize and receive quantifiable specificity in image indicators and sub-indicators such as: content, expression, meaning, identity, visibility, interactivity, dissemination, etc. These were presented in detail in an “analysis of the manufacture of castings and the perspective of virtual communication” [7].

Following the analysis of the position of manufacturers, with reference to the characteristics of business models, considered essential in promoting the circular economy in the manufacture of castings under the current IT conditions, four types of characteristics of these business models were identified: access and co-use (sharing) of services, products or raw materials, within communities, or value chains in a certain market; advanced use of state-of-the-art IT platforms, networks and mobile communication technologies for monitoring and management, use of aggregates, customers and
information; management and optimization of material assets (tangible or intangible), which are co-used, for the purpose of a valuable and relevant delivery and recovery; communication and relationship with users through social networks, exchanging offers, news, recommendations, appreciations or information.

Without going into detail on the development of the architecture of the IT platform (static platform and dynamic platform), starting from the analysis made and the need to adapt engineering behaviors to the requirements of economic models and virtualities of the moment, the main functions are presented:

the main functions are presented: general presentation of the fields (manufacture of castings, circular economy, informatics applied to industrial environments), socio-economic data of the fields; platform competences (animation of relations between members, communication - media communication and events, information, publication of specific materials, partnerships, technical coordination, legal services, professional information services and human resource provision, environmental protection, hygiene and security services, eco-responsible activities, domain development considerations); platform partners (professional associations, public authorities, licensing and certification institutions, research institutions, vocational and university training organizations, casting manufacturers, suppliers - technological infrastructure, raw materials, design, consulting, etc.), the technological potential of the platform (technologies, alloys terminology, computer aided manufacturing, etc.), innovation, research and development (technological innovation, organizational innovation, social innovation, fundamental research with application potential, technological research, innovative solutions in vocational training, etc.), eco-responsible activities environmental, social responsibility, etc.), considerations on the development of the fields, jobs and professional training, the news of the field, the management of the adherents of the platform, etc.

At the level of structuring the dynamic platform, the following components were taken into account: the platform management unit, the permanent virtual exhibition of the manufacture of castings at the conditions of the circular economy, the virtual conference of technical-scientific communications, multilingual institutional and technical dictionaries, general offer, general demand, specific commercial actions and component units. Starting from the analysis categories in the promotion of the circular economy, presented in Figure 1, we established the correlation which exists between the analysis categories and the defined functions of the IT platform for the promotion of the circular economy.

8. Conclusions
The construction of the paper presents a methodology for analyzing the problem of applying the circular economy in the manufacture of castings, with practical utility in implementing specific actions in a field of materials engineering, namely the manufacture of castings. At the same time, according to the analysis made, a procedural variant is offered for the choice of the partnerships necessary for the realization of the specific measures and the modalities of communication at their level.

One of the novelty elements used in the established procedure is the introduction of the notion of "material intensity" in the analysis. According to it, for the manufacturer’s attention and for creating a suggestive image at the communication level, it was calculated that a ton of good castings means the direct management of 1,644 tons of materials, which transformed from the point of view of biotic consumption represents 12,174 tons of materials, from that of water 99,399 tons, and in terms of air consumption 2,061 tons. From the analysis of the results of the casting process, it was found that the used sand has the potential to be capitalized in partnerships with the beneficiaries from the cement industry. Thus, through industrial symbiosis measures, the option of reducing the pressure on the environment was reached by the fact that out of the 325 kg of used sand generated per ton of good cast piece, 295 are taken over in the cement manufacturing process, for which the industrial landfill storage has been replaced with an intermediate platform for preparation in view of dispatching.

Considering the fact that the problems of applying the circular economy at the level of the castings industry is a multidisciplinary one, a fact that requires the realization of highly complex partnerships in a regime of maximum operability. Starting from this reality, demonstrated procedurally, the paper
suggests a possible architecture of an action platform for the circular economy. Considering the specificity of the existing situation at the level of the production of castings in Romania, with a value of 125,000 tons, from the discussions carried on at the level of producers, it was found that another development variant would not be possible, lacking large producers that could set the tone in this area. Therefore, the awareness communication becomes an absolutely necessary tool, in the given situation of Romania, which justifies the need for such an approach in introducing the principles of the circular economy in the manufacture of castings.

At the same time, the data provided in this paper can support the reform of training programs in engineering for the manufacture of castings, by introducing notions that support the acquisition of skills necessary for good management of the circular economy in materials engineering.

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