MATHEMATICS INDUSDTRY ECONOMY – MICRO-FOUNDRY

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Abstract: *This article presents that the main result of the final structure molded frosted or casting require the full capabilities of mathematics and a micro-foundry.*

Keywords: MATHEMATICS, OPEN INOVATIONS, MICRO-FOUNDRY

1. Introduction – Mathematics and economy

1.1 Mathematics

Definition of mathematics is by historical approach [1]: 1. Early definitions – Aristotle; 2. Greater abstraction and competing philosophical schools; 3. Definition in general reference works. Our opinion: mathematics is the science that takes care of its internal logic and never abandons not solved problems. Not resolved tasks often resolved after centuries.

Paper [2] presented the fundamental role of mathematics in thermodynamics. Other bright example for interaction between mathematics and physics is [3]. Today computational physics is a great part of investigations [7]. Multyscales modeling is introduced in [4 and 5]. At work with multiscale modeling must be render an account Gödel's theorems for precision of interaction between different mathematical methods.

For description of structure is use mathematical description in solidification zone introduce not only numerically of phase transition like area, but and descript and polycrystalline structure formation with maximum details [9]. The first is mathematical theory of scattering for introduction driving force of crystallization [8]. Second is description polycrystalline structure formation by quantum mechanics: the equations of the molecular mechanics

$$\ddot{m}_i \ddot{r}_i = f_i \qquad f_i = \partial U / \partial r_i \,, \qquad \text{(MM)}$$

where m, r and f_i – mass, coordinates and acting on atomic force derived from potential energy $U(r^N)$, where $r^N = (r_1, r_2,\ldots,r_N)$ introduced full set of *3N* coordinates of atoms; Planck's constant – ħ; ψ - wave function, m – mass of the electron. The potential energy can introduce: interaction between not connection and connected atoms; the atoms and electrons building the crystal lattice and behavior of electrons are describes with:

- Schrödinger's equation is an approximation of independent particles, independent of time

$$-\hbar^2 \nabla^2 \psi(r)/2m + V(r) = E\psi(r), \qquad \text{(Schrödinger eq., 1)}$$

- and time-dependent Schrödinger equation

$$i\hbar \partial\psi(r,t)/\partial t = -\hbar^2 / 2m \partial\psi(r,r)/\partial r^2 \,, \qquad \text{(Schrödinger eq., 2)}$$

For this equations is used methods which introduced of micro-foundry applied in their practice by investment of mathematical results – software. In work [6] present term open innovation which introduced Henry Kembarou in 2003 paradigm that requires companies to use external ideas as well as internal to find advanced technology. For companies this is an open market approach science technological transfer "maximum speed" to market a new product.

On Fig. 1 is show schema of office for transfer of open innovations (OTOI) which subject is to develop a system for services of branch machine building particularly – micro-foundry. That system mast helps full innovation process. Micro-foundries have not many and innovation capacitance. The generation of an idea mast led to a reasoned decision with minimal risk. On Fig.1 is shown the schema of OTT

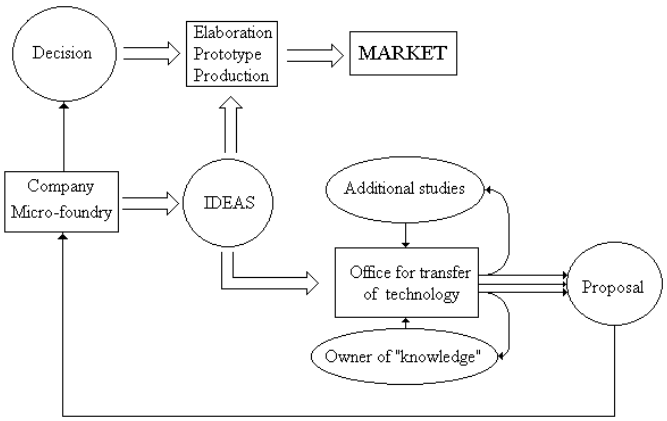

Fig.1 *Schema of Offices transfer of open innovations (OTOI) of technology and knowledge [6] – The most important stage of the information process* ***is generating idea and decision****.*

In this work we present mathematics with it in our papers. The mathematical based of the casting is theory of heat conductivity – Stefan-Schwarz problem. This theory today is developing by modern mathematics and mathematical physics for investigate by computational physics to design new structure at phase transition.

2. Micro-foundry – application of science and technology in casting practice

Fig. 2 presents the subject of foundry work: Fig. 2 *a* mold with cavity cast and Fig. 2 *b* machine for casting – gas counter pressure

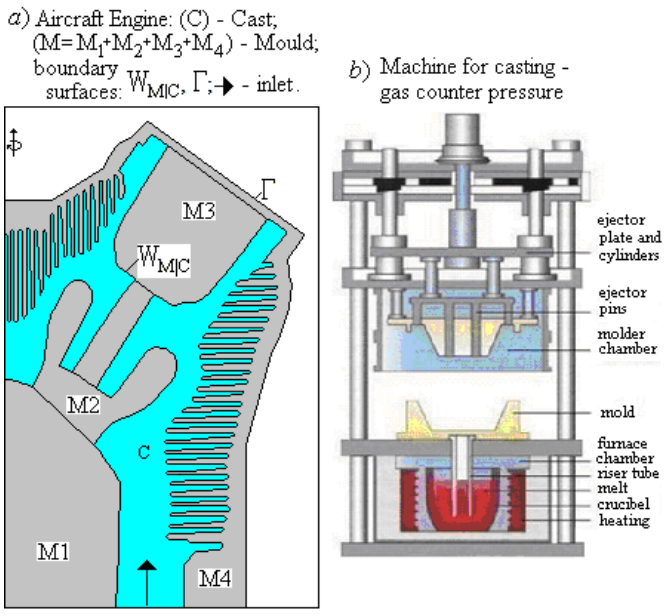

Fig.2 *Machine Foundry technology – gas counter pressure.*

Synthesis of open thermodynamic system (OTS) by computer-aided design of molds for machine gas counters pressure: **Basic**

casting process – creating a polycrystalline structure, (winner of working properties of casts) at the phase transition of first order; Sustainable system is achieved by operator of controllability based on generalized principle of OTS control [10]:

Control on account of information about the external effect on technological object feedback main processes (from indirect information carrier). (Control)

If main processes ≡ basic casting process than we have generalized algorithm for the stage of the information process is generating idea and decision from the micro-foundry: 1. Transfer of knowledge + technology + patents; 2. Mathematical description of the basic casting process; 3. Mathematical description of the controllability operator; 4. The most important stage of the information process is generating idea and decision.

3. Offices for science and technological transfer of branch machine building – micro-foundry.

Micro-foundry market knowledge is perceived by technology and/or patents, but computer design mold requires knowledge in the form of software. A basic principle of creating OTOI: **Formation of "the information flows" to "potential users"**. OTOI are the following groups of activities: First group – *forming target groups of companies (potential users) to which will be directed relevant innovative proposals*; Second group – *the creation of a database for the currently open innovation for the relevant target groups*. We introduced the scheme for business of OTOI (from [6]) to micro-foundry and casts market

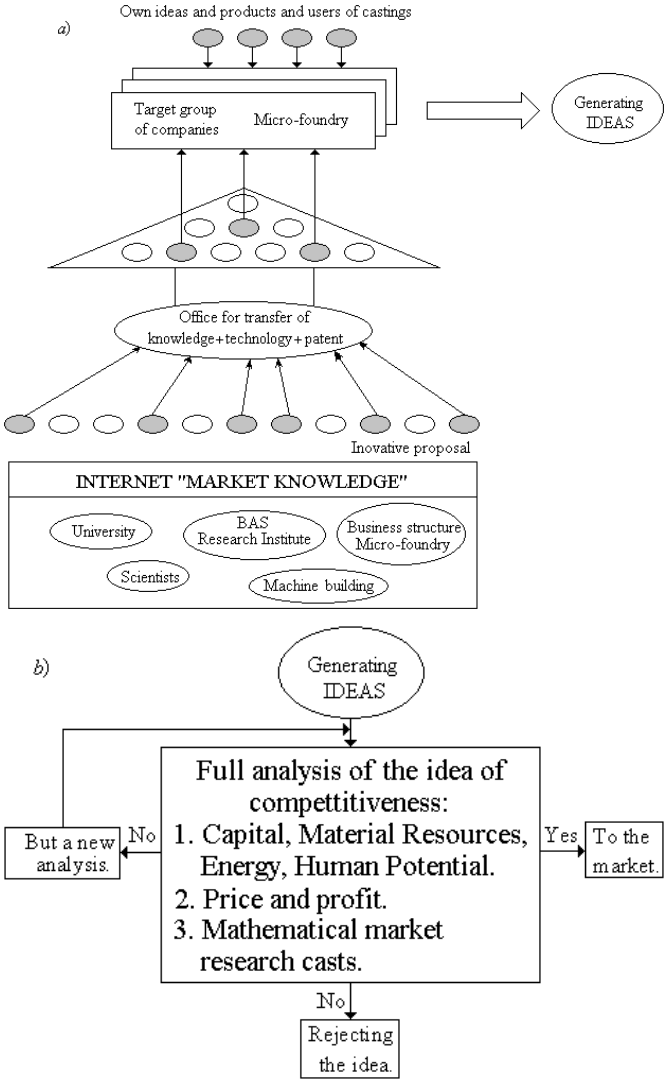

Fig. 3 *Scheme for business office to transfer open innovation – casts market: a) ⬭ – innovative ideas from other areas; ⬬ – innovative ideas for micro-foundry and casts market; education and science – University, Bulgarian Academy of Sciences and Research Institutes, Scientists; Business structure – micro-foundry; users of materials and castings of machine building – ingots and castings for aerospace, aviation, transport, railway transport, sea transport, building and others; b) Full verification with three possible outcomes: no, (but a new analysis); no (rejecting the idea); yes, (to the market).*

After full verification the necessary mathematical basis for open innovation is evaluated according to the activities divided into the above groups. First group: 1. mathematics for companies of target groups is based on the working properties of the materials and castings; 2. identifying specific areas such as mathematical analytical approach and mathematical modeling; 3. collection of experts and the formation of a working team - mathematicians, experts from industry branch and contact with companies; 4. explaining the mathematics necessary for innovation, developing innovation strategy; Second group: 1. database of mathematics for open innovation at the time; 2. Study research and choose a provider of mathematics; 3. Study of innovative proposals and determining appropriate for companies target groups. Translating, classifying and creating sectoral database.

4. Offices for mathematical transfer of branch machine building – micro-foundry.

Figure 4 shows a diagram of OSI to form information flows from open mathematical innovation

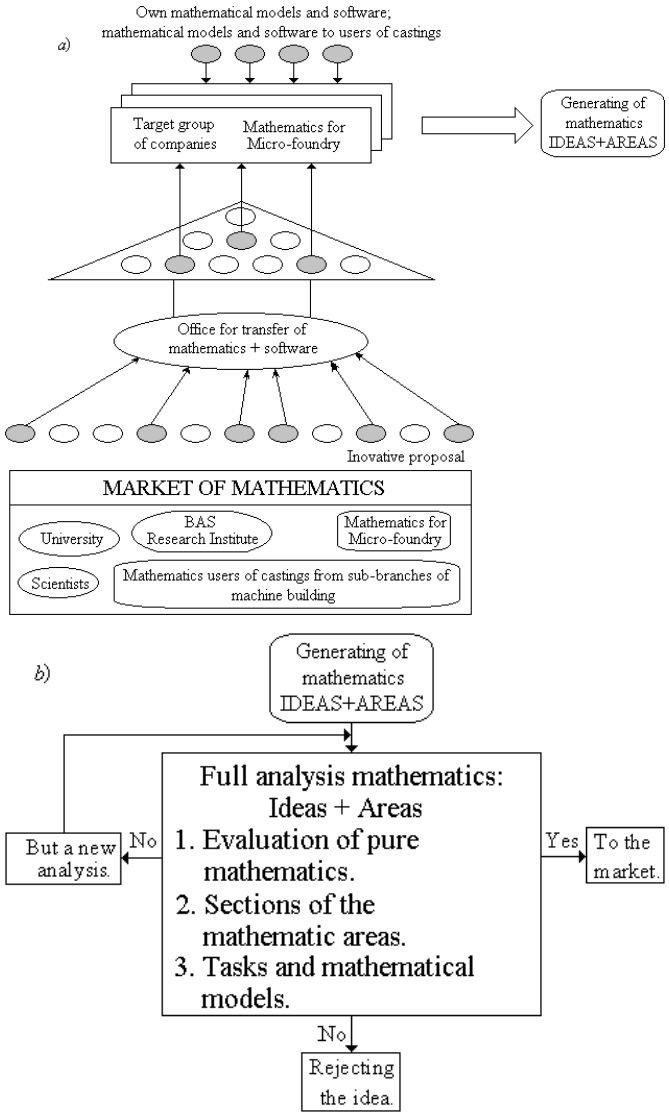

Fig.4 *Scheme for business office to transfer open mathematical innovation – casts market: a) ⬭ – innovative mathematics ideas from other areas; ⬬ – innovative mathematical ideas for micro-foundry and casts market;*

education and science – University, Bulgarian Academy of Sciences and Research Institutes, Scientists; Mathematics – micro-foundry; Mathematics of users of materials and castings of machine building – mathematical models and software; b) Full analysis of mathematics: no, (but a new analysis); no (rejecting the idea); yes, (to the market).

Mathematical theory of foundry process is the task of Stefan – Schwartz. In Fig. 5 is presented a process of stabilization in volume with complex geometry (see Fig. 2)

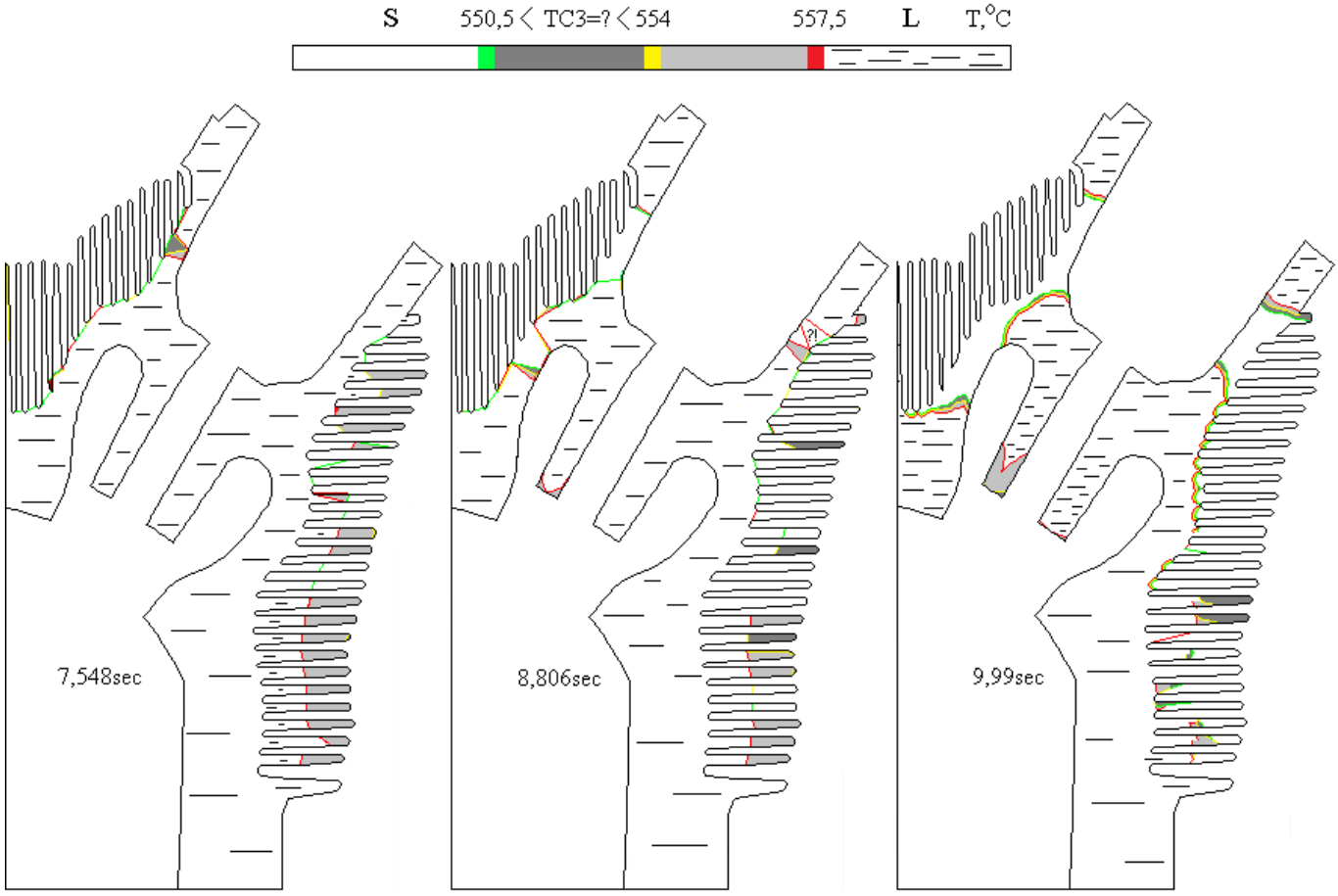

Fig. 5 *Phase Transition of first order; Solidification in volume with complex geometry: L – liquid, zone of phase transition $T \in [550{,}5 \div 557{,}5\ ^{O}C]$, S – solid.*

Solidification regime on Fig. 5 is not technological, but is free. This attractive picture always acts convincingly on every caster on the role of mathematics and computer design of the mold and casting technology. The talk about multi-scale mathematical modeling of structure formation of the polycrystalline structure of the solid phase is on the base of the next Fig. 6.

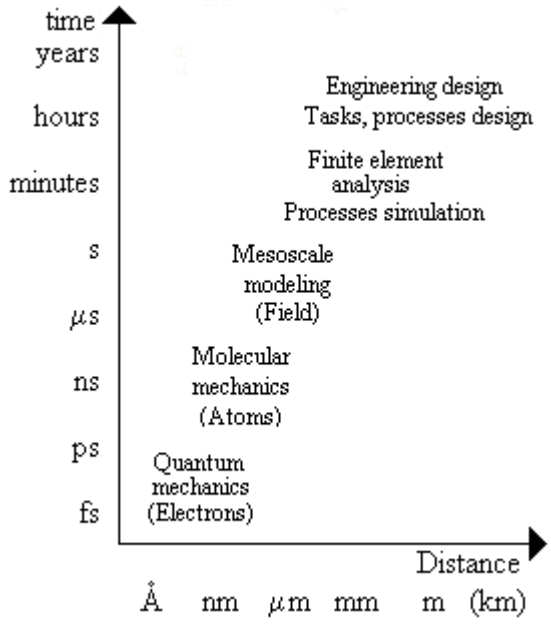

Fig.6 *Generalized scheme - Multi-physical hierarchy and multiscale modeling and design Multiscale axes (time - distance) are composed of parts with different scales. This scale only showing ascending order of ranking: quantum mechanics (electrons); molecular mechanics (atoms); meso-scale modeling (field); Finite Element Method (process simulation); engineering design (tasks, processes of design) [11].*

5. Industrial mathematics of branch machine building – micro-foundry.

Mathematics for description of structure formation of solid phase is the industrial mathematics of casting technology. Modern industry is experiencing acute need to use mathematics in their activities. The fact is that mathematics is entering the industry and it puts purely mathematical problems for future products. Therefore creating different mathematical fields titled "Industrial Mathematics" [12, 13, and 14]. The reports [12] are many analytic application of mathematics in different industries and industry feedback to mathematics. Based on this methodology is being developed to establish working groups and mathematical research for the future. Mathematics in medicine is the [15]. Education for the use of mathematics in the industry is much work for example [16]. Research center for mathematical research on current and especially future work is [17].

In foundry description of the structure of molded material requires not only mathematics, but also work with software-oriented quantum physics and quantum chemistry. The huge experience in the works [12, 13, 14, 15, 16, and 17] can be used creatively and for the economy of Bulgaria (Fig. 3 and 4).

5. Conclusion

Foundry It takes full advantage of mathematics as analytical; mathematical modeling; numerical methods and software.

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