

# FULL USE OF MATHEMATICS – FOUNDRY

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**Abstract:** In this work, we present the necessity of using the full mathematics in the industrial branch of machine building of the example of the foundry. Obtaining the necessary structures is accompanied by research work even in micro-foundries, which is provided by powerful and new software products, i. knowledge transfer with computational mathematics, physics and education.

**Keywords:** MACHINE BUILDING, FOUNDRY, CASTING STRUCTURES, MATHEMATICS, EDUCATION

## 1. Introduction

The importance of mathematics is represented by a general block diagram of "The History of the Development of Knowledge of Civilization from Antiquity to Today" of Fig. 1

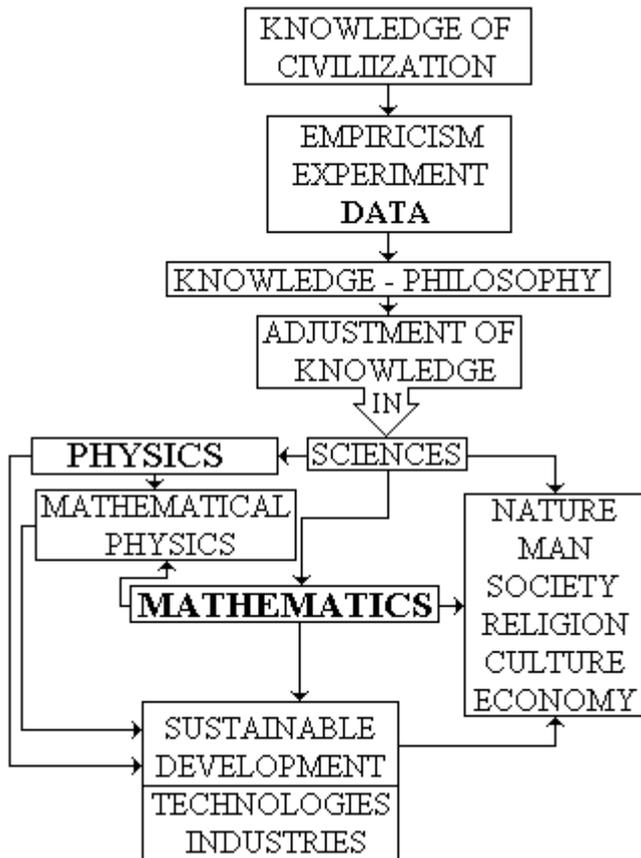


Fig. 1 Block diagram - Developing the knowledge of civilization from antiquity to today [1, 3, 4].

1 follows: 1. Initial knowledge is obtained through empiricism - obtaining and classifying experimental data; 2. Collecting knowledge in philosophy; 3. Knowledge is divided into separate sciences after Christ: 3.1 Physics - 18th Century; 3.2 Mathematics - the 19th and the beginnings of the 20th century; 3.3 Mathematics - Self Development; 3.4 Mathematics - a powerful tool for research: Description of physical processes and phenomena. Any theory is obtained only by using mathematics; 3.5 The term mathematical physics includes natural and theoretical physics; 4. Mathematics is in every area of human activity; 5. Sustainable development of civilization is based on: a sustainable society and economy - a challenge for every government; 6. Civilization only evolves by overcoming crises in society and the economy; 7. The challenge is the restructuring of the world by the fourth industrial revolution [1], involving education throughout every person's life, environmental technologies and industries.

The natural systems and the four main types of interaction forces in nature are classified in Fig. 2

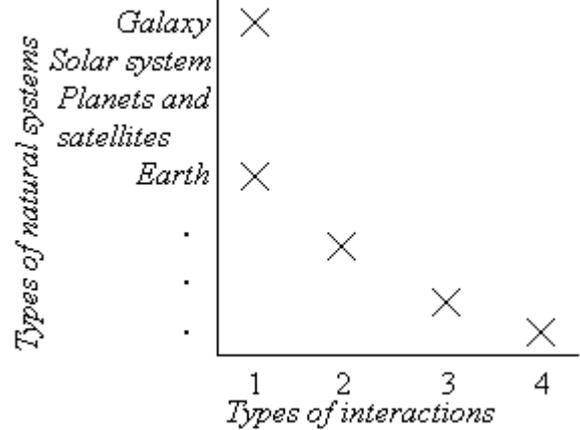


Fig. 2 Scheme - Natural systems and types of interactions [2]: 1 - gravitational interaction (large-scale events in the Universe), 2 - electromagnetic interaction (holds electrons in atoms and binds atoms to molecules and crystals (chemistry, biology)), 3 - strong interaction connects the nucleons (it unites protons and neutrons in the nucleus of all elements), 4 - weak interaction determines the forces acting between the light particles (leptons: electrons, neutrinos and muons) and between leptons and heavier particles).

The purpose of this work is to present the necessity of the complete mathematics in the foundry.

## 2. Foundry - physical and technological processes of structure formation

The casting structures are obtained in phase transition of 1st order is shown with the characteristic scale of the scheme of Fig. 3

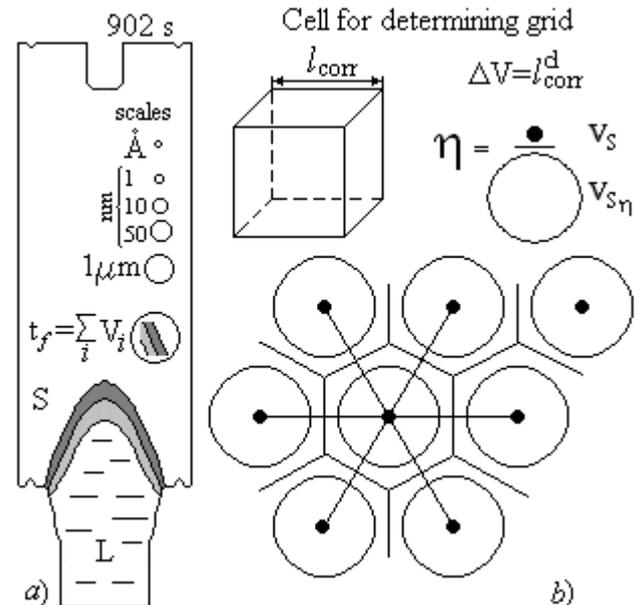
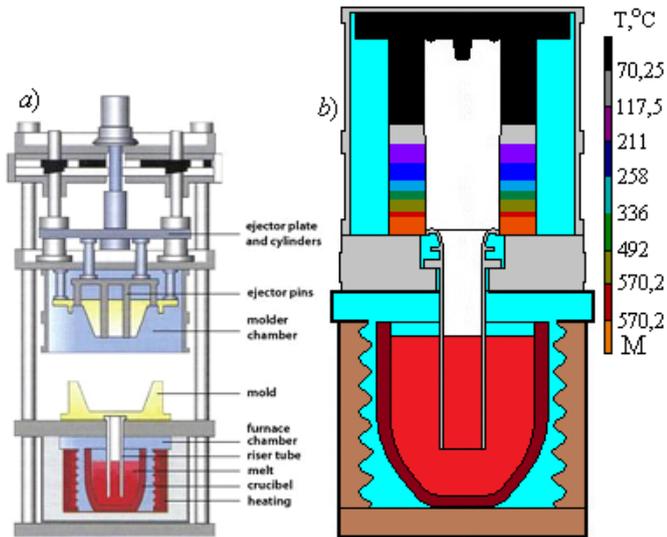


Fig. 3 The casting structures are obtained in phase transition of 1st

order (solidification) [5]: a) Numerical experiment: technological solidification of a cylindrical cast at 902 s, graphically represented by the geometry of the solidification zone (front) –  $\nabla$  between the liquid (L) and the solid (S) phases. Scales  $\text{Å}$ , nm,  $1\mu\text{m}$ .  $t_f$  – local time of solidification.  $V_i$  – chosen local volume for description of structure formation; b) Cell for determining grid –  $t_{\text{corr}}$  for  $V_i$ ,  $\Delta V_i$  – changing the volume  $V_i$  from melting (solidification),  $d$  – direction of growth 1D, 2D or 3D,  $\eta$  – packing density coefficient,  $v_s$  – volume of atom,  $v_{S\eta}$  – volume cell, Wigner-Zeit cell and structure.

The technological system of foundry we introduced on the example by the machine – Gas counter-pressure casting method Fig. 4

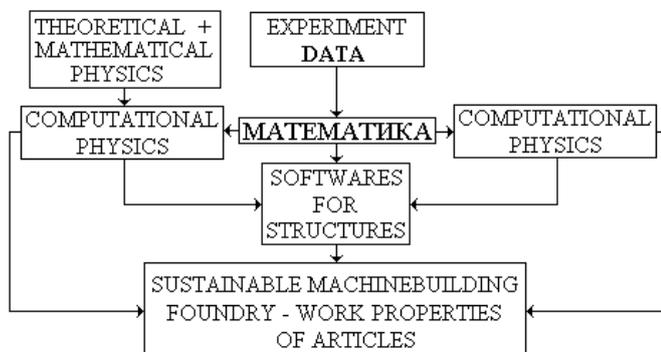


**Fig. 4** Casting technology system - Gas counter-pressure casting machine: a) General appearance of the casting machine; b) Technology for producing counter-pressure cylindrical castings. The technological regime shown (see Fig.2 a) is obtain with initial temperature of the mould without taking into account the filling process.

The technological system (see Fig.4) provides of macro-level to obtain the desired structure *average diameter of polycrystalline grains* [12]. Макропараметрите на лярската технология са преохлаждането на стопилката и скоростта на разсейване на скритата топлина на топене [5]. The macro-parameters of the casting technology are **the overcooling of the melt and scattering of the latent heat of melting** [3, 5, 11, 12].

### 3. Mathematics in Foundry

A scale of  $1\mu\text{m}$  is a macro-scale. Scale for nm or  $\text{Å}$  requires modern methodologies based on [8, 9, 10]. Обобщено това е математиката, теоретичете и математичната физика представено на Фиг.



**Fig. 5** Scheme - Full mathematics is needed in Micro-Foundry and Industry 4.0.

Full mathematics is called upon to create new purely mathematical theories. The new theories are evolving because Gödel's theorems of "incompleteness" clearly show that there is no complete mathematical theory. The history of mathematics shows the need for the development of pure mathematics, but it is challenging to suggest the assessment of the development of the necessary, for example, a "new mathematical field".

### 4. Conclusion

Mathematics is a powerful tool for research. Mathematics is needed in public development, for example "virtual factories", apart from technological, legal relations between companies, based on new experimental data, evaluations are also made for research ideas for development from "artificial intelligence". Hence Industry Change 4.0: "factories without people", and people naturally need life-long education.

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