INCREASE OF THE EFFICIENCY OF CASTING PROCEDURES - CROATIAN PERSPECTIVES

POVEĆANJE UČINKOVITOSTI I KVALITETE ODLJEVAKA - HRVATSKE PERSPEKTIVE

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Abstract: *In Republic Croatia after 1990 foundry production has been reduced up to 50%. In fact, due to market decay significant decrease of casting production for domestic industry. Some parts of productions practically disappeared. If we want to be serious producers of castings for western and oversea industrially developed countries it is necessary to solve a great number of different organizational and technological problems. The most important problem is quality of castings.*

Key words: *efficiency, influential parameters, casting quality*

Sažetak: *U R. Hrvatskoj od 1990. god. ljevaonička proizvodnja se do danas ukupno smanjila i do 50 %. Naime, zbog raspada tržišta došlo je do znatnog pada proizvodnje odljevaka za domaću strojogradnju, a neki dijelovi proizvodnje su praktički prestali postojati. Ukoliko želimo postati značajniji proizvođači odljevaka za zapadne i prekomorske industrijski razvijene zemlje potrebno je riješiti veliki broj različitih organizacijskih i tehnoloških zadataka, od kojih je problem kvalitete odljevaka najvažniji.*

Ključne riječi: *učinkovitost, utjecajni parametri, kvaliteta odljevaka*

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1. Introduction

Casting is one of technologies for achieving of a specific form of a metal objects by pouring a molten metal into a mould and allowing it to cool. The molten metal takes shape and size of the mould cavity and retains it after solidification (Bonačić-Mandinić & Budić, 2001).
Casting technology is one of the oldest and most efficient ways of product forming. In spite of diverse, highly competitive and new production technologies, enormous demand for castings, due to their simple manufacturing process, will continue High productivity and easiness of production of replicas make it extraordinarily suitable for serial and mass production. Frequently however it is also the only technology available for manufacture of highly complex components with internal cavities (such as motor blocs and similar), or for production of large and heavy machine casings. Casting technology also, enables pouring of machine assemblies all at once, which otherwise must have been poured partially. The forming is carried out in liquid state, and the melt, like all liquids, requires minimal energy consumption in bringing it to specific form, especially because gravitation is used as the pouring force. Total energy consumption is however substantial, because material must be melted beforehand. Utilization of energy is more favorable if the shape of the component is more complex, because the spent energy depends on the mass and not on complexity of the component. Therefore, casting is irreplaceable technology when it comes to production of complex shapes (Budić, 2006).
To make casting technology competitive, high requirements regarding quality and accuracy of castings, their mechanical and other properties has been established, because only up to 5% of defective castings are permitted (i.e. only random error). Mechanical and dimensional properties and other requirements regarding quality of the castings are achieved during solidification of the melt and change of aggregate state, i.e. processes still insufficiently researched, which consequently turns quality assurance procedures into very complex task.
This means that production of good castings requires great skill, even more because process of formation of casting cannot be observed visually, because the melt fills in the closed mould.
Casting is still regarded as hazardous technology due to continuity of the process, which makes it difficult to keep the process entirely under control. Therefore, casting technology will develop not only in direction of utilization of advantages of mass production, but also in direction of making it less hazardous.

2. Characteristics of casting in countries in transition

In countries in transition among which Republic Croatia also belongs, casting production has diminished since 1990 even up to 50% (depending on kind of castings). Depiction of the casting production in Republic Croatia from 1990 until 2003 is shown in Fig. 1. (Budić & Bonačić Mandinić, 2004). Namely, with disintegration of the market, it came to significant downfall of production of castings

for domestic machine building industry, with some parts of this production ceasing to exist.

Production of castings designed for Western markets remained the same, or shows signs of mild growth. If we want to become notable casting producer for Western and overseas industrial and developed countries, it is necessary to solve a large number of different organizational and technological tasks, casting quality management being the most important of all.

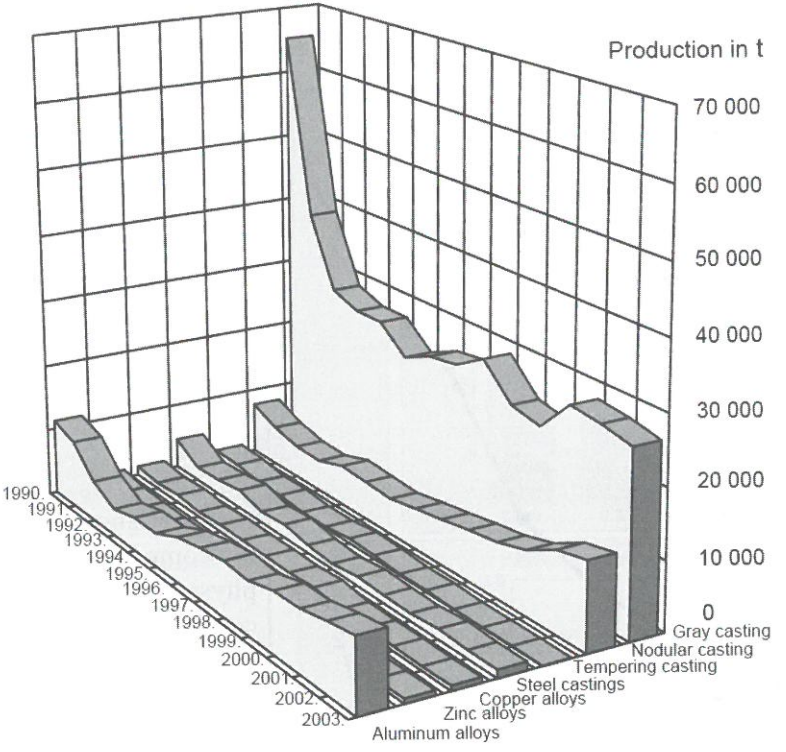

Figure 1. Depiction of the casting production in Republic of Croatia from 1990 until 2003.

Downfall or stagnation of the casting production is result of re-structuring of production and well-known problems in economy of country in transition. The exception is growth of casting production out of aluminum alloys since 1993. Rise in production of castings out of nodular iron with simultaneous downfall of production of gray casting has been recorded since 1994. At the same time, this proves the existence of the tendency for production of high quality kinds of castings.

The most production indicators present mainly total annual production, very often taking into account also the kind of casting. These indicators are important but not decisive because they do not give full definition of the future state of these issues. The assessment of the future conditions is extremely important. On the base of knowledge of the forthcoming structure, it is possible to assess easily prospective

production development trends. Subsequently, the need for eventual reconstruction of the existing foundry can be established (i.e. replacement of the cupola furnace with electric furnaces, or construction of the new foundry.

A typical case represents diminishing of production of the gray castings in the entire structure, regardless of the fact that the total production volume has increased, primarily because of application of nodular iron, aluminum and plastics in production of vehicles.

3. Characteristics of casting industry in developed countries

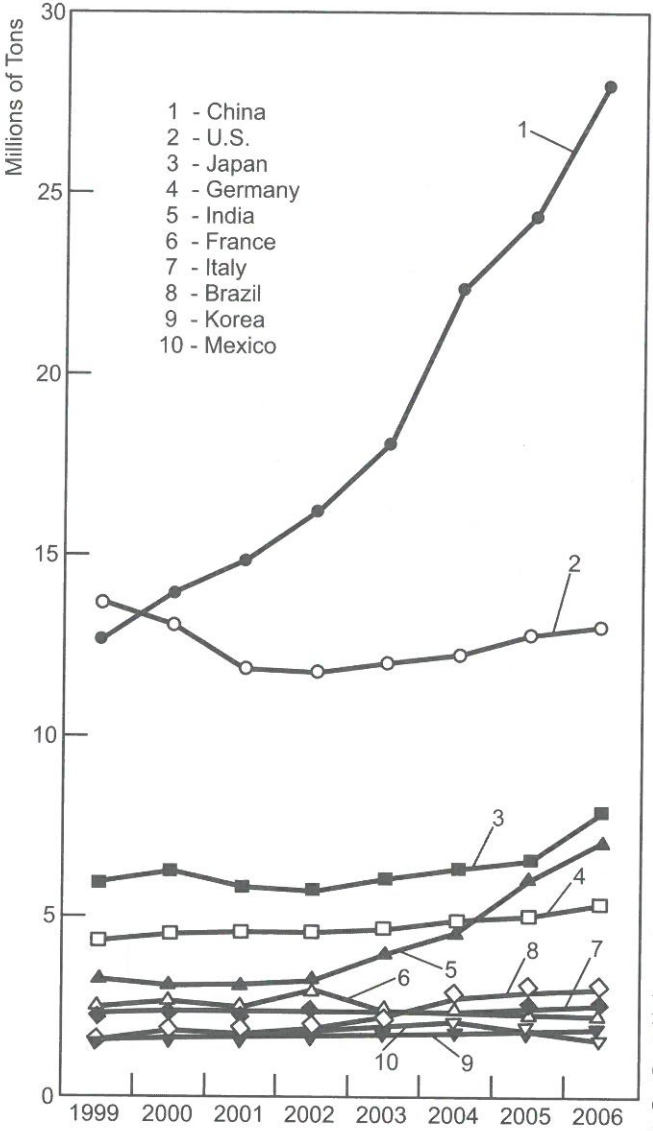

Figure 2. Casting tonnage trends for each of the Top 10 casting-producing nations

The market can be assessed only under precondition of existence of the worldwide stable economic growth. Automobile, machine building industry, construction of flats and consumption of commodities represent exceptionally large market for castings. In all these physical activities application of machinery is on the rise, because labor force represents noncompetitive source of physical force, even in countries with low paid word force.

Regarding intellectual jobs, certain preponderance must be given to underdeveloped countries, because of the lower price of professional work force. Production of castings in industrially developed countries will not increase (slight downfall is to be expected). (Bonačić Mandinić, 1995). In Fig. 2, we can see production of castings for ten biggest world producers. A certain re-structuring is to be expected within casting industry itself Staff Report (2007).

It will be replaced by aluminum alloy castings, while steel casting will be greatly replaced by nodular casting. Tempering casting will mainly loose market positions. Competitiveness of polymer materials will continue. Regarding new materials (ceramics, composite materials, polymer concrete and similar, it cannot be expected that they will replace metal, primarily because in most cases their properties are complimentary and not competitive, so that they will be used together with classical materials in new constructions. Besides that, limiting factor will be their high production price. (Bonačić Mandinić, 1995). Depiction of the world production by each kind of casting is shown in Fig. 3. (Staff Report, 2007).

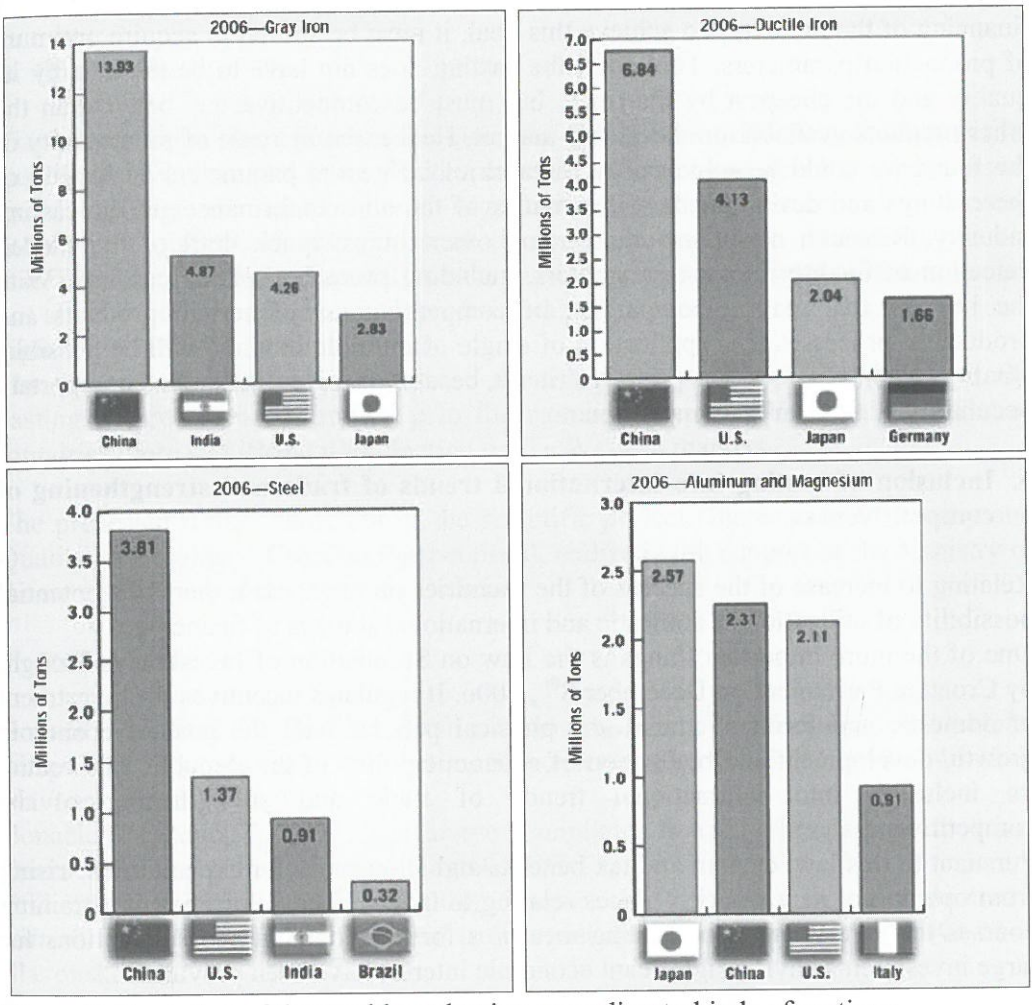

Figure 3. Depiction of the world production according to kinds of castings

4. Indispensable changes in the structure of casting production

Present situation in huge majority of Croatian foundries is far from good (in spite of huge export potential), which enables them only to survival. There are no possibilities

of major development and progress. Namely, western markets, where there is a system of unity of technological and commercial functions, system of fractal production (product development in one country, assembly in another, while products find their customers mostly in third country markets) is presupposition for further development. To advance foundries to that technological level, not only high quality understanding of global function, but also top technological expertise about produced castings is required. These requirements cannot be introduced into production process without extraordinary effort and engagement of the country's own scientific and human potential. This opinion is also shared by relevant world experts and financial institutions for which realized profit represents measure of success and criteria for financing of the projects. To achieve this goal, it must be strived to acquire optimum of production parameters. Therefore, the casting does not have to be the best by its quality and the cheapest by the price, but must be competitive, i.e. better than the other products available on the global market. Hence, the increase of productivity of the foundries could be achieved by research of influential parameters on quality of the castings and development of the matrix of the non-conformances in the casting industry. Research might include, among other things, quick draft of the model, detection of quality relevant parameters, including protection of the castings. With the help of this matrix, comparison of competitiveness of certain products and production processes (i.e. application of single of multiple moulds) will be possible. Quality has been selected as primary criteria, because it represents the most important peculiarity of the market competition.

5. Inclusion of casting into international trends of trade and strengthening of competitiveness

Relating to increase of the success of the foundries on the market, there is a potential possibility of utilization of domestic and international sources of financing.

One of the more important things is the Law on Stimulation of Investments brought by Croatian Parliament on December 8th , 2006. It regulates incentives for investment of domestic and foreign judicial and physical persons with the goal of economic growth, development and realization of economic policy of the Republic of Croatia, its inclusion into international trends of trade and strengthening of its competitiveness.

Pursuant to this law, custom and tax benefits and allowances for expenditures arising from opening of new working places relating to investments, allowances for training courses for investments, stimulating measures for development and subventions for large investments having significant economic interest have been provided.

Important are also international sources of financing provided through cooperation with EU and the World Bank.

Through the above specified sources of financing it is possible to purchase the equipment, technology and machinery, which contributes to expansion of production activities, product processing and implies the effects on the human factor, which will in such a way accommodate to new business principles and become capable and

qualified work force on the market. Use of new and innovative products and technologies, the acquirement of the new business processes leads to increase of quality of the output of the enterprise and reduction of all expenditures. In this way production activities in the segment of the economy are spreading, which naturally leads to better business practice and successful appearance on the market. Capital and joint venture investments with domestic and international partners are also possible, as well as creation of business clusters and networks. Such sources of financing would stimulate development of revenue activities and create more enticing business environment, which would lead to increase of total revenue and profit, and result in growth of the enterprise in the economic sense of word.

6. Conclusion

The precondition for Croatian foundries to become respectable manufacturer of castings for Western and overseas companies in industrial and developed countries is to solve a large number of different organizational and technological tasks. Hereby problem of quality of castings is of the primary importance. Primarily due to insufficiently qualified personnel and the burdens of the past, Croatian foundries are not at the required organizational, professional and scientific level, which can ensure rapid entry into Western integrations.
Therefore, it is necessary to increase the efficiency and improve quality of the castings, which in near future (up to forthcoming 5 years) would enable Croatian foundries more significant participation on the Western markets.

The presented results come out of the scientific project (Increase of Efficiency and Quality of Castings – Croatian Perspectives), realized with support of the Ministry of Science and Sport of the Republic Croatia.

7. References

Bonačić Mandinić, Z.; Budić, I. (2001). *Osnove tehnologije kalupljenja, Jednokratni kalupi - I dio*, Strojarski fakultet u Slavonskom Brodu, ISBN: 953-6048-19-1, Slavonski Brod
Bonačić Mandinić, Z. (1995). Ljevarstvo u zemljama tranzicije hrvatske perspektive, Znanstveno stručni ljevački skup, Zagreb 1995
Budić, I.; Bonačić Mandinić, Z. (2004). *Osnove tehnologije kalupljenja, Jednokratni kalupi - II dio*, Strojarski fakultet u Slavonskom Brodu, ISBN: 953-6048-28-0, Slavonski Brod
Budić, I.; (2006). *Posebni ljevački postupci - I dio*, Strojarski fakultet u Slavonskom Brodu, ISBN: 953-6048-35-3, Slavonski Brod
Staff Report (2007). 41st Census of World Casting Production—2006, *MODERN CASTING (December 2007). 22-25. Availabe from: http://www.moderncasting.com/*