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Serbian Journal of Management 2 (1) (2007) 57 - 65

Serbian
Journal
of
Management

INVESTIGATION OF THE INFLUENCE OF TECHNOLOGY LIFE CYCLE ON COMPANY LIFE CYCLE CASE STUDY: METALLURGICAL PRODUCTION OF COPPER IN RTB BOR (SERBIA)

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(Received 22 May 2006; accepted 27 July 2006)

Abstract

Technology, as a key factor for the bussiness results of the company, influences differently the competitive position and the global position of the company during its life cycle. Actual position of the RTB Bor company is considered in this paper from the point of view of metallurgical production of copper technology life cycle, as the most important one in the whole technological chain present in this company.

Keywords: life cycle, technology, company, RTB Bor(Serbia)

1. INTRODUCTION

Technology presents a key factor for the bussiness results of the company. Its great importance in succesful development of a company is mostly attached to technology intelligence [1]. But, there is also a possibillity that different reasons (i.e. limited learning capability, insufficient information on technological trends, managerial incompetence [2-4], etc.) can lead to technological discontinuities, decreasing of effectiveness and productivity, bad technological decision-making, and finally to the company demise [1,3,5,6].

The management of technological change in companies influences differently the competitive position and the global position of the company during its life cycle. In the case of a discontinuous technological change

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[7], there is a significant challenge for the companies operating in the affected industry. To maintain the competitive standing, these companies should master the new technology, ensure that the products and processes fully exploit it and move quickly to secure a position of market leadership. More, in multiple generations of technology paradigm, multitude of products could be derived from each technology generation [8], which follows a life cycle and is eventually replaced by the next generation. In such cases, both old and new technologies are based on the same technology platform and management of the transition of technology generations is especially important.

A special problem occurs in managing technology life cycle in transition countries. There are different channels of global technology transfer to these countries [9]: direct technology transfer through foregn direct investments, intra-industry knowledge spillovers from foregn direct investments, firm's own research and development accumulation and research and development spillovers through trade for total factor productivity growth of local firms. Under such conditions, the influence of technology life cycle on company life cycle is very important, as well as the investigation of such influence. Therefore, the example of the RTB Bor company, the greatest copper producer and exporter from Serbia in the second half of the twentieth century, was considered in this paper from that standpoint, taking the metallurgical production in the copper technology life cycle, as the most important step in the whole technological chain present in this company.

2. LIFE CYCLE ANALOGY

The life cycle analogy originates from biology, taking into account that the life of an individual consists of a series of different stages from birth to death. The growth and, especially, the successions of industrial sectors strongly suggests such an 'aging' phenomenon, and the Kuznets curve was originally based in 1930 on this notion [10]. So, the aging idea has been more fully elaborated into a life cycle scheme - conception, birth, childhood, adolescence, maturity and senescence, which corresponds quite closely with the observed stages of development of a new technology.

But, comparing to biology, the sequence in a life cycle of a technology is much less rigid and not absolutely irreversible. When this occurred it has usually resulted from the impact of another more rapidly changing technology, or may be the result of a new constraint, such as a sudden and unexpected scarcity, or it could result from a sudden increase in competition due to the removal of trade barriers. On the other hand, it is also possible for an industry to skip directly from childhood to maturity, or from adolescence to senescence, in certain circumstances [10].

The 'evolutional' approach may be also considered through three main technological phases involving - fluid or flexibile, transitional and focused phase. The occurrence of dominant design in the technological process is the most important point here, and according to [11], new cycle starts when the limits of the dominant design are achieved.

One of the classic theoretical models to determine the technology life cycle is well known technological S-curve model [12], schematically shown in Fig.1.

The S-curve represents the nonlinear function between the performances, determined by the physical limits of the technology, and the invested efforts.

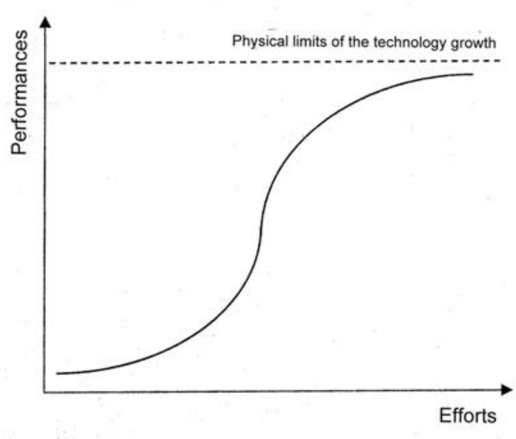

Figure 1. Technological S-curve model

But, successful product must be balanced - not only technology, but marketing and consumer experience play critical roles too (Fig.2.), and one cannot dominate the others. Different factors are important at different stages in the development of a technology. In the early days, technology dominates. In the middle stages, marketing dominates. And in the end, mature stages - the technology is a commodity, so user experience and marketing can dominate: accuracy is taken for granted.

Therefore, the classification scheme for users - adopters of innovative technology has been suggested [13] into the categories of 'innovators', 'early adopters', 'early majority', 'late majority', and 'late adopters or laggards', Fig.3.

The change in customers occurs as a technology matures. In the early days, the innovators and technology enthusiasts drive the market - they demand technology. In the later days, the pragmatists and conservatives dominate - they want solutions and convenience. Although the innovators and early adopters drive the technology markets, they are really only a small percentage of the market, while the big market is with the pragmatists and the conservatives.

Moore [14] gave a further contribution, introducing the challenge of marketing in high technology (Fig.4.) and distinguishing successive groups of adoptors [14]: innovators, early adopters, the chasm,

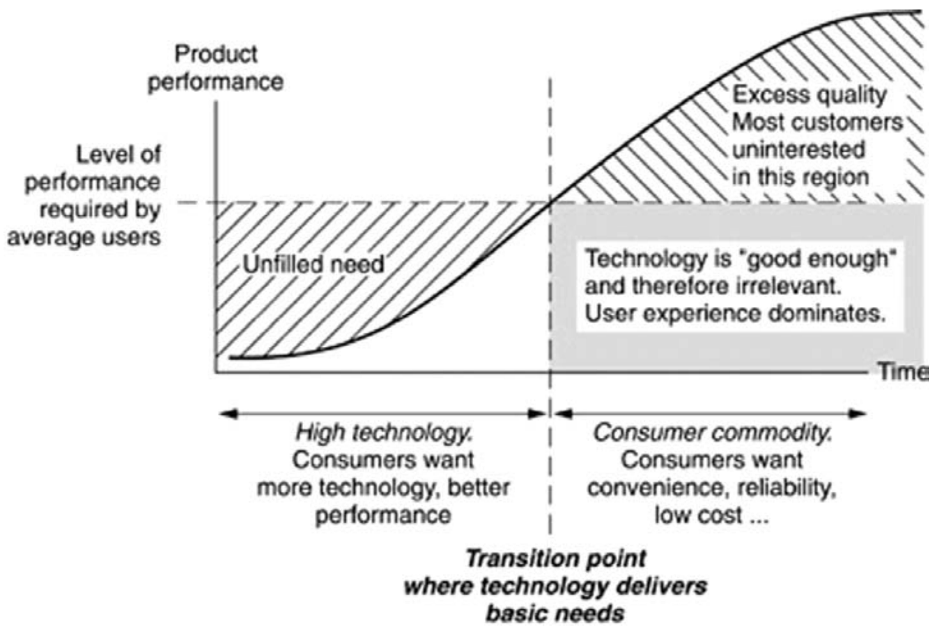

Figure 2. Technology vs. basic needs of a consumer

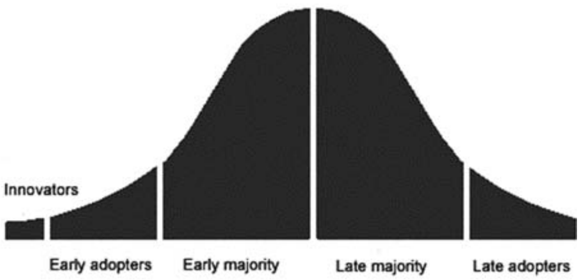

Figure 3. Classification scheme for users - adopters of innovative technology

pragmatists - early majority and late majority and tradicionalsts - skeptics.

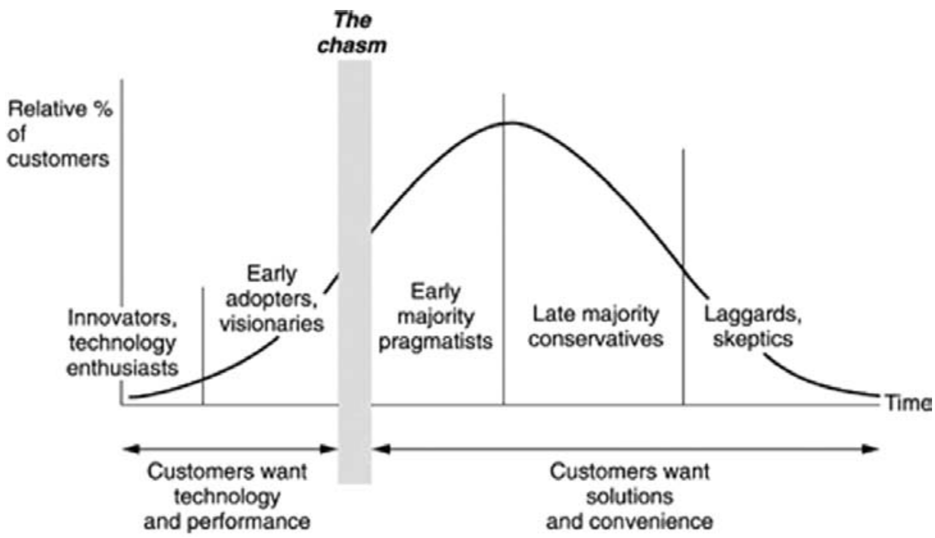

Figure 4. Moore - chasm theory

For Moore, the most important time gap in technology adoption, which he calls the Chasm, is between the early adoptors and the early majority pragmatists. Many companies have floundered in the chasm, just after volume starts to rise at the end of the early adoption phase. Moore suggests [14] that companies who successfully cross the chasm first establish a niche in the mass market from which they can expand.

3. BASIC FACTS ABOUT COPPER METALLURGY

The first wider application of copper, associated with industrial era, was in the field of electric power generating and distribution systems. Electrical conductivity and thermal conductivity - together with ductility and malleability, were the most important properties of copper as the main metal for electrical/electronic products production and application in wire-consuming industries - building construction, industrial machinery, etc.

From 1980s, the main challenge to copper - glassfiber, occured in the telecommunications market. The demand for telecommunications channel capacity has exploded since the Internet became a significant market presence in the early 1990s [15]. It is likely that within twenty years, and possibly less, virtually all telecom lines will be optical and demand for copper in this sector will become negative. Globally, future growth in different copper markets have been estimated as follows [15]: sheets and strips, tubes, electric power cables, electric power cables, telecom cables and winding wires for motors.

But, in spite of losing some traditional markets to other materials (mainly in telecommunications cables due to increasing use of glass fibers and wireless devices, or being under pressure from cheaper materials), other traditional copper markets, such as copper roofing, copper water pipe, and brass hardware of all kinds are to be present in future copper stock develpoment trends [15].

The basic technological sheme of copper pyrometallurgical production is presented in Fig.5.

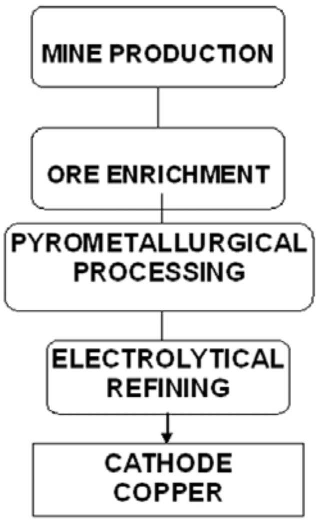

Figure 5.Basic technological sheme of copper pyrometallurgical production

Geological reserves of copper are continually increasing. In January 2001 US Geological Survey published that the world copper reserves were 340 106t, while the total explored reserves ammounted 650 106t. In January 2004, the same source produced new details on reserves ready for exploiting - 470 106t, while the total indentified reserves ammounted 940 106t. The ore content decreased in all mines worldwide, thus today ammounts within 0.5-1%Cu [16].

The sutuation, as well as an increase of copper requirements from one side, and strict environmental protection demends at developed industrial countries, resulted with many technological innovations and new technologies, especially in the stage of pyrometallurgical processing, where dramatical changes occurred that resulted with increase of technological efficiency, decrease of air pollution and dramatic decrease of production cost [17].

Within the period of time from 1970 to 1992 the development of copper pyrometallurgy experienced several remarable technological changes introduced my many companies worldwide:

- 1970-1980 Teniente converter (6 smelter plants)
- 1972-1978 TRBC converter (4 smelter plants)
- 1973-1992 Noranda (4 smelter plants)
- 1974-1981 Mitsubishi (3 smelter plants)
- 1982-1990 Vaniukov process (5 smelter plants)
- 1984 MCO (2 smelter plants)
- 1988-1995 Outokumpu (34 smelter plants)
- 1992 Isasmelt (2 smelter plants)

Totaly 63 smelter plants introduced new technologies in the stage of pyrometallurgical processing within the period of time 1970-1992. The essence of all these technologies consist of increased utilization of all components, especially of sulfur, that reduces production cost of refined Cu [15,18].

4. CASE STUDY: METALLURGICAL PRODUCTION OF COPPER IN RTB BOR (SERBIA)

Company RTB Bor (Serbia) has a long tradition in copper production. Copper mine started with work in 1902, and soon after the smelter plant and electrolytical refining, too. In the second part of the twentieth century, RTB Bor Co. was one of the important copper producers in the world, but drastic fall in production occurs in nineties.

The geological reserves within the company RTB-Bor (Serbia and Montenegro) are satisfactory and garantee production for another 50-60 years with a capacity of 80-85 000 t Cu/ ann. [18]. Cu content in average ammounts 0.65%, however there have been counted deposits with0.9%Cu, that indicates that this company has always had reliable mineral base, that has been verfied as a proof of existance for the company for following 50-60 years [16].

The world copper consumption has been increasing steadily and this increases its production, which ammounted app. 5 106t of refined copper in 1960, while in 2005 it ammounted app. 15.5 106t (refined copper), as shematically shown at Fig.6.

Details presented at Fig.6 direct clearly that tendency of world Cu production increasing within the last 40 years. That was the case with RTB Bor company until 1990, when this production has been decreasing and withing the last 15 years has been decreased ten times.

Although many different technologies occurred in copper metallurgy up to 1990, the latest alteration of copper smelting

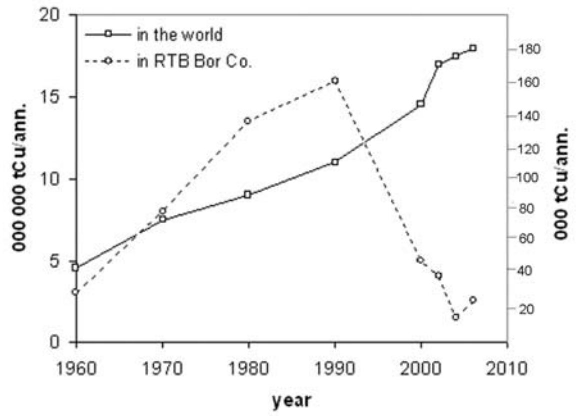

Figure 6. The ammounts of produced refined copper in the world and in RTB Bor Co.

technology at RTB Bor Company was peformed within the period of time 1970-1973, when, for that time, the most modern roasting method was introduced - fluosolid reactors and smelting in the reverberatory furnaces. This method, having been in the stage of development at that time, was applied at leading copper production companies.

Price of the refined copper depends on a few key technologies in the copper production. Having in mind that refined copper is product which price is formed at the metal exchange, profit of the company depends on the relation of production price and commercial price formed at the London metal exchange. Bearing in mind that the labour price was lower at RTB Bor comparing to competition, the profit at that company was considerably higher related to the competition in the period up to eighties, Fig.7.

Within the period of time 1960-1975, the profit at the company RTB Bor varied around US $ 200 106. Within the period 1975-1990 this profit level sustains due to

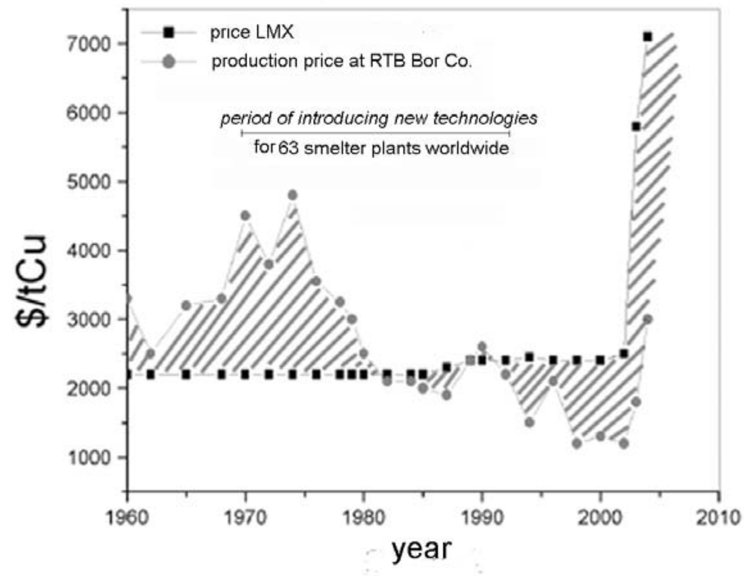

Figure 7. Comparative review of refined copper commercial price in period 1960-2005 related to:

- *price at LMX*
- *production price at RTB Bor*

production increase, low labour price and the type of economy prevailed in Yugoslavia at that time.

Within the same period of time, different studies of introducing new technologies have been presented by R&D departments of the company. Numerous smelting capacities worldwide were visited, however the company management board had not courage to bring the decision of introducing adequate new technology. This venture costed US $ 300 106 at conditions when the company had annual profit of US $ 200 106, and the copper smelter plant erection lasts three years. The company profit was taken by the goverment for servicing their needs and bying social peace.

The period after 1990 (desintegration of Yugoslavia), imposing UN sanctions to Serbia and Montenegro results withhard position of RTB Bor, that impacts the production which permnently decrease, while the copper production cost increases enormously even over US $ 8000/ tCu, while the world price is under US $ 1000/tCu.

The political establishment of the country forces copper production at all costs (not covering expenditures for power, water, oil, coal, ...), and this stream of events is harder and harder and it is a real miracle that the company did not stop at all at such conditions, because all production costs were covered by the government, including salaries.

The last increase of copper price could not improve the company's situation, due to low technological efficiency and incapacity of increasing mine production as the result of obsolency of the equipment.

The present time is the witness that, in the part of ore enreachment and smelting production, company RTB Bor uses technologies that have been abandoned all over the world, thus this company suffers hard times: without any viability, old and exhausted as a century man waiting for the last day.

5. CONCLUSIONS

At the time when reverberatory Cu smelting technology was on its maximum and generated a profit of US $ 200 106/ann., RTB Bor company was among the leading copper producers in the world - within the period 1970-1990.

When this technology ended it life cycle, and started to be driven out from the production streams, due to the fact that RTB Bor Management board did not change technologies, resulted that life cycle of the whole company was bounded for the life cycle of the company's key technology [19,20].

By obsolation of the key technology causes the succesive decain of the company, since the company kept the same position within the development strategy (there were no any diversification, but always emphasised that the mission of the company was refined copper production). This was a great illusion and a horrible error of the company management board [20].

Is there any chance for RTB Bor Co. at the present condition?

Considering verified Cu ore reserves within RTB Bor, it is quite a certain that an opportunity strongly exist, however the company except this and qualified human resources, unfortunatelly does not have ample financial resources that according to WB ammount app. US $ 750 106 and a period required for the total revitalization is 5 years long. Among the other items, introduction of modern technologies should be forced to the key positions. Only the strategic partner that is in capacity to invest US $ 750 106 will be able to revitalize RTB Bor company and bring it from the state of coma to the state of a modern company for what there are certainly existing potentials.

Acknowledgement

The authors are grateful to Mr Miroslav Piljušić for his assistance in prepartion of this paper.

References

1. E. Lichtenthaler, Journal of Engineering and Technology Management, 21 (2004) 331-348.
2. P. Tushman, M.L. Anderson, Research in Organizational Behavior, 14 (1992) 311-347.
3. R. Henderson, RAND Journal of Economics, 24 (2) (1993) 248-270.
4. M. Iansiti, Management Science, 46 (2) (2000) 169-185.
5. D. Sahal, Research Policy, 14 (1985) 61-82.
6. R. Henderson, K.B. Klark, Administrative Science Quarterly, 35 (1994) 9-30.
7. C.J. Lambe, R.E. Spekman, Journal of Product Innovation Management, 14 (2) (1997) 102-116.
8. B. Kim, Technovation, 23 (2003) 371-381.
9. J. Damijan, M. Knell, B. Majcen, M. Rojec, Economic Systems 27 (2003) 189-204.
10. R.U.Ayres, Structural Change and Economic Dynamic, 8 (1997) 413-426.
11. J.M. Utterback, Mastering the dynamics of innovation, Harvard Business School Press, 1994.
12. D. Sahal, Patterns of Technological Innovation, Addison-Wesley Publ.Comp., Reading, MA, 1981.
13. E.M. Rogers, Diffusion of innovations, The Free Press, New York, 1995.
14. G.A.Moore Crossing the Chasm, HarperBusiness, New York, 1991.
15. R.U. Ayres, L.W. Ayres, I.Råde, The life cycle

of copper, its co-products and by-products, Mining, Minerals and Sustainable Development (No 24), 2002, IIED&WBCSD.

16. N. Cvetanović, Copper in the world, IP Nauka, Beograd, 2005. (in Serbian)

17. H.D. Bruch et al., LC of copper production and processing, Düsseldorf, 1995.

18. International Copper Study Group, ICSG Copper Bulletin, 4(1)(1997).

19. T.E.Norgate, W.J.Rankin, Minprex 2000 - International Conference on Minerals Processing and Extractive Metallurgy (2000), Proceedings, pp133-138.

20. S.R.Robbinson, M. Coulter, Management, Person Education, New Jersey, 2005.