

Problems Associated with Investment in Advanced Manufacturing Technology from the Management Point of View

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Abstract: - Utilization of advanced manufacturing technology is considered as one of the key factors that help manufacturing companies worldwide to reduce the cost of manufacturing, improve the quality of their products, increase the throughput as well as production flexibility and altogether it should help them to maintain or even enhance their competitiveness on global markets. Moreover, manufacturing companies in economically developed countries cannot rely on cheap labor force and massive investments into advanced manufacturing technology seem to be inevitable necessity for them. On the other hand, these companies are under constant economic pressure and their managers are pushed to economize and cut cost whenever possible. Taking into account that investment into advanced technology is as a rule rather expensive, long-term nature and associated with a higher degree of risk especially if the particular company lacks experience with the particular type of technology, it is clear that the relevant decision making processes are not easy and straightforward ones. We will describe here some problems associated with investment into advanced manufacturing technology from the management point of view. We will demonstrate that managers show rather reserved attitude towards relevant projects and admit many difficulties when deciding about investment into particular advance manufacturing projects in their companies. We will support our views by selected results of two surveys that we did in the Czech Republic and we will compare our findings with outcomes of the similar surveys in other countries too.

Key-Words: - advanced manufacturing technology, management attitudes, short-termism, survey results

1 Introduction

It is widely accepted that manufacturing companies in economically developed countries tend to use advanced manufacturing technology (AMT). They cannot rely on cheap labor force and such technology should help them to reduce the cost of manufacturing, improve the quality of their products, increase the throughput as well as production flexibility etc. Altogether, it should help them to maintain or even enhance their competitiveness on global markets. As we stated above, these ascertainties are reckoned to be truth but is it really like this? Do managers of manufacturing companies in economically developed countries welcome advanced manufacturing technology projects and are they eager to promote the respective investment decisions? Or are there some difficulties that technology promoters must face to in order to see the technology deployed? We are afraid that the latter statement is quite common and we will provide some pieces of evidence of this ascertainment in the paper.

First of all, we will briefly review some earlier studies in this field that indicated that there are some clear obstacles and difficulties when studying the

management behavior concerning the advanced manufacturing investment decisions. Secondly, we will enrich it by the selected outcomes of two surveys that were conducted in the Czech Republic. We will compare our results with the findings derived from similar surveys that were done in other industrially developed countries too. And finally, we will make an attempt to explain the motives of managers for such behavior and we will try to suggest some possible ways to change their attitudes towards investment into AMT too.

2 Previous Work

We proudly acknowledge that the biggest motivation to start our own investigations in the field of AMT came from the work of Lefley and Wharton [1], Lefley [2], and Lefley and Sarkis [3]. These authors examined carefully the investment appraisal processes in the United Kingdom and the United States of America. They undertook extensive surveys both in the UK and the USA in order to learn more about current practices in respect of capital investment in AMT projects, to identify if there were perceived difficulties in appraising

these projects and to elicit the opinions of senior executives on the various issues related to AMT projects evaluation. Among other things they found out that AMT projects were evaluated by the simplest financial criteria that seem to be unsuitable in this respect. Moreover, they realized that financial directors do have many difficulties when assessing various benefits of AMT projects, and finally, that investment into AMT could be easily influenced by business culture where managers are under pressure to produce short-term results.

The first study in this field in the Czech Republic [4] revealed that despite of many differences ascertained especially in the extent as well as the level of evaluated and implemented technology, where Czech manufacturing companies lagged behind their western competitors, there were many problems that were common for managers from all the three surveyed countries. These results even fostered our interest to conduct the second survey in the Czech Republic in 2005 in order to identify the relevant changes in the results that were expected due to the quickly transforming Czech economy and its openness.

Before we will describe the survey methodology and selected results that reveal some serious difficulties of AMT investments from the management point of view, it could be worthwhile to mention here some other interesting publications in this field from the last decade.

Abdel-Kader and Dugdale [5] wrote an interesting paper reporting the results of a survey investigation into the investment decision making practices of large UK companies and their study focused especially on investments in AMT. On the other hand Ariss, Raghunathan and Kunnathar [6] published their findings concerned factors affecting the adoption of AMT in small manufacturing firms in the United States.

Chan et al [7] concisely reviewed various approaches used in the process of investment appraisal of AMT and concluded that improved approach that would integrate the currently used evaluation approaches was needed. Hofmann and Orr [8] presented the results of their postal survey that was conducted amongst German manufactures and one part of their questionnaire was devoted to the assessment of AMT proposal too. Finally, we have decided to put forward the paper written by Small [9] that summarizes the results of investigation on the justification of investments in AMT at US manufacturing plants.

3 Survey Methodology

To keep in line with the earlier UK and US surveys which were used as a basis for comparison we have decided to employ the same questionnaire as Lefley and Wharton [1] utilized earlier for their investigations. We

translated their original English questionnaire into Czech language and verified its localization by means of a pilot survey.

The original questionnaire comprised of three sections. Questions in the first part were intended to establish the level of implementation of AMT that had been achieved to date. Three levels of AMT were identified which correspond to the levels of sophistication proposed by [10] and [11]. Level 1 systems cover stand-alone projects e.g. robots, NC machines, CAD etc. Level 2 systems are linked systems e.g. linking together of a number of CNC machines, CAD/CAM etc., and Level 3 systems are fully integrated systems including computer integrated manufacturing (CIM) and flexible manufacturing systems (FMS).

In part number two of the survey the respondents were asked which techniques and criteria were used in capital project appraisal and what methods, if any, were used to measure and take into account project risk. Information was obtained about the measures used to assess the performance of senior executives as it appears that management in general is reluctant to make long-term risky investments (such as those in AMT) and prefers to invest in short-term projects that show early profits and low risk [2].

The third part of the survey was designed to explore opinions about the need for AMT investment, the efficacy of the investment criteria used and the extent to which other factors and considerations had a bearing on capital investment decisions.

We added one more additional section to the questionnaire that was used in the Czech Republic in 2005. It was devoted to the utilization of EVA (economic value added) indicator in our companies as there were some suggestions that there might be a relationship between utilization of this concept and investment behavior of manufacturing companies.

To assure a straightforward comparison of collected data in different countries we carefully followed the methodology used by our predecessors. The survey was aimed at those companies who, it was believed, would have had some experience in the appraisal of AMT projects and that the person who was asked to complete the questionnaire should have had a significant contribution to make in final investment decision. A number of databases were reviewed (with the main stress on data acquired from EDB and Czech business register) to identify the largest manufacturing companies. As we wanted to restrict the survey to 'large' Czech manufacturing organizations, we finally chose sample size of 416 firms in 1999. Within our last survey we have decided to include also the middle sized Czech manufacturing firms and so we have increased the sample to 1030 in 2005.

Our first postal survey started at the end of 1998 and of the 416 questionnaires sent out 92 was returned giving a response rate of 22.12%. A usable sample of 79 completed questionnaires with a response rate of 19.0% was considered to be reasonable under the existing circumstances.

The second postal survey has been conducted from January till April 2005 and 1030 questionnaires were sent out and 135 have returned, 3 of them were unusable. We can see that the rate of response is 12.8% only which is significantly lower rate than the one we achieved in 1999. The reason that we did not reach comparable numbers with our former survey could be explained by the fact that in our current survey the middle sized firms were addressed too.

This article deals with the selected results corresponding to the third part of our questionnaire only and due to limited space we cannot dwell on the other issues here. Readers who are interested in further details are advised to look at [12] or [13].

4 Management Attitudes towards AMT Projects

First of all it might be interesting to verify and confirm the generally accepted opinion that companies are truly interested in advanced manufacturing technology for the reasons that were outlined within the introduction of this paper. Do managers really think about investment into AMT as one of their top strategic priorities?

In order to learn more about the management attitudes towards this issue the respondents were asked to indicate based on their own experience and judgment, whether or not they agreed with the statement that non-investment in AMT was a high risk strategy. Responses to this statement were summarized in table number 1 and we can see there that surprisingly many executives in the Czech Republic (66.7% in 1999 and 69.3 in 2005) agreed that non-investment in AMT is a high-risk strategy.

Table 1. Non-investment in AMT is a high-risk strategy

Non-investment in AMT is a high-risk strategy	Agree [%]	Disagree [%]
CZ 1999	66.7	33.3
CZ 2005	69.3	30.7

Comparing these numbers with the results of Lefley and Sarkis [3] who reported more than the decade ago than in the UK it was 74.8% and in the US 81.9%, it is clear that significantly higher proportion of Czech

managers do not consider AMT as strategically important investment. As we have concluded in [14] it is likely that many of them have apparently decided to rely on relatively cheap labor force but we are afraid that it is a rather shortsighted strategy in today's mutually interlinked and quickly changing global world.

The second important issue concerns the AMT projects evaluation and assessment methods. We have described the problems of AMT projects economic justification in great detail in [15] and hence we will just repeat our main conclusions here. We have shown that AMT projects could be easily knowingly as well as unknowingly disadvantaged because of unsuitable selection criteria utilization. Based on our results and comparison with the findings of former surveys carried out in the United Kingdom and the United States of America it is clear that managers exploit rather unsuitable financial criteria and too much importance is given to the simplest methods such as payback period that clearly prioritize short-term outcomes and thus short-term projects. Therefore we have underlined the fact that economic justification of investment into advanced manufacturing technology is one of the three commonly used approaches and that is why its importance should not be overestimated. We have advocated that if the economic approach is used, the strategic and analytical implications should also be taken into account and utilized in combination with it for a better understanding of the impact of the project.

It sounds rationally, but as we have seen above that a quite considerable part of managers worldwide does not recognize the strategic importance of AMT what kind of results could we expect as an output of the strategic considerations of AMT? And here we can raise once again the question whether managers of manufacturing companies in economically developed countries actually welcome AMT projects and if they are motivated enough to promote the relevant investment decisions?

The results of our predecessors [1] clearly shown that there were some serious concerns over short-termism of British and American managers. It has been observed that too high emphasis on short term profits seems to be an important part of Anglo-American business culture where managers are under both external and internal pressures to deliver short-term results [3]. While the majority of authors put the blame on the pressure from stock markets there is also another explanation based on assumption that undervaluing the long term investments arises from managers themselves.

Laverty [16] goes even further as he discriminates between managerial myopia as a characteristic of a decision that over-values short-term rewards and is caused either by faulty decisions by managers or stock market pressures on the one hand, and short-termism as a systematic characteristic of an organization that

overvalues short-term profits and undervalues long-term consequences on the other one.

Whichever situation applies to a particular manager or a company, it is clear that it affects investment into AMT seriously. AMT projects as a rule tend to be rather expensive and are expected to pay-off over the long term. For the relevant manager the cost of that project occurs almost immediately and is easy to be calculated while its benefits are rather unsure, quite often difficult to express in financial terms, and these benefits will be realized over several years. Long-term decisions are always less predictable, more risky, and furthermore, management posts are almost never life tenures. Therefore it seems to be quite natural to produce some successful achievement within limited time, maximize short-term profits, and we cannot wonder that from the management point of view such a short-term behavior might be quite rational.

We have already indicated that Lefley and Sarkis [3] showed considerable support for the evidence of short-termism in British and US manufacturing industry. Based on their findings 62.5% of the US respondents and 53.5% of UK respondents agreed that there was a natural tendency to promote projects which give short term results in the interests of their own career. We used the same statement within our surveys organized in the Czech Republic and the results are summarized in table number 2.

Table 2. Management attitudes towards projects delivering results in short term

There is a natural tendency for managers to promote projects which give short term results in the interests of their own career development	Agree [%]	Disagree [%]
CZ 1999	62.1	37.9
CZ 2005	59.1	40.9

Surprisingly enough, we can clearly see that the Czech respondents admitted as high degree of short-termism as it was observed earlier in the US survey. Despite the reasons for their behavior could be very likely attributed to the transformation of the Czech economy rather than the stock market pressures, the implications for AMT projects are obvious. Furthermore, it should be noted that the small decline between 1999 and 2005 is insignificant and the short-termist approach seems to be well anchored in Czech manufacturing companies.

These concerns have been reinforced by the level of agreement with another statement that was put forward

within the questionnaire. Respondents were asked to indicate their level of agreement with the statement that as managers stay in one job for a short period of time it influences them to favor short-term projects and the results are shown at table number 3.

We can see there that every other respondent has agreed that short duration of managerial contacts influences them to favor short-term projects. It was interesting to realize that once again this short-term orientation feature has been more strongly accepted by Czech managers than by their western counterparts (Lefley and Sarkis [3] reported that 53.3% of the US and 49.3% of UK managers agreed).

Table 3. Management emphasis on delivering results in short term

As some managers only stay in one job for a short period of time (up to four years) this influences them to favor short-term projects	Agree [%]	Disagree [%]
CZ 1999	58.6	41.4
CZ 2005	57.1	42.9

Taking into account the fact that the stock market system in the Czech Republic is rather underdeveloped there must be some other factors that motivate Czech managers to behave in the just described way. First of all, these factors will be adherent to the current state of transition of Czech economy where many companies and their managers have to solve many problems of short-term or mid-term nature instead of concentrating their focus on strategic goals. Secondly, we should learn more about the methods of management appraisal as well as various incentive schemes that definitely influence the willingness or unwillingness of managers to implement and exploit advanced manufacturing technology.

Table number 4 shows various measures used by Czech manufacturing companies to assess the performance of their senior executives. The most popular measure applied is clearly "weighted-factor approach", used by 51.4% of companies in 1999 and 46.8% in 2005, while "sales growth" came closely second with 51.4% in 1999 and 45.2% in 2005. It is impossible to decode "weighted-factor approach" unambiguously in order to be able to claim that utilization of this particular measure contributes to long-term strategic orientation. Moreover, it should be stressed that number of Czech companies claiming that they use this method is much higher than numbers reported by Lefley and Sarkis [3] who found out that 12.7% of US and only 2.8% of UK companies

did so. On the other hand, “sales growth” as a measure of managerial performance is in general considered as one of the measures supporting orientation on long-term goals. The increasing number of companies utilizing “long-term strategic goals” is encouraging too.

However, rather high percentage of companies that use various options of “annual profit” or “cash flow” measures in order to assess the performance of their senior executives is rather disquieting because these measures are generally accepted as short-term measures. And finally, there is the clear evidence in table number 4 that Czech stock market system is still underdeveloped as only negligible number of companies use “earnings per share” as criterion for the senior executives performance evaluation.

Table 4. Measures used in Czech manufacturing to assess the performance of senior executives

Number of companies using:	1999 [%]	2005 [%]
Annual gross profit	37.5	42.1
Annual net profit before tax	27.8	30.2
Annual net profit after tax	20.8	19.8
Earnings per share	0.0	3.2
Return on investment	6.9	17.5
Sales growth	51.4	45.2
Cash flow	27.8	35.7
Weighted-factor approach	52.8	46.8
Level of strategic investment	0.0	0.0
Long-term strategic goals	20.8	34.9

We are fully aware of the limitations of the above presented attempt to analyze the performance measures and incentives and much more research effort would be needed in order to get a stronger ground for deriving further ascertainments. However, we believe that there are significant relations between specific management appraisal system and the willingness of managers to undertake long-term investment decisions and that is why we have decided to present it here.

5 AMT Projects Assessment Difficulties

Having demonstrated that managers in the above mentioned countries seems to be quite openly short-term oriented and that Czech managers on the top of it do not consider AMT as strategically important investment, it is

obvious that promoters of AMT have to face a significant problems because there are many opportunities for managers to influence the relevant decision making process.

First of all, it is extremely easy to reject any project when using a method that is inappropriate for that project. Being more specific, it is obvious and natural that AMT projects tend to be long-term and rather expensive projects. As we described in [14] too many managers employ the payback period as the criterion to decide whether to finance their AMT project or not and some of them utilize it as the only criterion. The chance of getting financed for such project is very easy to predict then because the payback criterion indisputably prefers short term projects. Indeed, many argue that the use of the payback method virtually guarantees the rejection of projects such as AMT, which involve the introduction of capital intensive technologies that tend to be rather slow to generating positive net cash flows [4].

The second important problem is that many AMT projects could be easily disapproved just because the lack of understanding on what the contribution of new technology really is. We have already described in [17] and [18] that majority of Czech, British, as well as American managers admitted that it is difficult to assess all potential benefits of AMT investments. We can see from table number 5 that more than sixty percent of Czech managers agreed with the statement, that AMT investments are difficult to assess because they have non-quantifiable benefits. Lefley and Sarkis [3] reported that in the US it was 63.9% and the management support for this statement reached up to 81.6% in the UK.

Table 5. AMT investments are difficult to assess because they have non-quantifiable benefits

AMT investments are difficult to assess because they have non-quantifiable benefits	Agree [%]	Disagree [%]
CZ 1999	67.1	32.9
CZ 2005	60.3	39.7

Moreover, four out of five managers in all three countries agreed with the statement that not all potential benefits of AMT are taken into account because they are difficult to quantify in financial terms. We can see the results concerning the surveys conducted in the Czech Republic in table number 6 and from [3] we can learn that the support for this statement was as high as 81.2% in the US and 80.9% in the UK.

The meaningful reason for this unsatisfactory and unfavorable state of the art is that the respective

managers are unable to foresee, measure and to assess the impact as well as magnitude of non-quantifiable benefits for company as a whole.

According to [19] people advocating investment in AMT have made considerable efforts to identify the company-wide benefits which it can produce. The problem is that they describe these benefits always in general terms, such as the following: increased flexibility of production, better-quality products, improved documentation, ability to respond to market needs, need to keep up with competition, improved company image, better management control, obtaining experience of new technology, etc. Managers usually start with the belief that a particular aspect of AMT could be used in their department and they would select an application which was aimed at improving operating efficiency. Having defined the required specification, they try to justify the expenditure afterwards. And now it is necessary to identify the benefits. The nature of intangible benefits is such that they do not have to appear in the department where the investment is made, but occur elsewhere in the company. In addition, the relationship between cause and effect is indirect, so that their magnitude has to be estimated rather than directly calculated. In fact there are two distinct problems and these must be dealt with separately. First of all the form in which the benefit is quantified, and secondly estimating the magnitude of the benefit (see [19] for further details).

Table 6. Not all potential benefits of AMT are taken into account because they are difficult to quantify in financial terms

Not all potential benefits of AMT are taken into account because they are difficult to quantify in financial terms	Agree [%]	Disagree [%]
CZ 1999	90.1	9.9
CZ 2005	81.7	18.3

It is perhaps the right place to repeat once again that our respondents were financial directors and decision makers of surveyed manufacturing companies. Having proved that managers of manufacturing companies clearly admit difficulties associated with the investment appraisal of advanced manufacturing technology projects we can conclude that the situation is very serious and some measures should be taken in order to make sure that AMT project proposals have a fair chance to get through the justification process and to get the pertinent investment approval. Of course, it is not our aim to drag all managers through mud or to malign them, but the

facts presented here suggest that there are some obvious obstacles to wider deployment of AMT.

We can support our view further by the ascertainment that more than four out of five companies overall in all three countries referred back for re-appraisal those AMT projects that had failed the initial financial appraisal which demonstrates the difficulty of the relevant decision making processes. The results concerning the situation in the Czech Republic are summarized at table number 7.

Table 7. Percentage of AMT project proposals re-evaluated

If a project looks as though it may not meet the financial criteria/hurdle rate set by your organization is it re-evaluated?	Agree [%]	Disagree [%]
CZ 1999	89.2	10.8
CZ 2005	81.5	18.5

Naturally, the introduction of a referral process into the investment justification procedure creates further opportunity for managers to examine the whole proposal carefully once again, to take into account strategic considerations, re-assess and quantify potential benefits or even adjust financial criteria that has to be fulfilled (for example, by increase of required payback period, or by lowering the pertinent discount rates). On the other hand, it is the very same moment when exactly opposite measures and actions could be taken and there is a large space in which the accept/reject decision could be manipulated. It could be anticipated that in these cases the formal appraisal procedure transforms itself into a ritual where the final decision is based on other influences, which might be of a political, rather than an economic nature. In this context we should put and understand the interesting ascertainment that more than eight out of ten respondents confirmed the referral procedure.

6 Further Concerns and Implications

We have mentioned above that there might be some space for political influence in the referral procedure and in the projects evaluation process in general. Therefore, it is natural to ask to which extent senior executives use their dominant role based on their formal as well as informal authority in order to affect the relevant decisions related to AMT investment in both directions. That is the reason why the respondents were asked to express their level of agreement with the statement that

more importance is attached to the experienced judgment of senior management than to financial indicators.

The results are shown in table 8 and we can see that slightly over fifty percent of Czech respondents agreed with the statement in 1999 (51.9%) and their number somewhat declined in 2005 (down to 45.7%). Nevertheless, it should be stressed that the number of managers who agreed with the statement is relatively high overall and it is clear the concerns expressed by some researchers as well as practitioners should be taken seriously.

While the excessive influence of senior management that prioritizes too much their experienced judgment over financial indicators could be counter-productive, the directly opposite situation when too much importance is given to financial criteria is unsound too. Such a policy would mean that there is no space for strategic considerations and that the relevant decisions would be made on the base of economic point of view only. Hence some researchers as well as practitioners advocate for exploitation of non-financial criteria and rather strategically oriented criteria believing that there is too much importance attached to conventional techniques.

Table 8. More importance is attached to the experienced judgment of senior management than to financial indicators

More importance is attached to the experienced judgment of senior management than to financial indicators	Agree [%]	Disagree [%]
CZ 1999	51.9	48.1
CZ 2005	45.7	54.3

In order to learn more about this issue we have asked the respondents to express, based on their own experience and judgment, whether or not they agreed with the statement that, "too much importance is attached to conventional techniques". Their responses are presented in table 9.

We can see that Czech managers do not feel like having a serious problem with conventional appraisal techniques utilization and their views are perfectly conformable with the opinions of British and US managers where according to Lefley and Sarkis [3] slightly less than five out of ten managers agreed with the above presented statement that too much importance is attached to the use of conventional appraisal techniques (42.8% of respondents in the UK and 48.7%

of respondents in the US agreed with the above presented statement).

We have already discussed above that it is easy to reject any project when using a method that is inappropriate for that project. Conventional financial appraisal methods are sometimes considered as methods that favor short-term projects and therefore these methods could be regarded as unsuitable for AMT project proposal evaluation. To tell the truth, it should be stressed that conventional financial appraisal methods do not automatically favor short-term projects providing that these techniques are used wisely. Of course, we can easily imagine the situation when short payback periods or unjustifiably high discount/hurdle rates are set up and then naturally a short-term bias can occur. However, it is clear that the problem is not inherently linked up with the method itself, but it is caused by its inappropriate utilization.

Table 9. Too much importance is attached to conventional techniques

Too much importance is attached to conventional techniques	Agree [%]	Disagree [%]
CZ 1999	51.4	48.6
CZ 2005	44.4	55.6

Nevertheless, the above discussed inability of so many AMT projects to meet financial criteria could indicate that these criteria/hurdle rates are simply set up to high and there might be miscellaneous reasons for doing so. Regardless of the particular reasons that contribute to such a decision it is obvious that too high discount/hurdle rates could constitute a very difficult barrier for many AMT projects and therefore we wanted to find out if there is a tendency to set up some tight hurdle rates for AMT projects justification in companies. The respondents were asked to express their level of agreement with the relevant statement and their responses are summarized in table number 10.

We can see that nearly every second manager agreed with the statement and admitted that there is a tendency to set up very tight hurdle rates which could indicate rather disadvantageous starting position for AMT projects. High hurdle rates in combination with the above mentioned traditional appraisal methods could easily result in the AMT project rejection. On the other hand we have to say that in many cases the high hurdle rates are used by managers in order to make appropriate adjustment for a higher degree of risk and uncertainty that relates to AMT projects and it is rather typical approach taken by many companies worldwide when

evaluating more risky investment project. Hence such behavior should not be automatically perceived as deliberate intention to discriminate against AMT projects especially when the particular company lacks experience with the project proposal that is under consideration.

Table 10. There is a tendency to set too high hurdle rates for AMT projects

There is a tendency to set too high a hurdle rate for AMT projects	Agree [%]	Disagree [%]
CZ 1999	48.0	52.0
CZ 2005	48.8	51.2

And finally, there has been observed a clear trend in all three countries indicating that at the beginning many projects were assessed on a higher technological level (for example, as a fully integrated system) but then a less sophisticated system has been deployed (for example, linked systems or even standalone machines) [20].

This phenomenon might be closely related to the widespread re-evaluation of AMT project proposals and we can easily imagine the situation when the project with more sophisticated technology does not meet the financial criteria and that is why it is necessary to reduce its initial cost by narrowing its scope as well as the level of technology being proposed. Such a compromise decision could help the technology sponsors to push the project through the approval procedure and at the same time it could help managers to keep the cost of the project as well as the risk associated with new technology within reasonable margins [15]. However, it is hard to say whether the relevant change is the best one from the strategic point of view because the restricted project is likely to be unable to bring up all the originally promised benefits (for example, some of them might be clearly related to the achieved degree of technology integration). Consequently the narrowed quantity as well as extent of benefits could easily decrease the level of satisfaction with the project as a whole and we can go on and on in circles.

7 Further research

There are several issues outlined in this paper that need to be examined in much greater detail and we would like to recapitulate them here.

First of all, our current research activities are focused directly on continuing research in the field of evaluation of AMT benefits. We have demonstrated that there are

many problems in this field. Managers of manufacturing companies openly admit that they are unable to identify various benefits of AMT and furthermore, they are unable to quantify them in financial terms. That is why we concentrate our effort on finding suitable ways and designing procedures of systematic identification of multiplex AMT benefits.

We believe that based on the analysis of particular types of advanced technology benefits for a company it could be possible to identify some general groups of benefits that will possess the specific attributes. Hereafter it could be anticipated that for each group of benefits there will be different possibilities and methods of their evaluation as well as different techniques allowing to assess their importance and their magnitude from the company point of view. Moreover, AMT are often implemented in specific clusters (several types of technology that supports and complements each other) and that these clusters bring up synergic effects from the point of view of the types of these benefits as well as their magnitude and that is why it is useful to find out what composition of possible clusters of AMT will prove to be efficient from the perspective of increasing productivity and competitiveness of a company.

Some authors also ascertained that there is quite often a substantial difference between benefits expected and benefits realized when the project was actually implemented. Sohal [21] prepared a pair of questions designed to examine the extent to which respondents' views of the benefits of investing in AMT has changed as a result of the project implementation. The survey was carried out in Australia and the UK and respondents scored the importance of a list of benefits as perceived at the time of the appraisal investment and then the extent to which these benefits were seen to have been achieved after the new technology has been deployed. Based on his findings we would like to verify whether similar differences between the benefits expected on one hand and benefits observed and virtually recognized on the other hand will be discovered in our country too.

The novelty of our current research compared with the previous investigations lies in the fact that the new subject of our research is not limited from the point of view of technology choice just to manufacturing technology, i.e. hard technology (technology as a means of transformation of inputs into outputs-production). That is why a much broader spectrum of advanced technology including soft technology will be covered this time. The soft technology is rather a supportive tool and method and therefore this technology itself does not make the contents of value creating activities directly but the soft technology assists these activities vicariously preparing the conditions for the most effective operation of hard technology. Statistical quality/process control (SQC/ SPC), just-in-time manufacturing (JIT), materials

requirements planning (MRP I), manufacturing resource planning (MRP II), and other similar technologies are classified as examples of soft technology. The ranking advanced technology as advanced manufacturing management technologies (AMMT) and as advanced manufacturing hard technologies (AMHT) that can be found in [22] is very near to the foregoing technology classification. From the nomenclature it is clear that soft technology belong to AMMT and hard technology to AMHT.

Finally, we have briefly discussed management attitudes towards AMT in the fourth part of this article and we have expressed our concerns related to short-termist behavior that seems to play important role not only in Anglo-American business culture but seems to be very relevant and present in Czech companies too. We have sketched some presumable motives for this kind of behavior but it is clear that more substantial research in this area is needed. In particular, we would like to examine the impact of various management appraisal and incentive schemes nature to the interest of managers in adoption and utilization of AMT and their attitudes towards advanced technology in general.

8 Conclusions

We have shown that despite of widely understood benefits of AMT managers of manufacturing companies in economically developed countries are not as much in favor of these systems as one could expect.

We have provided some pieces of evidence that managers show rather reserved attitude and admit many difficulties when deciding about investment into a particular advanced manufacturing technology project in their companies. Their attitudes are influenced by short-termism and we have seen that this feature is widespread not only in the US but also amongst Czech managers despite the explanation for this phenomenon is likely to be different in both cases and we explained the motives of managers for such behavior. We have pointed out that short-termist behavior of managers could be motivated to some extent by the inappropriate choice of senior executive performance appraisal and incentives system that could further strengthened their orientation on delivering short-term results. The chances for wider AMT adoption in the Czech Republic are also lowered by the fact that strategic importance of AMT is not perceived seriously enough and we have demonstrated that large proportion of managers does not support the view that non-investment into AMT is a risky strategy.

We have recalled our earlier results showing that there are many ways in which the AMT project could be knowingly as well as unknowingly disadvantaged. There are some obvious difficulties in the process of various

AMT benefits identification, evaluation and quantification in financial terms. While some authors blame conventional appraisal techniques like, for example, payback or return on investment, and label them as inappropriate methods for AMT projects assessment, we would like to stress that it is not the method but its improper utilization that causes the bias towards short-term goals and results. We have discussed three "extreme" approaches that might be harmful from the investment into AMT point of view no matter if it is a tendency to set up too high hurdle rates for AMT projects, or too much importance attached to conventional techniques or if there is a tendency to overvalue the experienced judgment of senior management.

We are fully aware of the limitations of our research and we have already described above several areas where further research is needed. Nonetheless, we believe that based on the results presented within this paper, there are some problems that should be tackled. Of course, there are no simple answers to complex questions and we cannot expect that problems that are sometimes deeply rooted in company culture could be solved overnight.

We can see three main approaches that should complement each other [20]. First of all, the owners and shareholders should exercise their rights and make managers pay much higher attention to the long term goals. In order to achieve it, the management performance criteria should be reconsidered and changed accordingly. Secondly, there is a great opportunity for technology specialist to play much more important role in the process. Their awareness of various benefits associated with the particular type of AMT should help them to describe these benefits in terms that will be comprehensible enough for financial experts who will be able to express them in financial terms and thus improving the chance of the project to get through. And finally, technology specialist should be well prepared for this role too. It means that we have to teach them to think about technology not only from the strict technological point of view. Their education must enable them to view the technology from some distance, from the point of view of its potential users, being able to take into account the various potential benefits for the company as a whole. It is without any doubt that they should be much stronger advocates of their projects to be able to push them forward.

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