Problems Associated with Initial Stages of Advanced Manufacturing Technology Projects

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Abstract: - Utilization of advanced manufacturing technology is considered as one of the crucial factors that help companies worldwide to maintain or even increase their competitiveness on global markets. However, deployment of complex and sophisticated advanced manufacturing systems is not an easy process and there are many pitfalls to be avoided in order to derive maximum benefits of the particular technology. This paper focuses on selected problems that are likely to occur in very early stages of the advanced manufacturing technology project preparation and these problems are connected with management attitudes towards these projects in general as well as their poor understanding of what kind of benefits and to which extent should be expected. We will support our views by the results of several surveys and we will demonstrate that the process of advanced manufacturing technology adoption could face serious problems at the very beginning.

Key-Words: - advanced manufacturing technology; problems of advanced manufacturing technology adoption; management attitudes; survey results

1 Introduction
It is a matter of fact that manufacturing companies worldwide make a great effort to maintain or even increase their competitiveness on demanding global markets. They strive to reduce the cost of manufacturing, improve the quality of their products, reduce work in progress and increase the throughput as well as production flexibility and they continually look for new ways on how to achieve it. And of course, it is obvious that manufacturing companies in economically developed countries cannot rely on cheap labor force and therefore massive and effective utilization of advanced manufacturing systems (ranging from isolated systems like CAD, CAM, robots etc. up to the fully integrated systems like CIM or FMS) is regarded as one of the crucial factors that help to achieve the above mentioned goals.

On the other hand, there are many problems associated with the advanced manufacturing technology (AMT) utilization. There is a whole range of problems - starting from the early stages of AMT projects preparation and evaluation, through various problems related to the actual project implementation, its integration within the whole company environment, up to the issues related to the efficient utilization of the already deployed system as well as the methods used to determine whether the system meets the originally planned objectives. It is impossible to discuss to the whole spectrum of the just mentioned problems within this paper and that is why we have decided to narrow our focus to the specific issues connected to the management attitudes towards AMT and the management expectations concerning AMT projects realization.

Although it is apparent that most of managers are well aware of the importance of AMT for the company and its competitiveness in general, it is an unquestionable truth that manufacturing companies are under constant economic pressures and their managers are pushed to economize and cut costs whenever possible. Taking into account that investment into AMT is as a rule rather expensive, long-term nature and associated with a higher degree of risk, it is clear that the relevant decision making processes are very difficult [1]. To make the situation even more complicated, there are some indications that many managers incline to follow their own career development paths and then it is clear that the strategic decisions and goals do not match with the length of their contracts. And on the top of it, criteria used to the top management performance evaluation in manufacturing companies very often further enhance their short-term behavior.

The aim of this paper is to demonstrate here that Czech managers show rather reserved attitudes...
towards AMT projects. And secondly, we will show that there are important differences between benefits expected at the time of project preparation and benefits realized at the time when the project has reached the stage of routine operation.

2 Previous Work
Our research has been inspired especially by the effort of Lefley and Wharton [2], Lefley [3], and Lefley and Sarkis [4]. 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 managers 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 comprehensive study in this field in the Czech Republic [5] 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 further two surveys in the Czech Republic in 2005 and 2009 focused on specific issues related to AMT projects evaluation and utilization in order to identify the relevant changes in the results that we expected due to the specific conditions of quickly transforming Czech economy and its openness.

Our second source of inspiration originated from several surveys that were carried out in the UK, New Zealand and in Australia [6, 7, and 8] in order to assess the anticipated differences between management expectations and real experience. Sohal [6] prepared a pair of questions designed to examine the extent to which respondents’ views of the benefits of investing in AMT has changed as the result of the project implementation. The 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.

The results of the research conducted in the UK and in Australia revealed that reduced cost, improved quality, increased throughput, increased flexibility and acquisition of competitive advantage were the top five expected benefits and that these benefits were placed within top six positions amongst benefits experienced after the relevant AMT project implementation [6]. On the other hand, there were many benefits whose ranking varied considerably. First of all, “enhanced company image” that was ranked sixteenth on the expectations list has moved to the very first position on the experience list. Similar perception change was registered at several other items as “improved workforce attitudes”, “widening product range” or “improved working environment” that were originally rather underestimated. On the contrary, a number of expected benefits as, for example, “reduced work in progress”, “better management control”, or “improved response to variations in production mix or in product volume” ranked noticeably lower after the AMT project implementation. We have discussed various reasons possibly explaining the differences between the expectations and experience list in [9 and 10]. We have speculated on the possibility that there could be some degree of coincidence between the relevant benefit measurability and the corresponding expectations-experience change. While the benefits that are difficult to evaluate and measure supposedly possess a tendency to improve their position in the experience column, the easily and straightforwardly measurable benefits tend to rank lower comparing with the original management expectations [1].

Some of the issues tackled here were already discussed in [9] too. Of course, this paper was based on the results of the survey carried out in 1999 and 2005 only and therefore we will return to them here again and enrich the already presented views and opinions by new pieces of information derived from our last survey.

3 Methodology
Our team carried out three major surveys focused on AMT utilization and exploitation in the Czech Republic within last two decades. Our first postal survey was realized in 1998 and we used the questionnaire that was derived from the original one that was used when the earlier AMT utilization surveys were carried on in the UK and the USA (see [2]). The goal of this survey was to find out the level of implementation of AMT that had been
achieved in the Czech manufacturing companies to date; to determine 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; to determine which measures were 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 [3]; and 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.

The second postal survey that was focused on the same issues was conducted in 2005 and we decided to include also the middle sized Czech manufacturing firms this time. Moreover, we added one additional section to the questionnaire that was used in the Czech Republic in 1998. It was devoted to the utilization of EVA (economic value added) indicator in surveyed companies as there were some suggestions that there might be a relationship between utilization of this concept and investment behavior of manufacturing companies. The results of the both surveys (1998 and 2005) concerning advanced manufacturing technology utilization in the Czech Republic were described in [5].

Our last survey in the Czech Republic was conducted at the end of 2008 and the beginning of 2009. This time a completely new questionnaire was designed and used. Of course, we have partially built upon our previous experience acquired during the former surveys, but as we already indicated above we wanted to enlarge the scope of our research focus too.

Due to the economic problems caused by the global financial crisis we have decided to further increase the set of respondents up to 1360 manufacturing companies. Unfortunately, many questionnaires returned back as undeliverable, some companies were closed down and several companies reported termination of their manufacturing activities, which restricted the original larger pool into 1127 virtual respondents. The questionnaires were send out in two rounds within a time span of six weeks and then we started a wide campaign based on individual attempts to get the results by means of individual e-mails and telephone calls. Altogether we have managed to collect 132 usable questionnaires out of 1127 respondents. The response rate 11.7% is slightly lower than in 2005 but taking into account the current economic circumstances it should be considered favorably.

The overall results of our research have been summarized in [11]. This article brings out selected results related to the topic of this paper only as we discussed it above.

4 Managers and AMT

We have already described at the beginning of this paper some reasons that should motivate the managers of manufacturing companies to invest into AMT. However, we have also mentioned that there are some issues and problems that could influence the relevant decisions and incur completely different attitudes. The question is whether managers are truly interested in AMT adoption and utilization. Do they really think about investment into AMT as one of their strategic priorities? Do they know what to expect and are their expectations realistic?

There were some indications that indispensable number of managers does not support the idea of strategic importance of AMT. For example, Lefley and Sarkis [4] reported that in the UK only 74.8% agreed with the statement that non-investment in AMT is a high risk strategy and in the US 81.9% managers supported this view. The responses to this statement recorded during our surveys in the Czech Republic are summarized in table number 1. We can see there that surprisingly many executives in the Czech Republic disagreed that non-investment in AMT is a high risk strategy. Comparing these numbers with the above mentioned results of Lefley and Sarkis [4] it is obvious that significantly higher proportion of Czech managers do not consider AMT as strategically important investment. As we have concluded in [12] 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.

Secondly, the results of our predecessors [2] 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 [4]. 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 [13] 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; and short-termism as a systematic characteristic of an organization that overvalues short-term profits and undervalues long-term consequences. 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 figure it out 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 and more risky, while management positions are almost never life tenures. Therefore it seems to be quite natural for them to produce some successful achievements within limited time, maximize short-term profits, and no one can wonder that from the management point of view such a short-term behavior might be reckoned as quite rational.

Our deep concerns have been further confirmed by the 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. The results show that every other respondent in the Czech Republic agreed that short duration of managerial contracts influences them to favor short-term projects. And this outcome is in conformity with earlier findings of Lefley and Sarkis [4]. Based on these ascertainments it is obvious that promoters of AMT have to face significant problems because there are many opportunities for managers to influence the relevant decision making processes.

<table>
<thead>
<tr>
<th>TABLE I. NON-INVESTMENT IN AMT IS A HIGH-RISK STRATEGY</th>
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<tr>
<td>Non-investment in AMT is a high-risk strategy</td>
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<td>CZ 1999</td>
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<td>CZ 2005</td>
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Lefley and Sarkis showed considerable support for the evidence of short-termism in British and US manufacturing industry [4]. Based on their findings 62.5% of the US 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.

It is evident that the Czech respondents admitted as high degree of short-termism as it was observed earlier in the previous surveys abroad. Despite the reasons for their behavior could be very likely attributed to the transformation of the Czech economy rather that the stock market pressures, we can conclude that the short-termism seems to be well present in the Czech manufacturing companies and the implications for AMT projects are obvious. Furthermore, we can see that the level of agreement has risen dramatically in 2009 and we think that this growth has been brought along with the global financial and economic crisis that hit severely many manufacturing companies and negatively influenced their investment decisions.

And thirdly, supposing that there is a sound interest to invest into AMT project, are the management expectations linked to the project outcomes realistic? We knew the results achieved by Sohal in the UK [6] and other countries as we described them above and so it was quite easy for us built on his experience. The original Sohal’s questions were translated into Czech language and we also followed carefully his layout (order of individual questions as well as the methods of their evaluation). It is interesting to mention that while the expectations were assessed by 5-point scale (higher score means higher importance perceived by the respondent), the attained experience was assessed by 3-point scale only. Nevertheless, in order to assure comparability of our results, we followed the Sohal’s work here too.

The returned questionnaires were processes using statistical software. Sohal [6] calculated the average score for each question and then the relevant benefits were ranked according their importance. That is why we did so likewise and our results are summarized in table 3. We can see there that the first four expected benefits (reduced cost, improved quality, increased throughput, and obtaining competitive advantage) preserved their position within top five benefits realized. The item “increased flexibility” improved its position from the seventh place up to the third one indicating that implementation of AMT facilitated much higher
degree of flexibility than managers originally expected. It should also be noted that the most desired benefit “reduced cost” has not been fully achieved as it scored on the fourth place amongst benefits realized.

Moreover, we can see that the significance of “increased sales” was clearly overestimated (it fell down from the fifth place to the eleventh) and the desired effect did not appear. We can observe the same trend at “improved integration of information systems across functions” (the eleventh place and then the fifteenth) and “improved integration of manufacturing information systems” (the seventeenth place and then the twenty-second). These findings could be interpreted in such a way that the expectations that new technology will bring alone a higher integration of information systems have not been fulfilled. And finally, it is obvious that the lowest descent has been associated with “improved workforce attitudes” which went down from the twelfth place to the twenty-first which means nine positions difference.

On the other hand, there are some interesting reverse changes of rankings too. It was already mentioned above that “increased flexibility” rose by four places but it is not the only underestimated benefit. It should be noted that “reduced product development time” went up by three positions (from the thirteenth to the tenth) but there are two very interesting benefits placed at the bottom of the table 1 that made even much bigger upswing. While “improved response in variations in product volume” went up from the twenty-first place to the twelfth, “widening product range” marked even higher leap as it jumped from the twenty-fourth position up to the thirteen (which means eleven position difference).

To make the just described differences more explicit we created table 4 where all the benefits where the difference between expectations and reality was three and more places are lined up. It is interesting to realize that there are 11 benefits (out of 26) where the difference of 3 and more points in ranking was found. Furthermore, there are 5 benefits (out of 26) in table 4 where the difference of 5 and more points in ranking was observed.

### TABLE IV. THE BIGGEST DIFFERENCES BETWEEN EXPECTATIONS AND EXPERIENCE RANKINGS (THREE AND MORE PLACES)

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Difference between Expectations and Experience Ranking</th>
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<tbody>
<tr>
<td>Improved workforce attitudes</td>
<td>-9</td>
</tr>
<tr>
<td>Increased sales</td>
<td>-6</td>
</tr>
<tr>
<td>Improved integration of manufacturing information systems</td>
<td>-4</td>
</tr>
<tr>
<td>Improved integration of information systems across functions</td>
<td>-5</td>
</tr>
<tr>
<td>Reduced cost</td>
<td>-3</td>
</tr>
<tr>
<td>Improved management attitudes</td>
<td>-3</td>
</tr>
<tr>
<td>Reduced product development time</td>
<td>3</td>
</tr>
<tr>
<td>Improved response to variations in product mix</td>
<td>3</td>
</tr>
<tr>
<td>Overcoming existing skill deficiencies</td>
<td>4</td>
</tr>
<tr>
<td>Widening product range</td>
<td>9</td>
</tr>
<tr>
<td>Overcoming PM skill deficiencies</td>
<td>11</td>
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5 Conclusions
We have narrowed our focus on selected problems arising in the early stages of AMT projects and we can see that these projects have to overcome many obstacles even at the very beginning. We have shown that despite of a widely spread opinion that AMT is one of crucial instruments helping the
manufacturing companies to increase their competitiveness, one third of managers of Czech manufacturing companies do not admit the strategic importance of AMT investment. Secondly, their short-term orientation clearly creates another important barrier for many AMT projects that are usually of long-term nature. And final problem discussed in this paper is very important too, because we can see that there are many differences between management expectations at the time of project preparation and real benefits derived after the particular technology reached the stage of routine operation.

Problems of strategic nature should be solved on a strategic level and we believe that the owners and shareholders should exercise their rights and power in order to “manage” the managers and to push them to do the right things for the company. First of all, it is necessary to formulate sound business strategy including the technology part of it. And secondly, the criteria used to the management performance evaluation must motivate the managers to follow the business strategy in general and compel them to pay much higher attention to the long term goals of the company. Proper reconsideration and sophisticated set-up of performance criteria is a crucial instrument that assures desirable behavior of managers and prevents short-term biases.

The problems related to the unrealistic expectations require a different approach. We believe that there is a great opportunity for technology specialist to play more important role here from very early stages of AMT project preparation. Their awareness of various benefits associated with the particular type of AMT should help them to identify the benefits and even assess their importance and magnitude. Prospective ability to describe the benefits in terms that are comprehensible for managers can significantly improve the chance of the AMT project to get approved. Here an important task for universities and other education institutions arises as technology specialist must be well prepared for this role too.

References:


