

# Problems of Advanced Manufacturing Technology Projects Approval

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*Abstract:* - This paper describes results of the recent survey targeted on utilization of advanced manufacturing technology in the Czech Republic. The results of the survey indicate that Czech manufacturing companies are still lagging behind their western competitors and the situation is changing slowly. On the other hand it is clear that comparing our results with the outcomes of similar surveys that were carried out earlier in the United States of America and the United Kingdom we can clearly see that there are many common problems that should be avoided in order to get the advanced manufacturing technology projects financed and implemented. These problems are described and discussed here together with some recommendations for specialists involved within the relevant decision making processes how to avoid them.

*Key-Words:* - advanced manufacturing technology, survey results, benefits identification

## 1 Introduction

The intense global competition in manufacturing forces manufacturers to increase their level of competitiveness in the global market. Therefore many manufacturing companies are pressurized to undergo a transformation processes in order to compete more effectively and under these circumstances advanced manufacturing technology (AMT) is considered to be necessary for their ability to succeed with their products on extremely competitive international markets. It is widely believed that AMT has a great potential to provide the respective companies by many tangible as well as intangible benefits [1]. Furthermore, utilization of a particular technology paves the road for adoption of another one and we can observe certain technology clusters where various types of AMT are mutually interlinked in order to derive maximum of benefits. On the other hand it is widely believed that the adoption of AMT requires a high level of initial investment and also the level of risk associated with the implementation of the AMT project is higher especially when companies do lack relevant experience. Moreover the payback period of such investments is usually longer than the payback period of rather traditional and usually less expensive technology.

The process of adoption and utilization of advanced manufacturing technology has been carefully examined in last two decades and numerous studies were published. We have co-operated with group of researcher that carried on two postal surveys concerned 'the state of art' of AMT projects in the UK and the USA ([2], [3]). Their work motivated our further research in this field and we were extremely interested in comparison with the

situation in the Czech Republic and we conducted the first survey in our country in 1999. We have validated our hypothesis that technological competitiveness of our country is not as good as it might be expected. Moreover, based on our research results we claimed that Czech companies were lagging behind their western competitors and there was still a long way towards massive adoption of advanced manufacturing technology. In order to identify the likely changes that happened in Czech manufacturing firms between 1999 and 2005 we decided to repeat the survey in the Czech Republic again in 2005.

Of course, we were interested not only in the levels of technology that were achieved in the relevant countries. We believe that it is important to study the respective processes when the crucial decisions about AMT projects implementations are made and to derive appropriate pieces of knowledge that might help technology specialists to get their projects financed and implemented. Based on our earlier papers [4] and [5] we believe that being empowered in advance by broader insight of what kind of difficulties to anticipate they might be able to prepare their AMT projects accordingly and to improve their chance to get the management approval for the project realization.

## 2 Methodology

We wanted to assure as much as possible compatibility amongst the original surveys carried on in the UK and the USA and the both surveys carried on in the Czech Republic. That is why we have translated the original

English questionnaire (see [6]) 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 [7] and [8]. 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.

From the point of view of this article the selected results corresponding to the first three parts of the questionnaire are the most important ones and we will focus on the outcomes that might inspire the technology specialists to change their attitudes towards project preparation and its presentation towards company management. The complete results of both surveys concerning advanced manufacturing technology utilization in the Czech Republic were comprehensively described in [9].

### 3 Survey Results

We have stated above that we will concentrate our effort on determination of common problems of AMT project approval but at the beginning it might be useful to present here some evidence that indicates fairly different view of technology state-of-the-art in the Czech Republic and the United States of America and the United Kingdom (the data describing the situation in the UK and the USA were obtained from ([3], [10] and [11])). However, we will see in the next section that despite the differences we will be able to discover several common problems and obstacles that negatively affect the relevant decision making processes in general and across investigated manufacturing companies in all three countries.

First of all, 95.8% of UK companies stated that they had evaluated AMT projects over the past ten years and 97.1% of UK companies stated that they expected to consider such projects within the next ten years. It is significant that, according to our results, only 82.3% in year 1999 and 78.3% in year 2005 of Czech manufacturing companies claimed they had evaluated AMT projects over the same time period. Furthermore, 84.8% of Czech manufacturing companies in year 1999 and 92.3% in year 2005 stated that they expect to consider such projects within the next ten years. We can see that there is a significant difference here despite the fact that the latter result might be considered as a positive signal evidencing the raising awareness of the importance of AMT projects amongst Czech managers.

Secondly, as we have described above we were interested in the level of manufacturing technology that was taken into consideration and consequently the level of technology that was implemented in companies. The respective results are summarized in the table number 1 and 2 below.

From the table number 1 and 2 it is clear that many projects that were originally planned on a higher level were unable to reach the stage of implementation and the restricted version of the project (on a less sophisticated level of technology) was carried out. There is an obvious positive tendency that we can see in the table number 1 as the percentage of Czech manufacturing companies that evaluated the higher level AMT project proposals have been increased in 2005. The same is true for the implementation stage but comparing these results internationally we have to admit significant differences in respect of stages reached by UK, US and Czech manufacturing companies in relation to the evaluation and implementation of AMT projects.

Table 1. Level of evaluation of AMT projects

% number of companies at:	CZ 1999 [%]	CZ 2005 [%]
Level 1 (stand alone projects)	57.0	40.4
Level 2 (linked systems)	35.4	41.3
Level 3 (fully integrated systems)	15.2	18.3

Table 2. Level of implementation of AMT projects

% number of companies at:	CZ 1999 [%]	CZ 2005 [%]
Level 1 (stand alone projects)	51.6	45.0
Level 2 (linked systems)	33.9	36.9
Level 3 (fully integrated systems)	14.5	18.0

For example, it is unmistakable that significantly greater number of UK (55.1%) and US companies (50.9%) had evaluated the most sophisticated projects (on the third level) while the Czech companies have in majority only the first and the second level experience (only 18.3% reached the third level technology evaluation experience). Taking into account the results shown in table number 2 it is evident that Czech manufacturing companies are lagging behind their British and American competitors in the adoption of advanced manufacturing technology. The contrast is especially visible when focusing on the most advanced fully integrated systems (only 18.0% of Czech firms implemented them comparing to the 43.0% in the UK and 43.4% in the USA). Moreover, as we can see in

table number 2 the situation in the Czech Republic has not changed very much during last five years and therefore the gap is still huge [12]. Unfortunately, we have found that reasons for this unfavorable position of Czech manufacturing companies does not lie with rather easily anticipated lack of investment money only but it might be deeply rooted in management attitudes too.

Respondents in all three countries 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 3. We can see that significantly fewer executives in the Czech Republic (66.7% in 1999 and 69.3 in 2005) than in the UK (74.8%) or the US (81.9%) agreed that non-investment in AMT is a high-risk strategy.

Table 3. Non-investment in AMT is a high-risk strategy

Non-investment in AMT is a high-risk strategy	UK [%]	US [%]	CZ 1999 [%]	CZ 2005 [%]
Agree [%]	74.8	81.9	66.7	69.3
Disagree [%]	25.2	18.1	33.3	30.7

Having realized that Czech managers do not consider non-investment into AMT as a risky strategy we can reach a conclusion that they are likely to rely on relatively cheap labor force which seems to be rather shortsighted strategy in today's quickly changing global world.

#### 4 Common Problems

The results described in the previous section demonstrated that the level of AMT evaluation as well as its implementation in the Czech Republic is lower than the levels observed in the UK and the USA. Furthermore, we have shown that the process of AMT adoption might be easily influenced by management attitudes towards technology investment in general and we have seen significant differences between attitudes of managers working under conditions of transforming Central European economy on one hand and the attitudes of managers representing two of the most developed countries in the world. It is interesting that despite of these dissimilarities we have found several issues that those two groups of managers have in common.

It is a widely accepted opinion that Anglo-American managers tend to promote projects which give short term results in the interest of their own career development. They usually stay in one job for a short period of time and this influences them to favor short-term projects. It

was interesting to reveal the same level of “short-termist” behavior amongst Czech managers though the motives for this kind of behavior are diverse. It is impossible for technology specialists to change it and therefore we will not dwell on this issue here. On the other hand it is important to know about it and to take it into your considerations when preparing the project.

Subsequently, if such behavior is perceived as natural by many managers there are many ways how to influence the decision making processes in order to achieve the desirable outcome. Above all, it is very easy to reject any project when using an inappropriate method. Being more specific, it is obvious that AMT projects tend to be long-term and rather expensive projects. Our survey has shown that, for example, 63.5% of Czech managers and 68.5% of British managers employ the payback period as the criterion to decide whether to finance such a project or not (see [5] for more details). The chance of getting financed for such a project is easily predictable 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 slow to generating positive net cash flows [11].

Unfortunately, technology specialists could scarcely ever influence the financial criterion being employed by financial executives but alike to the ascertainments given above it might advantageous to be aware of this drawback that affect the relevant decision.

While the chance of technology specialist to affect the above mentioned issues are commonly limited, there is a relatively huge space where their role is irreplaceable and where their input and co-operation might be of a great significance for the overall result of the specific investment decision. Based on our findings we can propose some clues where to start and what kind of arguments we shall bring forward.

In particular we have learned that many AMT projects have been disapproved just because the lack of understanding on what the contribution of new technology really is. We could see in table number 4 that majority of Czech, British, as well as American managers admitted that it is difficult to assess all potential benefits of AMT investments. The reason is that they are unable to foresee and to assess the impact and magnitude of non-quantifiable benefits for company as a whole. Moreover, as we can see in table 5 four out of five managers in all three countries do agree with the statement that not all potential benefits of AMT are taken into account because they are difficult to quantify in financial terms. It is perhaps the right place to repeat that our respondents were financial directors and decision makers of surveyed manufacturing companies.

And here we can see a great opportunity for technology specialist to fill the gap. Their awareness of various benefits associated with the particular type of advanced manufacturing technology 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.

Table 4. AMT investments are difficult to assess

AMT investments are difficult to assess because they have non-quantifiable benefits	UK [%]	US [%]	CZ 1999 [%]	CZ 2005 [%]
Agree [%]	81.6	63.9	67.1	60.3
Disagree [%]	18.4	36.1	32.9	39.7

Table 5. Not all benefits are taken into account

Not all potential benefits of AMT are taken into account because they are difficult to quantify in financial terms	UK [%]	US [%]	CZ 1999 [%]	CZ 2005 [%]
Agree [%]	80.9	81.2	90.1	81.7
Disagree [%]	19.1	18.8	9.9	18.3

According to Primrose [13] 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. In doing so they attempt to identify the benefits. The nature of intangible benefits is such that they do not 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 [13, pp. 47-50] for more details).

We strongly believe that technology experts have to accept this opportunity. Being able to co-operate with financial specialist to specify and quantify the relevant benefits they can significantly help to the decision makers and above all they can positively influence the adoption of the AMT projects [5].

## 5 Conclusion

The selected results of four AMT surveys focused on the specific issues of advanced manufacturing technology utilization that were conducted in three countries indicate that there are significant differences amongst these countries regarding AMT utilization. On the other hand we have shown some pieces of evidence that there are some common problems too.

Based on our findings we can claim that AMT projects are knowingly as well as unknowingly disadvantaged because of a whole spectrum of reasons. Some of these reasons, as for example, managers' focus on delivering positive results in short term period and contextual lack of rather strategic insight, or exploitation of unsuitable financial criteria, are well behind the border of technology specialist potential sphere of influence. Nevertheless, we believe that it is necessary to be aware of these circumstances, to anticipate them, and to use every opportunity to criticize them.

On the other hand, our results show that there are some possibilities for technology specialist to influence the processes when the crucial decisions about AMT projects implementations are made. Being able to identify, describe and explain the complex benefits of a particular AMT project they will be able to prepare better background material for financial specialist. Consequently, various tangible as well as intangible benefits will be taken into consideration, assessed and expressed in financial terms and therefore the chance to get the management approval for AMT project implementation will be definitely higher.

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### References:

[1] F.T.S. Chan, M.H. Chan, H. Lau, R.W.L. Ip, "Investment Appraisal Techniques for Advanced

- Manufacturing Technology (AMT): A Literature Review", *Integrated Manufacturing Systems*, No. 12/1, 2001, pp. 35-47.
- [2] F. Lefley, "Capital investment appraisal of advanced manufacturing technology," *International Journal of Production Research*, vol. 32, no. 12, 1994, pp. 2751-2776.
- [3] F. Lefley and J. Sarkis, "Short-termism and the appraisal of AMT capital projects in the US and UK," *International Journal of Production Research*, vol. 35, no. 2, 1997, pp. 341-368.
- [4] J. Hynek, V. Janeček, "How to Get your Advanced Manufacturing Technology Projects Financed?" *Proceedings of 1999 IEEE International Conference on Intelligent Engineering Systems*. High Tatras, Slovakia, 1999, pp. 229-232.
- [5] Hynek, J., Janeček, V.: *Information Gap between Technology Specialists and Decision Makers*. In: *Proceedings of IEEE 3rd International Conference on Mechatronics*, IEEE, Piscataway, NJ, 2006, pp. 61-64.
- [6] F. Lefley and F. Wharton, "Advanced Manufacturing Technology Appraisal: A Survey of U.K. Manufacturing Companies." *Proceedings of the 4th Int. Production Management Conference: Management and New Production Systems*, London Business School, 1993, pp. 369-381.
- [7] S. B. Dornan, "Cells and Systems: Justifying the Investment", *Production*, February 1987, pp. 30-35.
- [8] N. Suresh and J. Meredith, "Justifying Multimachine Systems: An Integrated Strategic Approach." *Journal of Manufacturing Systems*, 4 (2), 1985, pp. 117-134.
- [9] L. Hájek, J. Hynek and V. Janeček, *Hodnocení investic do vyspělých technologií*, Gaudeamus, Hradec Králové, 2005.
- [10] L. Hájek, J. Hynek, V. Janeček, F. Lefley, and F. Wharton, "Investment Appraisal of Advanced Manufacturing Technology in the Czech Republic, USA and United Kingdom." *Prague Economic Papers*, Vol. X, No. 2/2001, pp. 174-188.
- [11] F. Lefley, F. Wharton, L. Hájek, J. Hynek, and V. Janeček, "Manufacturing investments in the Czech Republic: An international comparison," *International journal of Production Economics*, Vol. 88, No. 1, 2004, pp. 1-14.
- [12] J. Hynek and V. Janeček, "Adoption of Advanced Manufacturing Technology – New Trends in the Czech Republic". In: *Proceedings of the IEEE 9th International Conference on Intelligent Engineering Systems*. IEEE, Piscataway, NJ, 2005, pp. 75-78.
- [13] P. L. Primrose, *Investment in Manufacturing Technology*, Chapman&Hall, London 1991.