Technology Transfer Issues of AITIME[1]

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1. Introduction

The paper characterizes Technology Transfer (TT), having critically examined important overall issues of TT, challenges of TT in Europe, methodologies of TT adopted in CIME R&D ESPRIT projects and the experience of AITIME project. It identifies problems and barriers that ought to be overcome by further research and demonstrates how new approaches of TT can be utilized to provide wider-scope solutions. An overview of the recent trends of TT in the context of European Projects is also presented. The performance and efficiency of the contemporary TT practices are further examined. Our scope is to better understand the potential advantages and limitations associated with these TT approaches and to show how new TT concepts can help utilize the CIME practices and conduct business in a more effective way. A conceptual model of TT functions and operations named the T-cube (Technology Transfer Tree) is proposed.

2. Overall Issues of Technology Transfer

2.1 Background

Today, we all accept that technology changes have the most powerful long-term influence affecting business and nations. Technological progress is a forcing concept but undoubtedly it operates on a time scale long enough to confound casual observation.

Technological progress, which originates in universities, research centers and laboratories of high tech companies of the scientific community, reaches the market place, serving the needs of people and nations interests via companies. As a result of this, there is a gap between the leading edge of technology and its application (otherwise known as "application gap"). This gap will continue to exist as long as technology advances rapidly. So on the one hand we have the research as the "source" of progress and on the other hand, industry as the "user" of technological progress.

It is well recognized that there are very significant differences in the practices and attitudes of Universities and Industry as far as TT is concerned. Most academics are more interested in scientific publications. This is

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understandable since promotion from one academic rank to the next is dependent on these. Furthermore there are no strong motivations for them to create links with industry, therefore such links are weak in most cases. Efforts in the direction of creating such links originated by the Fourth European framework, have already begun to bear fruit.

On the other hand, industry, which always works with tight schedules, is ever aware of budget and quality control and usually operates within low risk parameters. Obviously there is a gap between many excellent technological results and the market place, between research (the "source") and industry (the "user"). They lack a joint platform. Experience has shown that many market-oriented managers are not able to grasp and understand the overall potential of new and advanced technologies.

Similarly most academics and industry researchers seem to show little understanding of market needs. Technology Transfer (TT) in the strict sense is defined as a suitable joint platform, where the "source" can meet effectively the "user". Today TT takes on different forms and meanings. Some of these forms are listed below:

1. TT between university and/or research centers to large industries.
2. TT between university and/or research centers and SMEs.
3. TT between large industries and SMEs.
4. TT between industrial research labs or centers or a company to the production division of the same company.
5. TT through interdisciplinary University-Industry-Government Centers.
6. TT between developed nations and developing or underdeveloped nations.

Many studies further reveal that there is a technology transfer gap between technology users and vendors. This gap has been widened due to lack of sufficient and well-defined links and co-operative actions, different interests and objectives, insufficient utilization of the already available solutions in various areas of research and technology, unclear definition of end-users requirements, short- sighted policies and short-range planning.

The parties involved in a TT scheme fail to interact successfully and to integrate their complementary activities. Some examples of insufficient co-operation between parties involved in TT operations are :

I. Universities and technology institutes are deeply engaged in research activities in various (Theoretical, Basic & Applied Research) areas.

II. Vendors do not have the resources (people, funds) to study in detail the SMEs' problems and meet their challenges.

III. Vendors lack the capability of dealing with strategic and organizational issues.

IV. Consulting companies are concerned only with market, economic, strategic and organizational issues.

V. Users lack the information needed to gain a clear-cut view of the innovated technologies.

VI. Users hold their own definition of the most effective production management and technology scheme. They claim that they are the experts.

VII. Most users experience difficulties in defining modern production methods and thus taking full advantage of new technologies.

The above lack of co-operation should be considered as the main reason for people failing to exploit the existing technology effectively. Additional factors referring to the technology itself such as under-usability, usefulness and implementation strategies go beyond the scope of this paper. However extensive discussion on these issues can be found in [7].

2.2 The Technology Transfer Tree (T^3)

The Technology Transfer Tree (T^3) analogy (Figure 1) illustrates in a vivid way technology

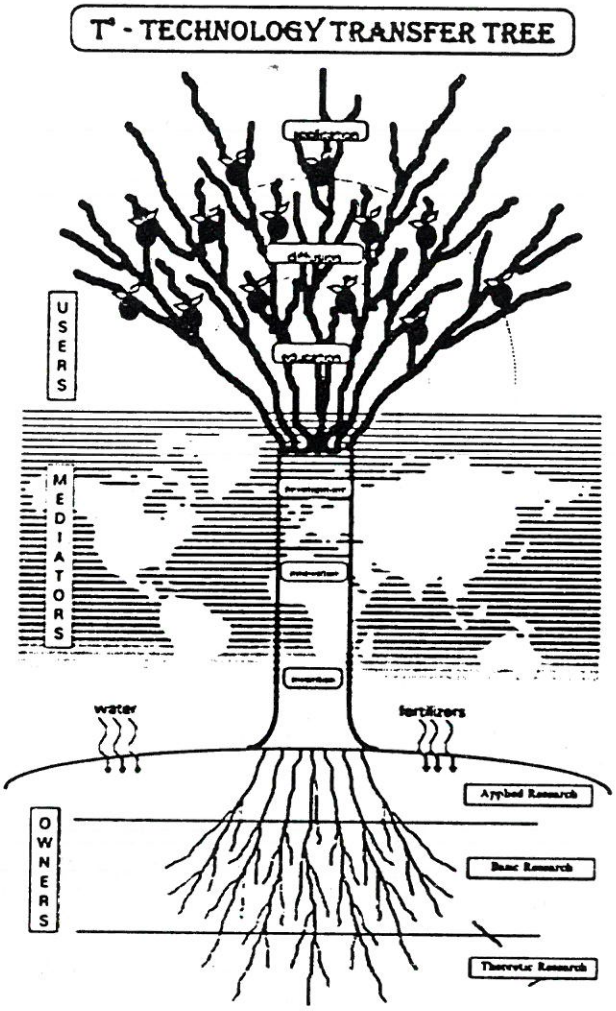

Figure 1 : The T-cube concept.

transfer operations/functions. On several occasions, we have experienced that this analogy helped us to highlight some concepts and ideas of how Technology Transfer could find its way to industry and how TT problems could be addressed properly in more productive shapes/forms. We made the (T^3) symbolism in a philosophical sense. In that way the analysis of various TT operations should not be considered as complete or perfect.

The Ground ≡ Technology Generation

Is the place where knowledge is procreated and generated. The **roots** of the tree are the origins of knowledge. The roots of the T^3 support the main body of the tree and provide the living organization with nutritious ingredients (Know How and R&D results).

The **ground** is divided into three layers where Theoretical Research represents the deepest layer followed by the Basic Research layer and the more superficial R&D layer.

Water and fertilizers account for the overall funding and strategies in the research domain on behalf of industries, governments or other authorities (EC, etc.).

The Tree Trunk ≡ Technology Highway

Is the medium thereby technology emerges into more tangible forms through the three phases of invention, innovation and development.

The **tree trunk** represents the evolution of innovative products. The base of the tree trunk is where research results transform into inventions. The innovation and development of new technologies are the next steps as we go up the tree trunk. The upper part of the tree trunk is where the diffusion of technologies starts.

The Branches ≡ Technology Diffusion & Applications

Is the medium where technology is actually implemented through education, diffusion, and application successive phases.

The **main branches** represent the main sectors of industry. The side branches represent technology users (Industries, SMEs, etc.).

The **fruit** of the tree represent the products of the technology transfer operation which are success stories of co-operation among users and developers of IT.

3. The TT Challenge in Europe

3.1 Background

New IT and especially CIME technologies are often slow to be accepted by European industry and public utilities. This is not due to lack of proper R&D but even ready and available ITC CIME technologies do not diffuse naturally to other sectors or regions. One reason is lack of awareness among user of the existence of

technological solutions or ignorance of information sources. In general often when the availability of new technology is known users lack the ability and knowledge or they do not have a TT approach to adapt it to their particular needs. There are further TT barriers relating to a more general reluctance to change especially in traditional industries, a problem more acute in SMEs.

Moreover obstacles still exist for technology to pass from one country to another. For many reasons providers and users of IT and CIME technologies from different countries do not come into contact or fail in their attempts to work together. Language barriers and geographical distance reduce the chance of success while remaining national differences in technical norms and the legal environment add to the problems. Cultural differences increase the obstacles to transnational TT particularly when traditional industries are involved.

Today nobody can dispute the fact that technology and know-how are unevenly distributed in the European Community. There are substantial disparities not only between industrial sectors but also between European regions. It is believed that wide-spread diffusion of available and emerging IT and CIME technologies could significantly contribute to European economic and social cohesion if the still existing TT barriers are overcome.

There is an ever increasing awareness in European Community of the need to assist SMEs to improve their competitive position and in recent years many programs have been launched for this purpose. The EC wants to encourage greater participation of SMEs in Community R&D programs and to set up the means of TT to facilitate a more effective diffusion of new technologies. Although the EC has invested billions of ECU in three RTD framework programs, till today there has been little transfer of many IT and CIME results of the research to SMEs in the more traditional manufacturing sectors. This is especially not only for SMEs but even for large industries located in the least developed regions.

However it must be pointed out that in the last few years a number of successful ESPRIT projects have been initiated with the specific objective to explore the opportunities and find ways for effective TT to SMEs. Such projects are AICIME, I-SMILE, DONQCIM, ATTRACTION, NETCIME and AITIME.

3.2 Technology Transfer Methods in ESPRIT Projects

The typical TT methodology adopted by almost the majority of CIME ESPRIT projects is shown in a consolidated form in (Figure 2). These projects have an objective in common to narrow the gap between the CIME R&D work and the manufacturing practice observed more intensely in the so- called Less Favoured Regions (LFR).

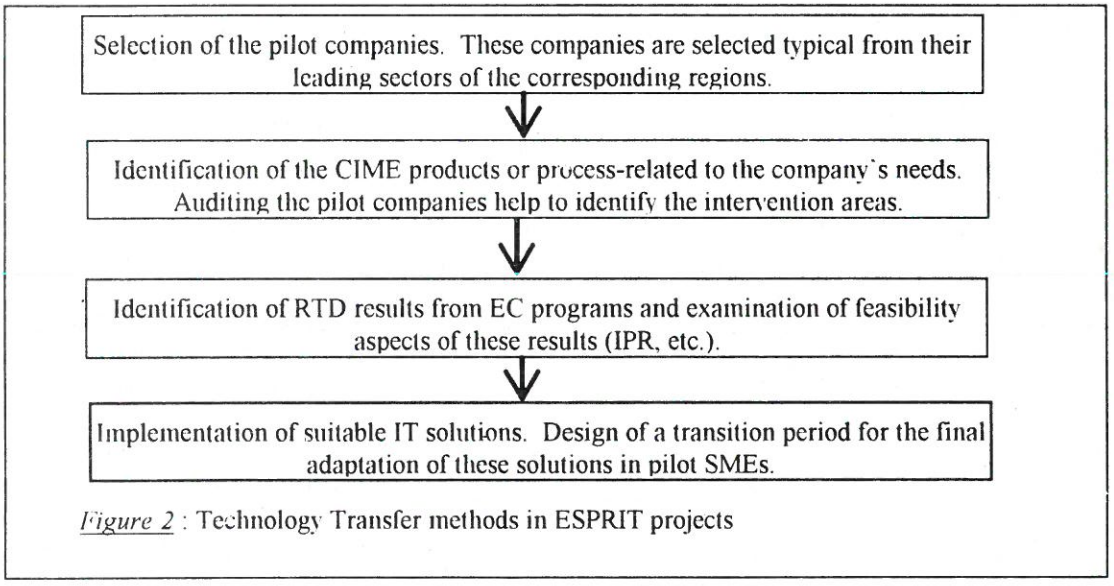

Figure 2 : Technology Transfer methods in ESPRIT projects

Step 1:

During this phase the section of the pilot companies takes place. This operation is considered of great importance because the proper selection of the pilot companies will reflect positively to the entire project's life- cycle. Typical criteria for selection are presented below:

- The pilot companies should represent the industrial profile of each region.
- They should have a background of common experiences and ambitions, rooted, at least partially, in common features.
- A significant variety in production capacity (small/ medium versus large industrial enterprises) is usually asked for.
- The pilot companies should offer a considerable degree of success in the implementation of advanced tools and methods, and share commitment to investigate and use advanced solutions in order to modernize their whole business.
- User's knowledge and clear understanding of their specific needs is also a crucial factor in the success of the overall project.

Step 2:

This step consists of an exhaustive auditing process which comprises all the elements of companies operations, underlying organization features and structures as well as level of technology, including both installed systems and software development practice. The main goals of this step are a complete and thorough description of the functional operations within the pilot companies, the identification of the new technology penetration in each of them, and a clear understanding of the way how integration of processes and operations should proceed.

Step 3:

It is realized that the research which has been conducted within the various EC-frameworks has produced a number of tools and technologies, which, while highly applicable to a variety of industrial situations as may probably be the set of the pilot companies, fail however to reach the end- user. A common attitude adopted by TT ESPRIT projects is that one should not proceed on designing solutions and entering an implementation phase, without having established an effective and permanent access to sources of applicable technology. This is done mainly by means of a series of concerned actions :

- A survey of proven technologies and methodologies relevant to users' needs and requirements.
- An evaluation of feasibility and applicability of CIME tools and methods.
- A report on the CIME commercial framework (costs, installation, training support, IPR)

Step 4:

During the design and implementation phase the results of Step 2 and Step 3 will be transformed into specific guidelines and integration plans of transferable tools and products. The detailed design of the implementation projects will involve functional organizational and technical aspects as well as the integration of transferred tools to specified solutions. During this phase appropriate measures should be taken in order to decrease and smooth the transient period from the old, non-integrated to the new integrated operational practices with everything this implies.

4. AITIME TT Methodology

4.1 Research Approach

Bridging of the technological gaps between developed and less developed regions rarely happens spontaneously. Quite the contrary, those regions which have more advanced technological capabilities tend to create internal markets which strengthen the region's potential for exporting economic growth. Therefore, it can be said that market mechanisms work systematically against industries in less developed regions.

The conventional approach to technology transfer typically consists of information actions and pilot plant demonstrations. This approach almost always succeeds in generating awareness of the problem. Nevertheless, pilot plants can only show a way ahead. They do not solve any of the problems the companies are likely to be facing when moving on the road of innovation. Each

company is a particular case and often companies present major differences in their needs and qualifications even when operating in the same sector and in the same region.

The problem of technology transfer is much more intense when we consider the Greek industrial sector which is not a very powerful one yet. Indeed the majority of Greek industries stick to old fashion production methods and they are rather vulnerable to adopt new technologies. AITIME demonstrator companies, despite the fact that they are typical Greek SMEs, seem to have realized the need for investing in IT and CIME technologies in order to improve their competitive position. It is interesting to note that although AITIME pilot firms operate in different industrial branches (vineries, wood industries, canneries), audit procedure has proven that they have many problems in common. The main reason for this result is the fact that all the companies lack the necessary infrastructure (industrial networks, computer- aided production planning, monitoring tools, etc.).

AITIME project follows a pattern essentially inspired by AICIME, which turns out to be a successful industrial modernization initiative in Portugal. In the following section we present the research approach adopted by AITIME consortium with respect to the investigation of possible routes for technology transfer to the AITIME demonstrator companies.[2]

Familiarization with the problems of the pilot industries

⇩

Overview of selected IT & CIME ESPRIT projects aiming at a particularly large

CIME-knowledge base or European wide standards

⇩

Focused Survey of a number of IT R& D projects with close relevance

to the needs of the pilot industries

⇩

Questionnaires to research consortia and CIME vendors

on the specific technical problems

⇩

Suggestions & recommendations for technical solutions

based on the European experience.

4.2 Activities

1. The acquaintance with the three industries involved in the project was made through the presentation of the demonstrator companies' profiles. The in- depth familiarization with the problems of these companies was secured by taking into consideration the companies' audit results.
2. A comparative view of selected IT&CIME ESPRIT projects with those relative to the needs of pilot industries commenced. AICIME database was the first source of information . However because AICIME had been developed mainly for automobile industry, there were some difficulties in finding appropriate links with the Greek industrial reality. So the need for creating a new complementary database of proper CIME projects emerged.
3. A first scan into the ESPRIT IT & CIME projects was performed. More specifically, AITIME research group reviewed 40 ESPRIT projects which were selected from the summaries of ESPRIT II & III. Several criteria for the selection of the most appropriate projects were set. These selection criteria had to do with parameters for applicability, tools availability and dissemination activities. Special provision was taken to report on the technical points of the selected ESPRIT-CIME projects. All the information gathered was very enlightening in the context of project results and

[2] At the time when this paper was written AITIME project was still running. Therefore, the presented methodology does not involve the implementation of suitable IT solutions phase.

implementation parameters. However, more has to be done in the direction of feasibility of these solutions on an individual basis.

4. A focussed survey on European IT R&D projects referring to similar industries with the demonstrator companies of AITIME was conducted. For the needs of this survey the AITIME research team made a preliminary scan into the following programs: ESPRIT, BRITE-EURAM, COMMET, FLAIR, FOREST, EUROTECHNET, ICPECO, RAWMAT, SPRINT, AIR, BCR, CAMAR, COST, CRAFT, DELTA, ECLAIR, ENALT, ENDEMO. The selected projects were classified according to their relevance to the specific technological problems of the pilot companies. The CORDIS database was used as a pool of information.

5. A market survey was conducted to identify the available commercial products which could be used to solve specific problems of the industrial partners. For the sake of this survey, the AITIME research team asked for information from about 200 CIME vendors all around Europe. An evaluation survey of 50 products, that could fit AITIME demonstrators requirements was concluded and an analysis report was produced in order to stir the awareness of the CIME commercial framework.

4.3 Conclusions

In the framework of AITIME project a Technology Transfer scheme was used. This TT scheme was very much like the TT methodology adopted by many other CIME projects as described in the previous section. As a matter of fact AITIME consortium was inspired directly by the AICIME consortium which was regarded as a successful project.

An extensive survey over a specific Greek high technology companies and industries has been undertaken, in order to describe the degree of utilization and the current state in the field of advanced CIME technologies. The problems of efficient information dissemination and technology transfer have been encountered among many other problems. In the following section a first approach and analysis of these problems is presented.

Using the European experience and the acquired knowledge in the field of advanced CIME technologies, we have tried to reveal the current situation in Greece and to suggest solutions for an efficient technology transfer. Our survey has set off some interesting conclusions which are presented as follows:

1. Greek industry is willing to invest in high technology. This way it is believed that the company competitive position will be improved.

2. Ways to improve the company competitiveness are higher productivity, quality products, shorter delivery time and decreased personnel costs.

3. The second important problem concerning the application of high technologies, beside high purchase and installation costs, consists in the difficulties encountered in training.

4. The need for education in CIME is widely recognized by both managers and engineers.

5. The implementation of high technology solutions is not feasible due to the lack of a well-defined transfer mechanism and of guarantees of successful and profitable operation.

Based on AITIME`s extensive survey, the successful CIME R&D projects are the projects that have attained the following goals.

- To design CIME solutions suitable to the industrial needs.
- To implement these CIME solutions in real applications.
- The CIME solutions should be re-usable.
- To extensively disseminate these CIME solutions.

To conclude with, AITIME consortium acquired a unique experience in analysing this kind of advanced IT product integration into a peripheral region through the research involvement in the market analysis. Such a technical and professional support is not easily available in the SMEs with weak technical teams unable to study and advise on advanced solutions on a cost -effective basis.

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