PLANNING FOR SCIENCE & TECHNOLOGY PARKS IN SOUTHERN EUROPE: EXPERIENCES FROM SPAIN, ITALY AND GREECE

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ABSTRACT
We present the experiences when planning for Science and Technology Parks in Southern Europe describing the approach followed and the factors considered, especially the ones related to the stage of the economy in these countries.

The methodology used included background analysis, strategy definition, drafting of an action plan and implementation framework analysis. Main concern was the mobilization of intangible technological resources in the respective areas and local sources for technology belonging to the Universities, Research Institutes, larger companies and Technology Transfer Organizations.

We also present the current state of development of these Science and Technology Parks and try to link their state of success to the social and economic environment in which they operate. We use as a case study Thessaloniki Technology Park and present its stages of evolution, developing through four phases and reaching at what appears to be a maturity state thus creating an environment requiring further growth.

INTRODUCTION

The last two decades represent a period of intense development of science and technology parks (STPs) in southern Europe. Local, regional, and central administration authorities, universities, and research centers have undergone numerous initiatives for setting-up innovation centers, property based technology parks, technopoles, and technology transfer related mechanisms. The European

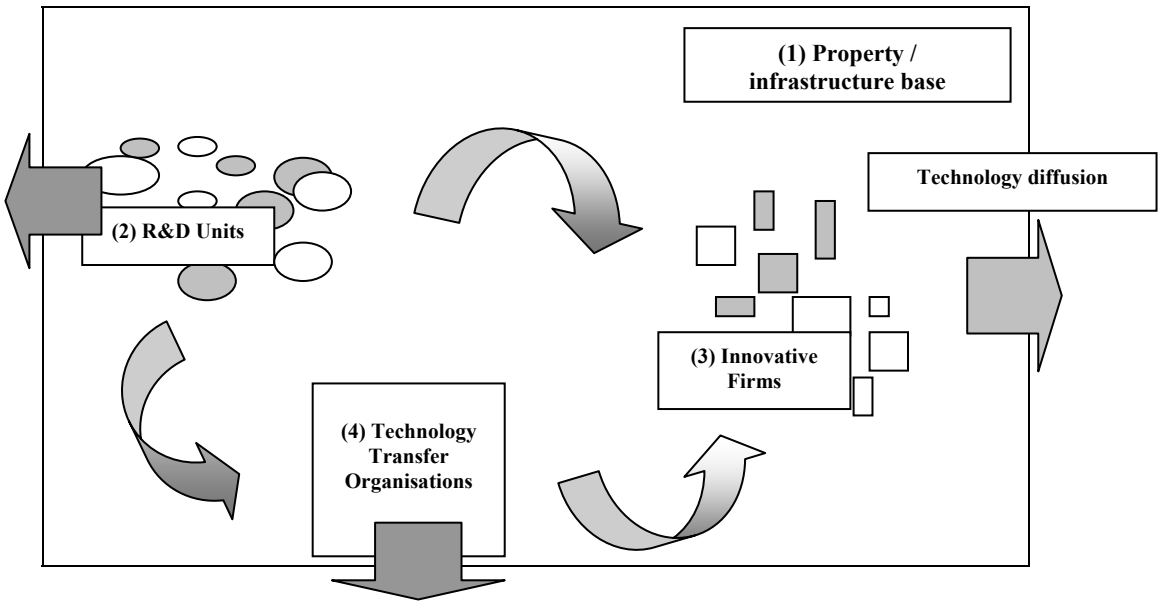
Community exercised a pro-active policy, supporting STPs through the SPRINT and INNOVATION Programs, the Structural Funds, and relevant Community Initiatives, such as STRIDE, SME, and others. The 1980s and 1990s was a period of proliferation of science and technology parks in all southern European countries, including Spain, Portugal, Italy, and Greece. However, the strategies which were adopted and the procedures followed vary considerably, showing the non existence of a 'best practice' for creating a Park, and the opening of alternative routes, equally acceptable and efficient. To this question of strategy for the formation of STPs we devote the first section of the paper.

In the second section we follow the evolution of Thessaloniki Technology Park, describe its operation, present the operational difficulties and the strategy adopted for overcoming them. Though in operation over a short time period (less than five years) its steady evolution led to what seems to be a maturity point thus creating a favorable environment, to government, regional and Park authorities, for considering further expansion.

1.0 STRATEGIES FOR SCIENCE AND TECHNOLOGY PARKS IN SOUTHERN EUROPE

A generally accepted understanding of a Science / Technology Park includes the following four components: (1) it is a property based initiative, which (2) has formal operational links with a university, Higher Education Institution or major center of research; (3) it is designed to encourage the formation and growth of knowledge based businesses and other organizations, normally resident on site; and (4) it has a management function which is actively engaged in fostering the transfer of technology and business skills to the organizations on site (IASP Directory 1998). Diagram 1 illustrates this definition, showing the constituent elements and the relationships of integration, based on technology transfer and co-operation between the R&D institutions and the innovative firms.

Diagram 1. Science / Technology Park elements and relationships



The cluster of R&D activities, innovative companies, and technology transfer organizations gathered into a Science / Technology Park is created upon a given

technological and institutional environment, which exercises a very strong influence. A statistical analysis of European STPs shows that this background environment is one of the two major determinants for the growth of a Science Park; the other one is the technology and industrial specialization of the Park (Hadjipandelis and Komninos 1992). The question of strategy refers exactly to this issue, to the choices and procedures, which assure the development of the Park's components with respect to a given background.

What is specific in southern Europe is the technological and institutional background which provides the context for the development of STPs. It is a rather restrictive environment, since most southern countries are characterised by limited technology resources and low spending on R&D, technology and innovation (Table 1).

Table 1. North-south technology divide in Europe

	GR	P	ES	NL	FR	D	EUR
GDP per head (1993)	58	60	76	109	109	117	100
Unemployment % (1993)	7,8	4,9	21,3	8,2	10,3	7,0	10,4
GERD as % of GDP (1990)	0,47	0,50	0,87	2,06	2,42	2,81	2,00
BERD as % of GDP (1990)	0,10	0,12	0,52	1,11	1,48	2,02	1,30
Government RTD as % of Budget (1988)	0,60	0,98	2,19	2,50	6,91	4,11	3,24
RTD scientists per 1000 labor force	1,4	1,1	2,2	4,0	5,1	5,9	4,2

Source: Commission of European Community 1994 (GDP: Gross Domestic Product, GERD: Gross Expenditure in Research and Development, BERD: Business Expenditure in Research and Development, RTD: Research and Technological Development)

Table 1 suggests that disparities in factors of technology and innovation (RTD, BERD, R&D scientists) are far more important than disparities in GDP and unemployment.

- The Community three weakest members (Greece, Portugal, and Spain) have R&D expenditure levels three to four times lower than the Community average. In terms of gross R&D expenditure, the gap between advanced and less advanced regions is 1 to 6, while in terms of GDP per head is 1 to 2,5.
- Business expenditure for R&D in Greece and Portugal are one tenth of the Community average, and 15 to 20 times lower than in France and Germany. State expenditure for R&D in the same countries is one fourth of the Community average.
- R&D personnel in Greece and Portugal is only one quarter to one fifth of the same personnel in the more advanced states, and one third of the Community average.

Furthermore, within the European Union, most technology and R&D supply and demand are found in few areas, around capital cities and metropolitan areas; resources

for research and development, the large research institutes, the engineers and scientists that work in research, technology markets, all of these are concentrated in a small number of core regions, the so-called 'islands of innovation'. On Europe's fringes, the scant technology resources are mainly located in the national capitals and the larger metropolitan centers. In Spain, Greece and Portugal, 60-90% of all public and private spending on R&D occurs in Madrid, Athens, and Lisbon (CEC 1994).

These structural deficiencies constitute major obstacles in the processes of STPs creation. Principal task of the authorities responsible for the Parks developed in Greece, Italy, and Spain was to cope with the limited technology supply and demand locally available, and to 'invent' strategies capable to deal with these barriers. Our experience from a number of Parks in these countries indicates that three strategies were mainly followed, based on real estate assets, technology assets, and industrial clustering (Komninos, Mercier, and Tosi 1995, 1996, 1998).

Property led trajectory
This strategy is mainly found in the large technopoles and technology parks of the Cote d'Azour in France and Costa del Sol in Spain. It starts by the acquisition of a land, the construction of appropriate infrastructure, the planning and promotion of the lots, and the attraction of technology intensive companies and R&D organizations. The strategy is suitable for local and regional authorities having limited experience on innovation management, since the R&D and technology organizations come into at a later stage.

The Andalusia Technology Park illustrates a typical case for this trajectory. It has started by the characterization of a piece of 168 Ha as the Technology Park, the establishment of a management and development company, the construction of infrastructure, and planning of the area. The first step of the strategy was to offer a high quality environment, flexible premises for location, and generous incentives, in order to attract important R&D and multinational companies. In the first 5 years, the Park marketed the area to 15.000 companies in the USA, south east Asia, and Europe, achieving to attract a good number of them, including Hudges, Alcatel, Air Liquide, and Fudjistu. The second step, was to create a number of specialized technology institutes and centers, in the field of telecommunications, automation, quality, environment, etc., on the basis of contractual co-operation with regional and national R&D organizations, the universities, and professional organizations.

Critical issue for this strategy is the capacity of the host region to attract technology intensive companies. Important parameters are the accessibility of the region, the markets that are located near-by, the incentives and other aids offered to companies, the national / regional regulations for foreign direct investment. The main target group is the multinational branch plants which choose a region under well defined location and operation specifications.

Technology led trajectory
Many regions hosting a STP do not have the profile to attract foreign direct investment and they target the Park for developing technology and know how and on attracting local SMEs rather than multinational companies. Most of the Technology Parks in Greece and the newest Parks of Italy followed an alternative to the previous

property based strategy, linking the development of the Parks to the technology assets of a university or research institute(s).

The Technology Park of Chania, an initiative of the Technical University of Crete (Greece), represents an example of Park which initially adopted a property based strategy, but it turned soon towards the technology capabilities of the University research institutes and laboratories. The revision of the Park's strategy, realized at 1996 under a SPRINT project, targeted the Park around four Technology Centers dealing with (1) technology transfer, (2) the provision of advanced technology services, (3) the hosting and support of start-ups, and (4) innovation financing.

Thessaloniki Technology Park, an initiative of FORTH/CPERI, depended on the technological capabilities of CPERI and the complementary laboratories of Aristotelian University of Thessaloniki and involved:

- Laboratories for the Institute's research needs
- An incubator for accommodating technology based innovative start up companies which could benefit from the close proximity to CPERI laboratories
- Administration and conference center for serving the needs of TTP

TTP's development strategy, realized in 1993 under a SPRINT project (Vasalos and Bakouros 1993) focused on regional development, contract research, technology transfer and contract education and pointed out that with commitment and efficient management, TTP would be a fully fledged Technology Park in Greece.

These structures outline the technological and institutional character of the Parks, focus on the scientific and research community of the University or the research institute as main pool of expertise, and is addressed to the local and regional SMEs which may profit from the technological services of the Park to become more innovative and outward looking.

Critical issue for the technology led strategy is the background technology capacity of the host region, and the close co-operation with technology and research institutions. Instead of developing real estate approach thus creating high cost infrastructure, planning and marketing pieces of land, the strategy is based on research institutions, human capital, and the management of knowledge and technology. The Park becomes a point of reference for the entire local productive system, developing technology and providing services to both tenant and outside companies.

Cluster based

Many regions of southern Europe are deprived from both attraction capacities and local technology resources. This is the case of agrarian regions, remote from the main population and industrial centers, characterized by traditional industrial branches and practices. However, in many backward localities and regions, Science and Technology Parks are put forward as instruments of a regional development policy.

To organize the complex structure of a STP with all its components and integration relationships, as presented in Diagram 1, on a backward and technologically poor environment is a rather difficult problem. The choice to invest massively on new R&D and technology infrastructure is not always the best, since for a long period of time the inward technology activities will be cut from the local environment. The

counter argument for such trajectories (cathedrals in the desert) point out the high risk for the planned R&D/technology facilities, and the low integration with the productive activities of the host area.

An alternative strategy that was applied in Sicily, is to target the Park on a local productive/ industrial cluster. The distinctive characteristic of a cluster is the segmented population of small firms, and the division of the different phases of the production process between the firms, each of which specialized in one or a few phases of production. Interfirm alliances and institutional regulation assure the co-ordination and integration of the different production segments. Becattini (1979) pointed out that this industrial organization was already described in the concept of "industrial district' developed by Alfred Marshall in the early 20th century, and he characterized the Industrial District as "creative milieu", an environment of targeted creativity, which allows the tiny firm to develop an innovation capacity and to change rapidly the production process and the products (Becattini 1991).

The Science Park of Belice in Sicily illustrates the convergence of the concepts of *Science Park* and *Cluster*, linking the development of the Park to the institutional agreements and the market of the local wine cluster. The Park is defined as extension of the cluster activities, and it is composed of three Centers promoting the wine cultivation, production, and marketing: (1) the Center for the wine varieties and processing, (2) the Center for advanced cultivation techniques and tools, and (3) the Center for networking and co-operation on markets and technologies. The overall objective for the Park is to support the transition from a production model of large quantities and low quality to a model of flexible specialization based on the variety of production, brand names and international markets.

The above three mentioned strategies for setting-up a Science / Technology Park illustrate different starting points, defined with respect to locally available technology resources and background conditions. As the Parks grow and mature, the initial conditions become less apparent since all Parks evolve towards a same model, of a spatial cluster of R&D, technology transfer, and innovative production activities. At this later stage, the initial qualitative differences are reduced to differences of size and scale of operation.

2.0 DEVELOPMENT AND OPERATION OF TECHNOLOGY PARKS - THE CASE OF THESSALONIKI TECHNOLOGY PARK

Brief Overview

CPERI: The Chemical Process Engineering Research Institute of Thessaloniki (CPERI), the developer of TTP, was established in 1985. In 1987 it joined the Foundation for Research and Technology-Hellas (FORTH) which is administered by the General Secretariat of Research and Technology.

CPERI is a non-profit organization with the goal of establishing a center of excellence that carries out applied research working closely with industrial partners. It aims at developing and promoting high technology, thereby increasing the competitiveness in the Chemical and Petrochemical Industry. The research focuses on petroleum refining, energy conservation, polymeric materials, catalysis and environmental technologies.

Thessaloniki Technology Park: Thessaloniki Technology Park (TTP) was established in 1990 by CPERI to meet the need for a greater exchange of ideas, people and facilities between universities and industry. It is located 12 km outside Thessaloniki in Thermi with easy access to the local airport and highway system. It is adjacent to the American Farm School, which owns about 150 Hectares of land where TTP could expand its future activities.

From the very beginning CPERI created an environment where the physical area, with well-landscaped surroundings provides a good atmosphere. The goal is to promote significant opportunities of interchange with CPERI, local Universities and industry.

To preserve the nature of the Technology Park, an effort is made to restrict the use of the buildings to:

1. Scientific research associated with industrial production
2. Technical and/or Management activities linking research to industry
3. Company supporting activities (accounting, marketing, etc.)

Development of TTP

In 1988 CPERI presented a detailed study outlining the development of TTP. After extensive consultations with national, local authorities and officials from DGXII and DG XVI of the European Commission, the plan was officially approved in January 1990 and it included the following:

- Laboratory facilities to accommodate the research activities of CPERI including pilot plants
- An Incubator building designed to accommodate up to 12 companies involved in knowledge based activities
- An Administration/Conference Center serving the administration needs for CPERI and housing Technology Transfer activities

Approval for the entire plan was received in 1990, local authority permits were received by February 1992 and the foundation was placed in June 1992. Operation in parts of TTP started in 1995. Completion of the full development (final phase) is planned for May 2000. Total cost for the development is 15 MEURO for the infrastructure while the budget raised by CPERI's R&D competitive programs is ~10 MEURO. Funding for the development of TTP was from the Operational Program of Research and Technology of GSRT, with the agreement of the Community Framework Support Program of DG XVI of the European Union.

Pivotal point in the development of TTP was its gradual development, through four phases, in order to secure required funding and minimize risks.

It was planned from the beginning that CPERI would be the owner and operator of the facilities. In 1994 CPERI, in cooperation with the Association of Industries of Northern Greece created a separate company, Thessaloniki Technology Park Management & Development Corporation S.A. (TTP/MDC S.A.) with the goal of managing all Technology Transfer activities.

Operation - Evolution - Difficulties

FORTH/CPERI: Since its establishment in 1985, the Institute focused on petroleum refining research, energy conservation, polymeric materials, catalysis and

environmental technologies. Over the years it has extended the research areas to electrochemical processes, computational process systems, aerosol and particle technology.

Some of the major accomplishments of CPERI include:

- The establishment of Technological Park of Thessaloniki and its organization into a center of technology transfer to industries
- The establishment of technical infrastructure for the conduction of applied research and the supply of high quality services to industry in the focused areas
- The undertaking and promotion of European competitive programs, often taking the leading role
- The promotion of cooperation with Greek and European industries

Today CPERI, due to its diversity of interest, has all the characteristics of a European scientific institute: a valued partner for industry and a growing influence in socio-economic stage of the country and of the Northern Greece, in particular.

Operational issues that CPERI has faced included:

- Phasing out of government support for basic and applied R&D (now at ~20% of total budget) leaving little room for own development of new processes or products.
- Pure contract research, with funding directly from industry, is not undertaken extensively, mainly because Greek companies (large and SMEs) are not accustomed to contract research.
- The main focus of the Institute being the Chemical / Petrochemical industry has by definition a narrow list of Greek clients with many clients coming from abroad thus pointing out to the expansion of TTP's technological base.

Incubator

The concept of the Incubator was entirely new in Greece when operation started in 1995. The original idea was to attract start up companies that could be supported by CPERI. After extensive advertisement few companies satisfying the required technological profile had indicated their wish for installation at TTP. Over time we attracted more companies (now the Incubator is fully occupied with 11 companies) and have started a waiting list for new companies.

The areas of operation of the companies in the Incubator can be grossly classified as:

a) analytical services

- services for wine making - services for metrology - products for diagnosing human diseases - services for CAD and mold development - services for water analysis / environmental projects

b) information technologies

- Electronic Data Interchange - Internet provision / Electronic Clearing Center - Software solutions for businesses - Software and continuing education for telemedicine

So far two companies have moved out from the Incubator leaving space for new companies.

Operational difficulties encountered over the years include:

- Difficulty in finding Innovative Companies satisfying original entrance criteria
- Innovative & start up companies have difficulties with cash flow as no mechanisms available (even today) for funding support (e.g. seed capital)
  - ♦ Start up companies do not normally have the flair for business operation and encounter cash flow problems
- Critical mass of companies and the size of incubator is not achieved thereby having companies of mixed activity thus not benefiting from the operation in close proximity.

TTP/MDC SA

From its creation, TTP/MDC SA focused on Technology Transfer. During the past years and after an extended campaign we approached the companies in the Region determining their needs and we have started the development of Technology Transfer Services.

It is a small company still establishing its territory and developing know how for Technology Transfer. Services on Technology Transfer are new in Greece and to properly develop them we need to establish networks, methods and tools (Kelessidis 1998) with most of these already developed. The critical mass of people has not yet been achieved and will materialize when income comes mainly from technology transfer services.

Image

CPERI being in operation for a few years before the operation of TTP had already established its own image and was well known to the scientific and business community. Technology Parks, however, as a concept, were totally new (and still are, although to a lesser extent) to the Greek community. Through the extensive promotional campaign we have expanded the base of people knowing of the activities of TTP.

There is still a long way to go before TTP becomes easily recognizable and efforts will focus on promoting the conference center, the organization of conferences, visiting more local companies and research laboratories and promoting the analytical services of CPERI and R&D laboratories.

Infrastructure - Support Services - Maintenance

Maintenance of infrastructure is subcontracted and the occupants of the Park share the cost on a surface occupied basis. Difficulties have been experienced covering the cost, at least in the first few years, with TTP/MDC and most of the Incubator companies since all have a common characteristic, they are new companies and cash flow was a common problem.

The communication networks were highly advanced from the beginning but usage of Internet services were not well developed within the research and business community in Greece. Nowadays with more and more users of Internet by persons and Greek companies, full appreciation of the availability of such a network starts to be realized. Thessaloniki Technology Park with its advanced capabilities for networking can and should be the vehicle for further promoting / using the capabilities that the communication technologies can offer.

Employment Creation
There were no specific difficulties in attracting high caliber scientists & support personnel mainly for two reasons:

- The availability of employees, many returning from studies from abroad and many graduating from Greek Universities and finding one of the few places in Greece where they could continue with research and could havemany opportunities for further development
- The high quality of the work environment commended by many visitors, with the high standards in infrastructure

The evolution of employment from 1994 to date was as follows:

	1994	**1995**	**1996**	**1997**	**1998**
FORTH/CPERI	100	105	120	120	118
TTP/MDC		3	4	5	8
INCUBATOR		12	22	42	46
TOTAL	**100**	**120**	**146**	**167**	**172**

3. 0 MATURITY / EXPANSION STAGE

Operating the Institute for 15 years and Thessaloniki Technology Park for five years we have encountered many difficulties which were successfully overcome by tight control over budget and personnel, by attracting high caliber personnel and by generating income opportunities. The continuous support of the government (General Secretariat for Research and Technology), European Union (DG XVI), the industry (Association of Industries of Northern Greece) were more than essential. The support from FORTH/CPERI was critical in many instances both through the development and operation stages.

Today FORTH/CPERI has established its focus in seven areas, the Incubator companies are flourishing, with growing demand for more incubator space, some products / processes from research may generate spin off companies and TTP/MDC is finding its role. The business community having seen the successful evolution of TTP is now considering and discussing the enlargement of the technological base of the Park. This could be accomplished by the expansion of the Incubator and by attracting new R&D Institutes covering needed areas for Northern Greece, namely for agro-technologies, textiles and information technologies.

All these factors point out to the fact that TTP achieved its original goals, it has reached its maturity stage and discussions have already started on expansion possibilities.

Expansion Stages
We foresee two scenarios depending on amount of funding and the funding mechanism:

a) enlargement of the Incubator by 5000 m^2 , or,
b) acquisition of nearby land of 12 hectares and creation of infrastructure for a much larger expansion, thus changing the initiative from technology led trajectory to property led trajectory.

To follow through the expansion stage, the following steps are envisioned:

1. Creation of Thessaloniki Technology Park S.A. (TTP SA) with activities
   - Site management - Attraction and installation of Organizations and Companies - Marketing of Institutes at TTP premises - Technology Transfer Center - Business support services - Telecommunication and computational support Services - Financial services - Legal services
2. Development of land layout
3. Construction of new buildings
   - TTP SA 'builds' the expansion of Incubator, 5000 m^2, housing Spin off and Start Up companies
   - The Institutes, under establishment, sign an agreement with TTP SA for installation and construct their own buildings
4. Attraction of Institutes and innovative companies

Critical Factors for Success

Factors deemed very critical for carrying out the plan under elaboration include:

- The agreement among all principal actors involved: Government, regional and local authorities - Research community - Business community
- The justification of the scenario for the large expansion through a major feasibility study
- Securing the funding which could be accomplished through a phased expansion, already followed until now at TTP
- The support of Greek government through the establishment of the necessary mechanisms which would enable such initiatives to flourish, for e.g.
  - legislation for start up / spin off companies - venture and seed capital - continuation of the already good support for R & D and promotion of innovation

CONCLUSIONS

We have shown through the analysis of the local productive system in Southern Europe that structural deficiencies in these countries like, limited technology resources, low spending on R&D, technology and innovation, constitute a major problem in the process of Science and Technology Park creation.

Authorities in Greece, Italy and Spain followed mainly three strategies based on real estate assets, technology assets and industrial clustering. The property led trajectory was followed by Andalusia Technology Park and is considered successful thanks to the capacity of the host organization to attract technology intensive companies. The cluster-based strategy, followed by the Science Park of Belice illustrates the convergence of the concepts of Science Park and cluster. The technology led trajectory links the development of the Parks to the technological assets of a University (Technology Park of Chania) or a research institute (Thessaloniki Technology Park).

We have followed through the development and evolution of TTP, our case study, and have illustrated the major operational difficulties and strategies followed to overcome them. The success generated by the operation of TTP formed the basis for considering its expansion. We started planning for the expansion following the necessary steps for establishing STPs and taking into account the three main strategies for the development of STPs in Southern Europe. These plans now complement the original

strategy of technology led trajectory and may transform it into a property based strategy.

We conclude that STPs may start under different initial conditions but as the Parks grow and mature, the initial conditions become less apparent and all evolve towards the same model. This model includes spatial clustering of R&D activities, technology transfer and innovative producers. The maturity of the STPs thus reduces the initial qualitative differences to differences of size and scale of operation.

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