Cooperative Technological Development in Italian Industrial Districts

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La Storia nel Futuro® www.storianelfuturo.org
Workshop “Prospettive per i distretti e parchi scientifici e tecnologici: il ruolo del Marketing”
Università di Genova, Facoltà di Economia, 7 aprile 2006

Abstract: *The problem of technological innovation in Italian industrial district to face the present increase of complexity of technologies and globalisation of markets is one of the most troublesome aspect of the crisis affecting the growth of industrial sector in this country. Cooperation is generally recognised as one of the possible solutions and effective cooperation in technology innovation and R&D projects is possible by taking account of the complex technological structure existing in the districts. The various aspects of organisation of cooperative development of technology innovation and generation and management of cooperative networks for R&D projects are discussed presenting successful experiences carried out in Italian districts producing faucets and valves.*

1. Introduction

Industrial districts are a form of firm clustering very diffused in Italy and characterised by manufacture of similar products commercialized in the many forms produced by the various district firms. District enterprises are normally medium and small firms, although the total turnover of a district may reach values comparable to that of large firms, individual firms turnovers are limited and it is difficult for them to invest in R&D especially for radical innovations requiring large financial availability and long term commitments. This situation is an handicap for technological development of the districts especially to face globalisation of markets and productions. Although technological innovation alone is not the solution to these problems, it is however essential to raise the competitive level of such types of industries and to contribute to assure a future to the districts. One way to overcome such difficulties is organisation of cooperative R&D projects in which costs are divided and results shared among the firms participating to the project. This approach may be successful taking account of the delicate equilibria between competition and cooperation existing in a district and of the complex structure of technology distribution existing among the firms. Industrial districts and technologies are seen through the perspective of the science of complexity, such as that for example developed by the Santa Fe Institute, and that has been object of an international conference on “Complexity and Industrial Clusters” held in Milan on June 2001 and whose proceedings have been published by Quadrio Curzio and Fortis M. (2002)

In Chapter 2 we present the importance of industrial districts in Italy and the typical structure and models for Italian industrial districts, especially from the technological point of view, and their problems in making technology innovation because of limited size of enterprises. In Chapter 3 we discuss our bottom-up approach in the organisation of cooperative development of technology innovation in the districts describing some specific successful experiences made in Italian districts producing faucets and valves. Finally, in the last chapter, we discuss various aspects about creating and managing cooperative networks for R&D projects in industrial districts.

2. Technological innovation in Italian industrial districts

When speaking about Italian industrial districts, it is difficult to give reliable and accurate figures about their economic activity. Many types of classifications are proposed and none constitutes an exact representation of such types of complex phenomena. Aggregation of firms in a cluster is a process largely spontaneous and behaviour of a district is not controlled by anyone but emerge by the complex interactions among the various firms in what is commonly called in science of complexity as a complex adaptive system (Rullani E. 2002). Nevertheless it could be estimated without doubts that total turnover of Italian industrial districts is of the order of magnitude of tenths of billions Euros, with tenths of thousand employees with major districts reaching turnovers above one billion Euros equalling that of a very large firm. Industrial activity of Italian districts is estimated around the half of the total manufacturing activity in Italy and its contribute is essential to determine the economics of this country. Although the existence of industrial districts in Italy can be documented since the second half of the XIX century, it is only in the '70 of the past century that this phenomena has been studied from the social and economic point of view. These studies have been reviewed recently by Becattini (2002) that is considered the initiator of such types of investigations.

Development of a theory and modelling of industrial districts is a hard work and our experience has suggested that an approach based on science of complexity, such as that sketched by Lane D. (2002), is the most useful for our purposes. This model, thought especially for Italian type of districts, considers a district, with its highly diversified products of the same type, as a subsystem of a market and may be described not just simply by a network of firms but also by a network of agents constituted by entrepreneurs and employees that would become entrepreneurs. In fact, the dynamic of a district during its formation and expansion is often dictated by generation of firms by past employees or separation of former associated entrepreneurs and also the inverse phenomena of entrepreneurs that close their firms and become simple employees in other firms. A district could then be considered as a double network of firms and agents with complex relations between the two networks. The existence of these two networks and the consequent dynamics is essential to assure to the district a good exchange of ideas, knowledge, know how and technologies for its development. Another important aspect of this model of district is the existence of a specific scaffolding structure that is important for creating and maintaining of networks and social cohesion in the district. Components of such scaffolds may be formal such as sector associations, fairs, research laboratories, firms and local public agencies delivering special services, but also informal such as regular meetings, talk shops among people and firms of the district, etc. As we will see later scaffold components may play a very important role in developing cooperative projects in a district.

There are many types of industrial clusters including the typical Italian industrial districts. An article of Bottazzi G. Dosi G. Fagiolo G. (2002) has presented a variety of agglomerations divided in five broad classes including: horizontally diversified agglomerations producing a large variety of products and agglomerations of vertically disintegrated activity in which production is assured by a sort of process of division of labour. Such types of agglomerations are the most diffused in the typical Italian industrial districts. Other types of agglomerations such as hierarchical spatially localized firm, based mainly on subcontracting networks organised often around large firms, and agglomerations based on knowledge complementarities, such as the famous example of Silicon Valley in the USA, are much less represented in Italy. Finally there is a last class of agglomerations in fact constituted by clusters of industries, without specific advantageously interactions among them, resulting by industrial history of the area and casual factors, that is without interest for our studies. For our purposes it is useful to also consider a specific classification of firms existing in typical Italian industrial districts from the technological point of view and, to do that, it is necessary to define a certain general model for technology.

The science of complexity offers two types of approaches to model technologies, one considers technology as an artefact made by various components, such approach has been extensively described by Frenken K. (2001), another one considers technology as a process as described by Auerswald P. Kauffman S. Lobo J. Shell K. (1998). This last approach is the most useful for our purposes and it has been generalised by Bonomi A. Riu A. Marchisio M. in a working document (2006) for application in real cases. This approach considers technology as a sequence of technological operations such as heating, drilling, assembling, etc. each characterised by a certain number of possible instructions such as temperature of heating, depth of drilling, choices for assembling procedures, etc. An important point is that operations are not specific of each technology but may exist also in other technologies as is their combination in the sequence that makes different the technologies. Used instructions for one operation may of course be different from the same operation used in other technologies. Another important point is that the choice of a specific instruction for an operation may influence the efficiency of other operations and then the total efficiency of the technology. This aspect is considered as the intranality of a technology and may assume different configurations for the various technologies.

When proceeding to a technological classification of firms in a district it is useful to consider the various operations constituting the technology used for the manufacturing of a certain product. In Fig. 1 we have reported, as example, a schematic view of the sequence of operations used in the production of faucets. Starting from brass bars or ingots, they are separately treated by hot stamping and machining, casting and finishing, chromium plated and finally assembled to make the final product. In a typical Italian industrial district the various operations are not made by single firms but are distributed in various firms. For example in the district producing faucets operations such as casting, hot stamping and chromium plating are often made by different firms than those making machining and assembling the final product. From this point of view we may classify the firms in a district in horizontal firms that produce and commercialise the final product and vertical firms dedicated to execution of specific manufacturing operations for the horizontal firms in a complex exchange of subcontracting agreements and flux of semi-finished products. Although there are districts composed essentially by horizontal firms, the mix of vertical and horizontal firms is quite diffused and makes more complex the networks existing in a district. In fact, many horizontal firms have the capability to make most of the operations for the production of the final product but prefer to use vertical firms to produce part of semi-finished goods, avoiding to take the risk of investing in expansion of capacity of their plants. On the other side vertical firms are not particularly touched by a crisis of production of some horizontal firms because they deserve normally numerous different firms. This way of production assure a good flexibility to the district but has an handicap in the introduction of technology innovation already discussed by Russo M. (2003) studying the district of tile production. In fact, when a particular firm consider the introduction of a particular technology innovation, because of the intranality of the technology, it could make necessary important changes in the carrying out of operations and even change of equipment in other firms subcontracting certain operations that not necessarily are willing to make such changes, especially in periods of stagnation of business. That leads to abandon many potentials innovations and limits the possibility to generate patents.

Despite of their limitations Italian industrial districts are nevertheless attentive to technology innovation using methods based mainly on adaptation and combination of new technologies existing in other sectors, while innovation made through laboratory R&D is much less diffused. This way of making technology innovation has been effective in the past also to develop radical innovations that have given high competitiveness and business expansion to the districts but it is now less effective because the level of complexity of present technologies makes less probable to develop radical innovation outside laboratory R&D. Another important source of technology

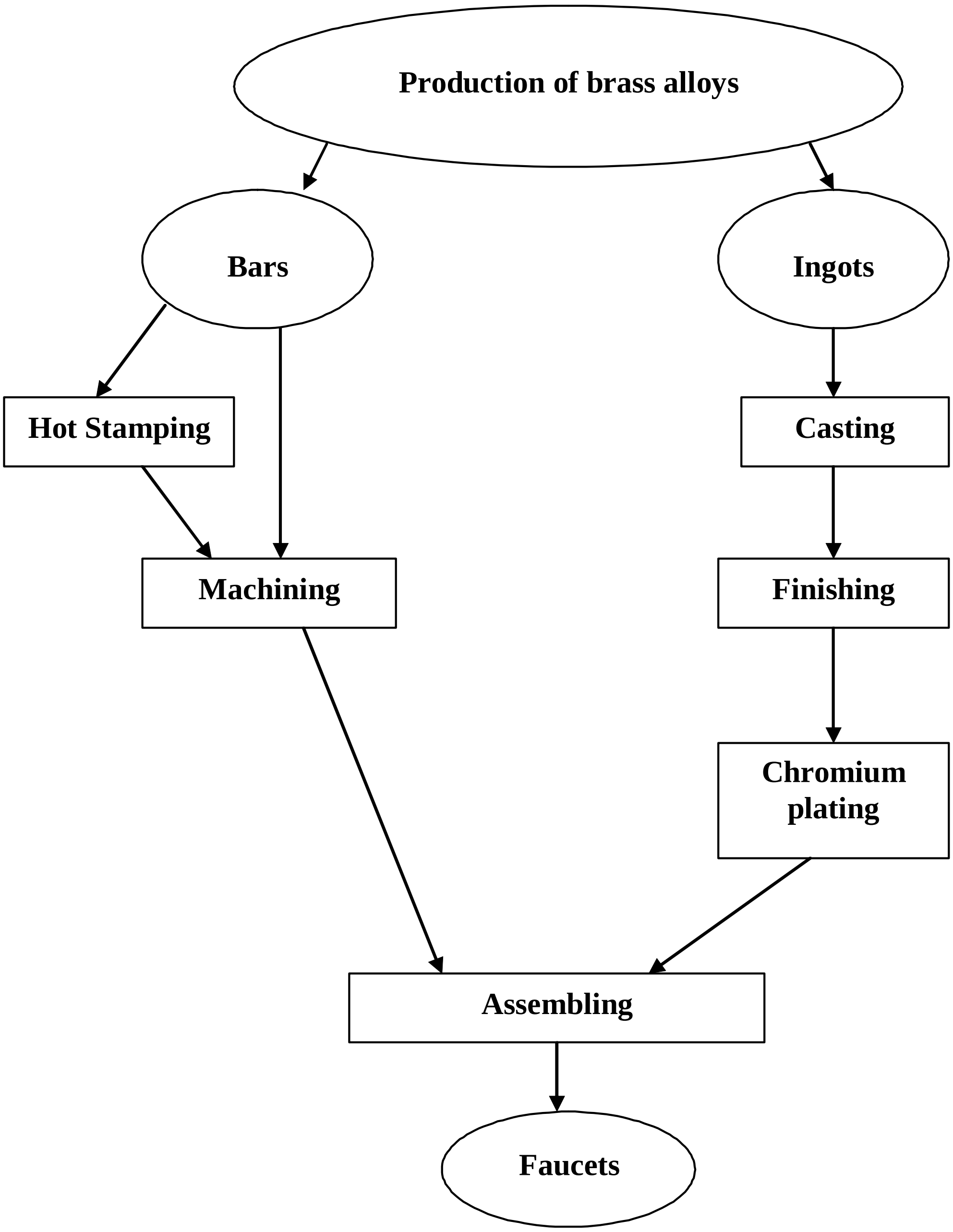

Fig. 1. Technological operations in production of faucets in Italian industrial districts

innovation is constituted by innovative production equipment developed and offered by engineering firms active also outside the districts. However, technology innovations made by engineering firms, that have generally interests also outside the district, may induce an opposite effect as these firms may propose new technologies also abroad to firms in competition with the district as described by Russo (2004) in a study on the ceramic industrial district. Nevertheless, positive examples of contribution of engineering companies to technology innovation in a district exist. A remarkable example is that of "Bresciani", a developing district of scrap steelmakers near Brescia, that at the end of '70 caused the closure of many traditional plants all around the world, producing steel long products from iron ore and ingot casting, as consequence of use by Bresciani of new more effective technologies constituted by ultra high power electric furnaces, developed by the Italian engineering company Tagliaferri, and continuous casting plants developed by Danieli, another Italian engineering company.

In fact, most of the limitations of technology development in Italian industrial districts are those typical of small enterprises and discussed for example in a previous article by Bonomi A. Haour G. (1993) and may be condensed in three points:

a) Lack of competences to carry out and manage a complex activity such as R&D necessary to technology innovation
b) Lack of capitals available for technology innovation, especially for developing phases after feasibility studies
c) Lack of time for people working in small and medium enterprises to follow R&D projects and have a continuous activity in this field

Cooperative work through studies and R&D projects may be a solution to the previous problems supplying competences, reducing financial requirements to the single firm by sharing costs with other partners and making available time for the development work. Such approach with examples of carried out real experiences is described in the following chapter.

3. Organisation of cooperative technology innovation in districts

The major problem that should be solved when beginning an activity in organising cooperative technological development in a district is not necessarily the lack of competence, capitals or time but the problem of what innovation should be done. In fact district firms do not know well what kinds of innovation project or new technology would be useful for the district and, when they have some idea, not necessarily it corresponds to what is the best to do and, in every case, they have difficulties to put the idea in form of valid project. This aspect constitutes a great limitation to the efficiency of the top-down approach made generally by public agencies or laboratories that make available money to promote technological innovation waiting from small business enterprises for R&D projects to be financed. Actually our approach is bottom-up and the first task is to launch a cooperative preliminary study able to emerge possible technological innovations useful for the district carrying out evaluation and selection of the projects. This preliminary study is followed by the work of organising the cooperation networks that would develop the new technologies and finally by the R&D work on the projects.

As the cooperative technology innovation is thought as work useful to the whole district, it is important to avoid the raising of competition among various district firms around a cooperative project. For these reasons the technology innovations are searched in the context of technological operations commonly made by districts firms avoiding to enter in the final design of the products that determines most of the competition existing among the firms of the district. From the methodological point of view the launching of the preliminary study of identification of potential R&D projects starts with the preparation of a preliminary program of the study and a questionnaire to be sent to district firms. Reply to the questionnaires and meetings among interested firms will be used to refine the proposal and making the official launching of the study. It is important for the validity of the results of the study that the group of companies participating to the study shall be not only enough large to cover the budget of the study but also include companies covering all together all the technological operations used for the production of the district. Identification of potential projects results by in depth study of documents, collected also by data bank investigations, and covering scientific, technical and market aspects of interest for the district. Essential are direct discussions and meetings with firms participating to the study and meetings to identify, evaluate and select the projects. The general consensus normally arisen around the selected projects will make easier the following work to build up the necessary networks to carry out the various R&D projects.

It should be noted that R&D projects may be of various nature, someone concerning long term development of radical innovations, others may be very close to the industrial stage. Cooperation is useful not only for projects with large financial supports and long term commitments but sometime also in situations of quite simple introductions of well known new technologies because costs of testing are too high in respect to the limited expected return of investment caused by the small production size of the enterprises.

In order to explain better the work concerning the organizing of cooperative technology innovations in districts we present here the experience of two applications of our bottom-up methodology carried out in the two Italian districts producing faucets and valves existing near Brescia and in the northern part of the province of Novara in 1997 and 2005. The first experience has been carried out by Tecnoparco del Lago Maggiore in 1997, acting as component of the scaffolding structure of the districts, and following some contacts with firms of the sector of valves production. The preliminary study launched through pre-proposal, questionnaire and meetings concerned the search of new technologies for substitution of galvanic technologies and materials in faucets and valves for drinking water. A total of 23 companies joined the study, three more than the twenty necessary to cover the budget of 50 million Lit. with single participations of 2,5 million Lit. It is interesting to see how participations arrived with time during the launching of the study as reported in Fig 2.

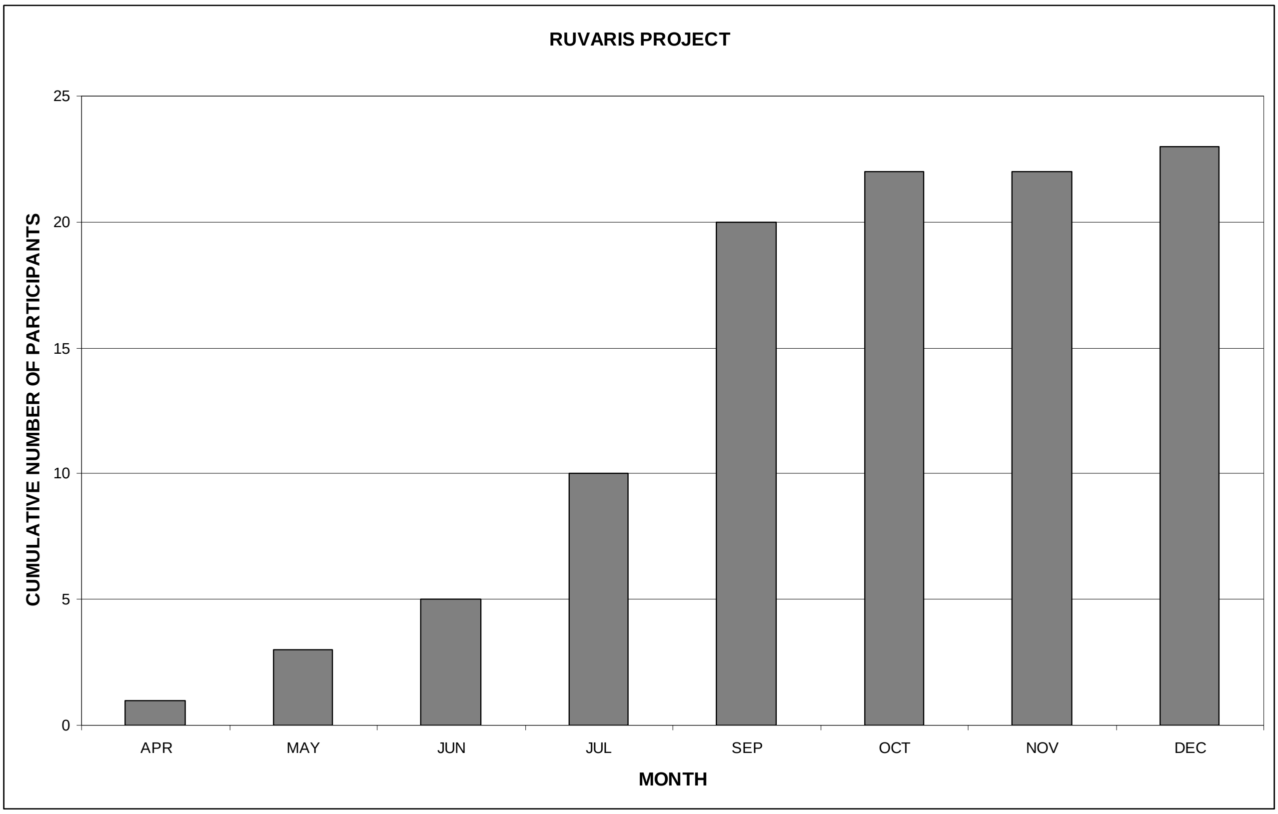

Fig. 2. Evolution of number of participants in the first study creating Ruvaris

Official launching of the study started on April 1997 and in July 1997 it has been decided to start the study after collecting about ten participations. The starting of the study had an agglomeration effect in September with joining of other ten companies and reaching the total final number of 23 in December 1997. This agglomeration effect caused by the start of the study before the reaching of the total number of partners necessary to cover the budget is well known in launching multiclient studies and should be exploited to avoid a slow increase of number of participants existing before the starting of the study that could take long time and possibly causing a loss of interest for the study. The study, terminated in January 1998, resulted in three projects but only the most important, concerning the development of a process for the elimination of lead from the surface of brass in order to comply new regulations about contamination of drinking water, was successful in joining six companies of the sector that founded in June 1998 the company Ruvaris to develop the technology. The composition of the associated companies was well sorted as included four horizontal firms, three in valves and one in faucets production, and two vertical firms, one in surface treatment and the other one in manufacturing of products and plants for surface treatment. The development of the technology lasted about two years and technology is now commercialised under the trade name of RUVECO® and is presently used in about twenty plants in Italy but also abroad. Furthermore Ruvaris developed other collateral activities concerning consulting and laboratory testing for the products of the districts to verify the complying of norms and regulations and offers a certificated trade marks called "green taps" and "green valves" for taps and valves free of toxic contaminations of drinking water by heavy metals.

The second similar experience has been carried out recently in 2005 still in faucets and valves districts. In absence of any initiative of this type by public agencies and aware of the need to promote more and more technology innovation in the districts, Ruvaris decided at the beginning of 2005 to launch a similar preliminary study, that was at the origin of its creation, in order to identify useful R&D projects involving the entire set of operations carried out to produce faucets and valves, as reported in Fig. 1, with the exclusion of assembling and specific design of the products. Pre-proposal, questionnaires, final proposal and meetings were done to prepare the official launch of the study on May 2005. The evolution of number of participants is reported on Fig. 3 and reached the number of 19 in December 2005. Confronting with Fig. 2 the agglomeration effect is a little less pronounced and happened before the decision to start the study made end of July 2005. The budget considered was 40'000 Euro with a minimum of 16 participants to cover the budget at a cost of 2500 Euro for each participant. The study is terminated in February 2006 with the identification of six possible R&D projects, three of them quite important and probably able to form the necessary networks of companies to carry out the projects. An important issue of this study is the intention to give to the districts a continuity of activity of monitoring studies, identification, evaluation and selection of R&D projects and their running through networks of laboratories and firms. For this purpose it is necessary to have a suitable true scaffolding component in the districts and Ruvaris has decided to take up the challenge by selling its interests in RUVECO® technology and trade marks and transforming the company in a consortium open to the participation of all the firms of the districts and offering such service of cooperative activity.

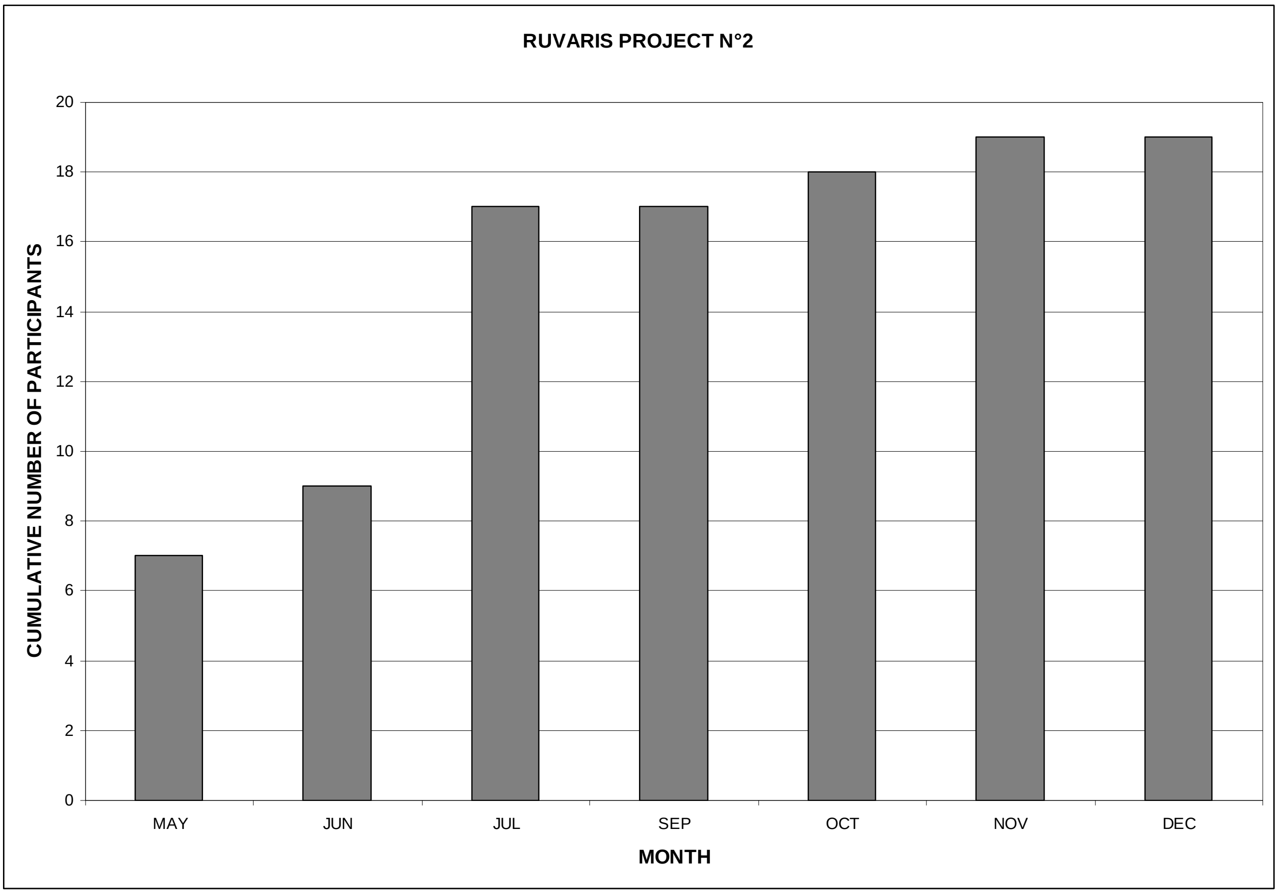

Fig. 3. Evolution of number of participants in the 2nd study promoted by Ruvaris

4. Organisation of cooperative networking for R&D projects

In order to understand our method of organising and management of R&D network projects in districts it is useful to have a certain model for the R&D activity existing in a firm. A useful model for our purpose has been described by Dumbleton J. (1986) and we have developed a modified version suitable for cooperative R&D. In this model R&D activity is considered as fed by two types of fluxes: one is capital financing and the other one information. The production of R&D activity, independently of its success, is essentially information. Such information can be divided in two fluxes: one external to the firm in term of publications, documentations, patents, etc. the other one is internal to the firm in term of reports, samples, prototypes, etc. as well as general experience available for future R&D activity. Such internal information may be used to develop new processes or products whose profits combined possibly with external various types of capitals finances future R&D activities. Possible external public aid may also be available to finance R&D. In this way R&D activity includes two cycles: one external constituted essentially by information also coming from other R&D projects, technologies and scientific research, and the other one internal of capital financing and information transformed in capital financing by profits of new processes or products. A schematic view of such model of R&D activity is reported on Fig. 4.

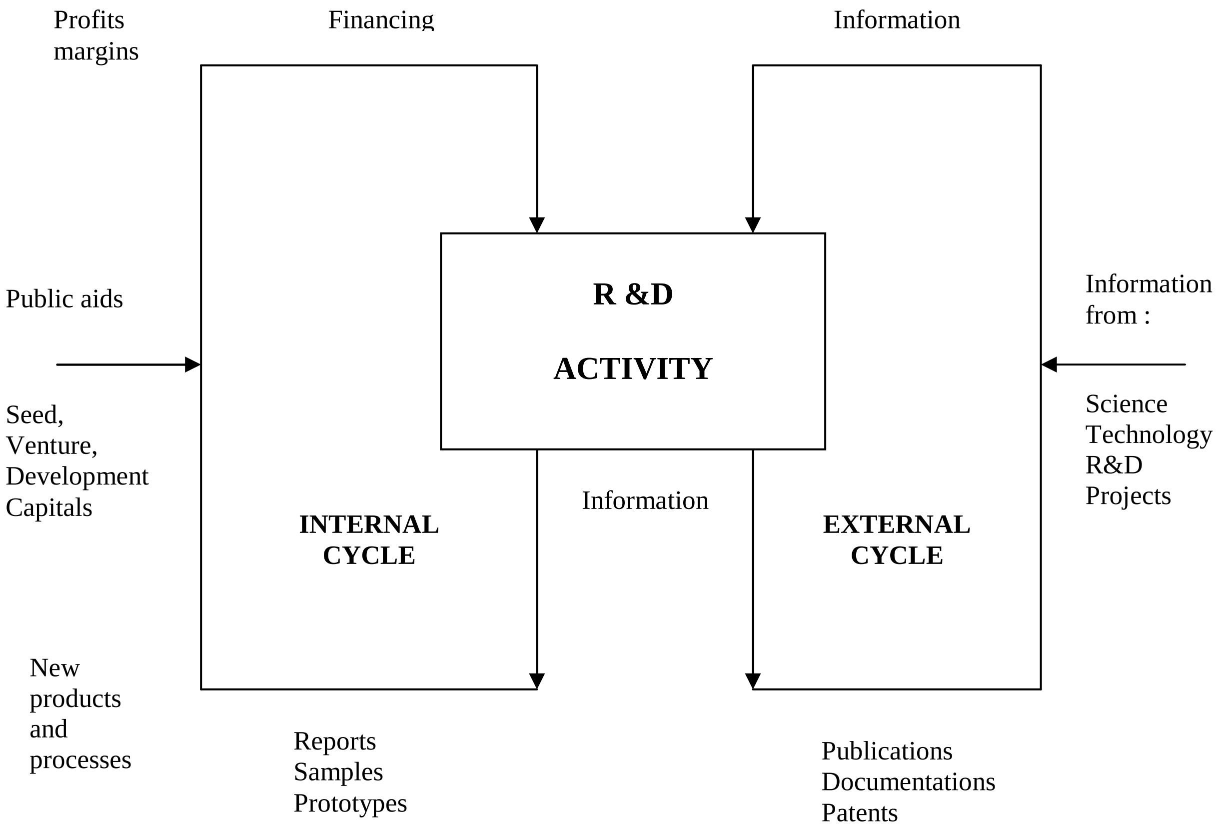

Fig. 4. Financing and information cycles concerning R&D activity in a firm

When considering a R&D activity in networks, the situation may be more complex as fluxes of information and financing are not simply internal to the firm carrying out R&D, but distributed in a more or less complex way throughout the network. Managing R&D activity in a network means to manage the fluxes of financing and information in the network. Another complex aspect arising from making R&D activity in a network concern industrial property coming for this activity and that should be distributed in an equilibrate way but we will not discuss this problem in this paper.

Fluxes of financing and information in a network may be easily represented by a graph in which nodes correspond to the various elements of the network (firms, research laboratories, public organisations financing research, etc.) and oriented arcs the flux of financing or information through the nodes of the graph. In Fig. 5 we present a simple network for R&D project constituted by a firm A that makes R&D in a research laboratory L with the aid of a public agency P. Information coming from the R&D activity goes from L to A and to P and arc from L to P is marked different as information required by P is normally of different type from that required by A. Flux of financing are from firm A and agency P to laboratory L. This kind of R&D network is quite used by medium and large enterprises exploiting public aids for R&D, however it is not well suitable for district firms that for their small size are not able to finance alone the development of the technology and face difficulties by the existing intranality because of the complex distribution of the technological operations in the district as discussed previously. Furthermore the project may be originated by the laboratory L or firm A but it not constitutes necessarily the best R&D project for the district.

Fig. 5. Simple network for R&D projects

In Fig. 6 we present the fluxes of information and financing in the traditional network structure existing in CRAFT projects promoted by the European Commission. In this case a research laboratory L makes R&D for a group of firms A1, A2, A3, … generally small enterprises without available laboratories to make the research. The project is partially financed by the Commission P. This kind of network may solve the problem of financing but has a hierarchical structure that imparts a certain rigidity in its functioning. In fact, it does not take account of experience and development capabilities that may exist in the group of companies supporting the project that may play an important role in assuring the success to the project. Furthermore, as it is unlikely that a small enterprise will be initiator of the project group, frequently is the research laboratory to take the initiative to build up the necessary group of cooperating firms. That gives a top-down character to this kind of cooperation and the proposed projects tend to be more linked to ideas and capabilities of the laboratory than being the most appropriate projects needed in a district.

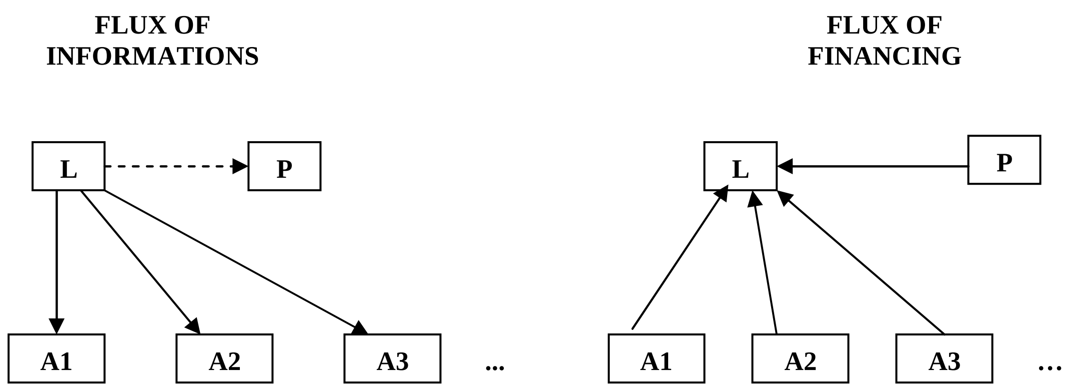

Fig. 6. Traditional network for CRAFT projects

In our approach cooperative networks in R&D are generated in different way in a bottom-up process coming from ideas of projects emerging from specific studies and having a certain consensus in the district. We may illustrate such approach using a real example originated by our studies in the districts. There is a foundry with a modern technology, used mainly for cast iron, that could be a valid alternative to traditional brass casting used by faucets producers. However, use of this new casting technology requires a certain investment in making a suitable equipment for trial that may be considered by a faucet producer too high compared with advantages coming by their limited production size. One possibility to overcome this problem is to carry out these trials in a cooperative way in order to decrease sensibly cost and risk for each enterprise. Simple casting trials are however not sufficient to give useful results but it is necessary to verify by testing real faucets parts produced with this new technology compared with the same parts produced with traditional casting. The idea of using an external laboratory to make foundry trials and verification testing is unsuitable for the high costs and it has been decided to use small size casting capabilities existing in the foundry for trials while one of the faucets producer will supply the testing faucet part and make all the necessary verifications. The results obtained will be made available to all the other faucets producers participating to the trials. In Fig. 7 we present three possible arrangements of a cooperating network indicated as Case A, B and C. In the networks F represents the foundry, R1 the faucets producer that supply testing faucet part and make verifications of resulting castings, R2, R3 … the other faucets producers that cooperate in the network, C is a particular scaffolding component of the district that in our case has been played by Ruvaris with its study on identification of R&D project for the district. In the first Case A the network is composed only by the foundry and faucets producers. Information fluxes come from either the foundry and faucets producer R1 to all other components of the network. Financing fluxes come from all faucets producers to the foundry. Cost supported by faucets producers are only a part of the total cost of trials and the foundry participates for the other part. In the second Case B the scaffolding component C, that has promoted the network, participates externally to the network of financing fluxes but receives, in exchange of its promotion action, the information coming from trials that may be useful for its activity. In the Case 3 the scaffolding component C play a central role in the network by collecting and redistributing information and financing among the foundry and faucets producers. Practically Case B is that presenting the most effective situation. In fact, Case A is unlikely to be realised by initiative of a faucet producer. The foundry may be the initiator, however the credibility of its proposal may be invalidated by being a part offering the technology. Promotion action of C is then essential to facilitate the formation of the network, however in Case C the role of C is a little too wide and not necessary for such simple and low cost project. In other types of more important networks C may assume a very important central role for the formation and management of the network. A case of this type is now under consideration and concerns the introduction of a new material for the production of faucets and valves. The possible network under organisation is reported in Fig. 8. The determination of the validity of a new material in faucets and valves production implies the examination of behaviour of this new material in various operations such as hot stamping, mechanical working and suitability to surface treatments such as chromium plating used essentially by faucets producers. To make such project it is necessary to build up a network composed by faucets and valves producers indicated respectively as R1, R2, … and V1, V2, …, a laboratory L that makes material characterization, a firm able to make machining trials M, a firm for hot stamping trials S and a firm able to verify suitability of material for surface treatment T. In this case the central role of a scaffolding component C is essential to organize and manage the network. It should be noted that machining firm M, hot stamping firm S and surface treatment firm T may be either suppliers of information from their trials or supporters for financing if interested to have the whole results and possible industrial property coming from the project. In Fig. 8 we present the network in the simplest case in which such firms are not a part in financing the project. Another aspects to be considered for the network is that treatment surface studies are of interest only for faucets producers and fluxes of information and financing for faucets producers should be different from those for valves producers. In the case that firms M, S or T participate to financing in the network there will be a double inverted arcs for flux of information and financing between C and these firms not reported in Fig. 8.

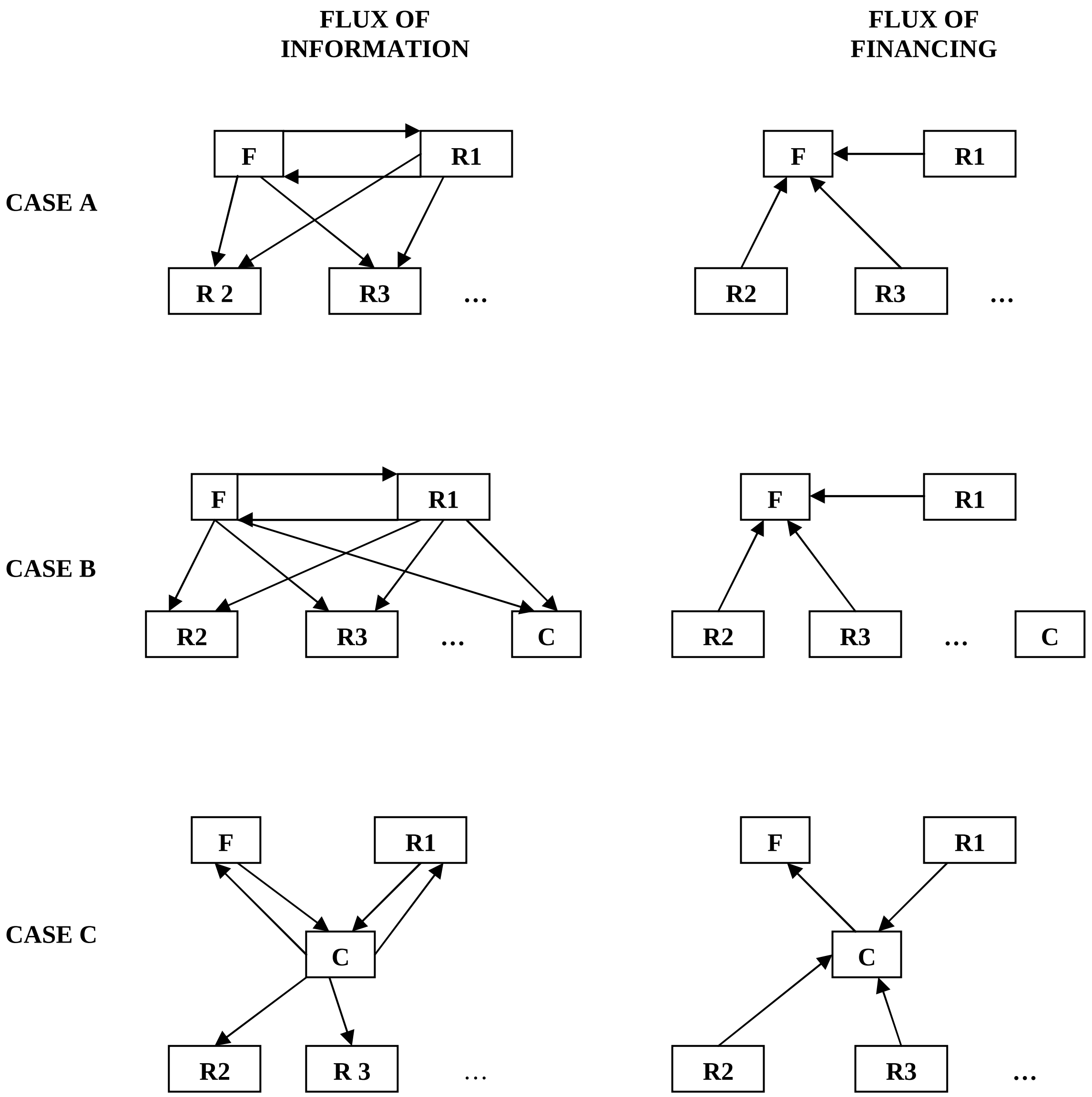

Fig. 7. Examples of possible cooperative networks: foundry project

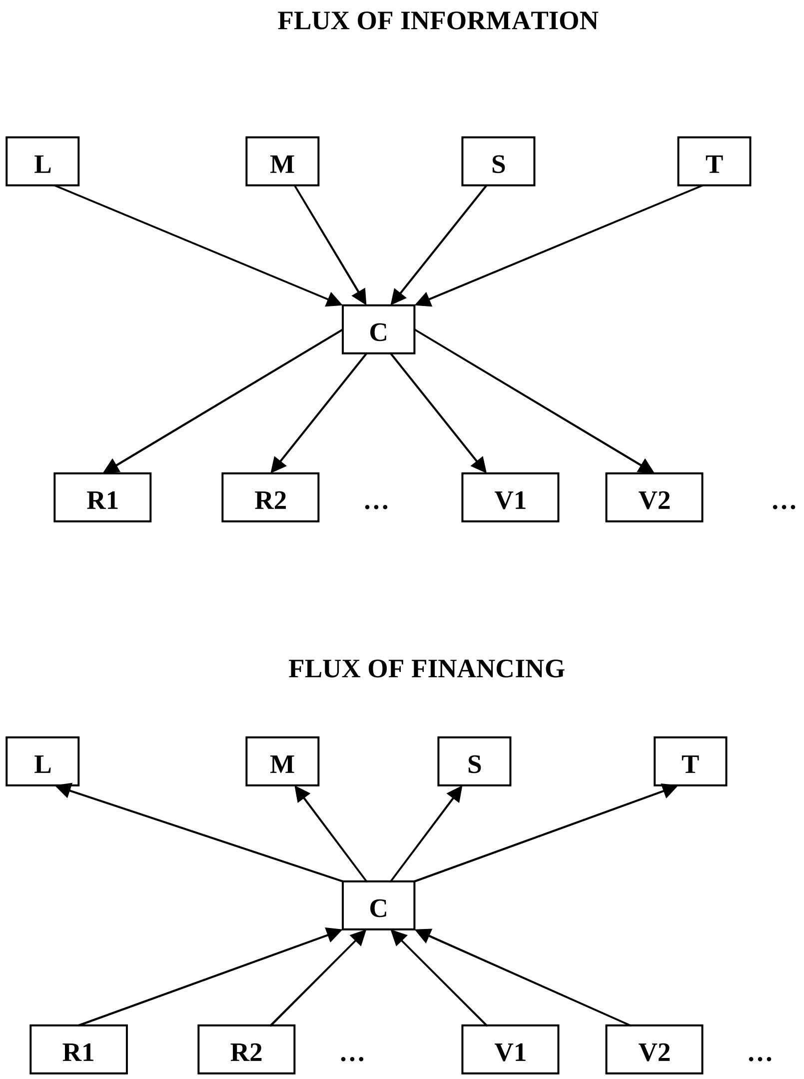

Fig. 8. Example of possible cooperative network: new material project

5. Conclusions

We have shown in this paper that an industrial district is not simply a group of small firms but a complex network of interacting firms with a specific technology distribution in manufacturing the district products. For these reasons conventional top-down methodologies used by public agencies for supporting R&D activity for large and small enterprises have a limited effect in districts. Bottom-up methods, such as we adopt in cooperative projects, seems well suitable as the two experiences carried out in the Italian districts of production of faucets and valves have shown.

Because of the complex technology distribution in a district, single R&D projects proposed by research laboratories or single firms are not necessarily the most effective in raising the technological innovation level in a district and studies that make the emergence of R&D activities supported by a general consensus in the district are important for reaching such objectives.

The carrying out of cooperative R&D projects in the districts needs the generation of quite complex and flexible networks we have given a few examples in the paper. Conventional cooperative top-down projects, such as CRAFT projects, have some times an excessive hierarchical rigidity to reach effective objectives of low cost, maximum capability exploitation, and rapidity necessary to development of technology innovation in industrial districts.

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