

\\ 272 \\

**Complementary Innovations and Generative Relationships  
in a Small Business Production System:  
the Case of Kervit**

by

Margherita Russo

April 1999

Università degli Studi di Modena e Reggio Emilia  
Dipartimento di Economia Politica  
Via Berengario, 51  
41100 Modena (Italia)  
e-mail: [mrusso@unimo.it](mailto:mrusso@unimo.it)

### *Acknowledgements*

The support of the European Union T.S.E.R. project “Industrial Districts and Localized Technological Knowledge” and of CNR (CT.96.15670.10) is acknowledged.

This study could not have been performed without assistance from Antonino Dal Borgo, who patiently took me for a trip through a technology that even now presents a challenge for experts in ceramic tile production. I wish to thank him for what he has taught me.

Thanks to Leopoldo Cini and Gastone Vecchi, Paolo Zannini and Giorgio Olivieri I was able to track down the technical material on kervit and Maurizio Korach used in this article. Thanks also to the staff of the Economics Faculty library, Modena, for help with bibliography.

Thanks, lastly, to Marco Bellandi, Giovanni Bonifati, Franco Carnevali, David Lane, Daniele Libertucci, Giovanni Solinas, Michelangelo Vasta and those attending the Nice Seminar of the TSER-INLOCO research group for comments on a previous version of this paper.

### *Abstract*

Why is it that, after two decades of successful use on an industrial scale, with a couple of dozen licences granted to firms in various overseas countries and a marked degree of competitiveness in terms of cost, a technology is abandoned even though several basic characteristics featured in the processes that will become standard in subsequent decades? What are the conditions in which patent protection of a production method can actually bring about a decline in the use of the patented technology?

This paper offers an answer these questions by pointing out the irrelevance of «natural» technological trajectories in the process of innovation and highlighting the way in which the technical developments under discussion present marked discontinuities. These can be explained by the fact that development of a new technology does not feature merely elements of technical necessity but, rather, that path-dependent processes come into play influenced by heterogeneous and contingent factors – technical, social, economic factors and, to some extent, also political and institutional factors – that interact to produce the particular form of technological development that ultimately manifests. A case study of a failure offers us the opportunity to analyze phenomena that are not generally visible but are relevant in interpreting the dynamics of innovation. In particular, the paper makes use of the notion of «generative relationships», put forward by Lane and Maxfield (1997), and adopts the ethnographic method to analyze the process of innovation.

JEL Classification number: O 30, L60, N84

*Key words:* dynamic complementarities, innovation dynamics, generative relationships, local production systems, patents

## CONTENTS

1. *Introduction*
2. *Localized knowledge and patents*
3. *The method of data collection and analysis*
  - 3.1 Generative relationships and innovation: looking for an adequate language
  - 3.2 Ethnographic method to describe and interpret the dynamics of innovation
4. *Kervit technology: changes in artifact attributions*
5. *Relational aspects: continuity and discontinuity in the dynamics of change in the agent/artifact space*
  - 5.1 Maurizio Korach appears on the scene
  - 5.2 The failure of Ceramica Veggia
  - 5.3 Small improvements within the firm vs. collective invention in the local system
  - 5.4 Enterprise organization models and social relations
  - 5.5 Technical knowledge and industrial dynamics
6. *Monitoring and fostering generative relationships: the missing conditions*
  - 6.1 Internal relations: the lack of heterogeneity and right permissions
  - 6.2 Technical and social dimension of the imitation process
  - 6.3 The social dimension of patents

## 1. Introduction

Why is it that, after two decades of successful use on an industrial scale, with a couple of dozen licences granted to firms in various overseas countries and a marked degree of competitiveness in terms of cost, a technology is abandoned even though several basic characteristics featured in the processes that will become standard in subsequent decades? What are the conditions in which patent protection of a production method can actually bring about a decline in the use of the patented technology?

This paper offers an answer these questions by pointing out the irrelevance of «natural» technological trajectories in the process of innovation and highlights the way in which the technical developments under discussion present marked discontinuities. These can be explained by the fact that in the development of a new technology there are not just elements of technical necessity but, rather, path-dependent processes come into play influenced by heterogeneous and contingent factors – technical, social, economic factors and, to an extent, also political and institutional factors – that interact to produce the particular form of technological development which we finally observe.

The process whereby knowledge is created and transmitted is a critical aspect in the analysis of how innovation comes about. The dynamic dimension of this phenomenon requires us to identify the analytic tools which will enable us to define and interpret the historic sequence of different, but endogenous, spatial interactions – between agents and between agents and artifacts – by means of which codified knowledge, tacit knowledge, technical practices and cultural values are interwoven and fused into a specific local fabric which sustains and fuels innovation. To understand the laws of the aggregate dynamics of localized technological change, in this paper I shall adopt an ethnographic method and I shall use the notion of «generative relationships» put forward by Lane and Maxfield (1997). This notion provides an appropriate language to single out and describe the elements that define the dynamics of changes in the agents and artifacts space.

In section 2 the paper presents an overall picture of the topics to be discussed in the empirical analysis; section 3 illustrates the relevant features of Lane and Maxfield's notion of "generative relationships", and the ethnographical method I have used in collecting the data for this study; Section 4 outlines the social, technical and economic features of the kervit technology; section 5 highlights the relational dimension of knowledge and the changes in the agents and artifacts space and, lastly, section 6 points out the chief conclusions to be drawn from this study, referring both to the dynamics of innovation in a local production system and to the more general analytical aspects of the innovation process.

## 2. Localized knowledge and patents

The empirical research concerns the case history of kervit<sup>1</sup>, a radical innovation in the production of ceramic tile which was first tested by an Italian firm at the end of the 1930s and protected by various patents obtained at the end of the 1940s. For about twenty years, the firm that had initially patented and introduced it (S. A. Industria Ceramica Veggia) was also responsible for building all the machines and equipment needed to improve the technical and economic efficiency of kervit. After two decades of improvement in its use on an industrial scale during which a couple of dozen licences were issued to various firms in European and Latin American countries, the kervit technology went out of use owing to the closure of the company that had patented it.

When kervit was abandoned in the mid-1960s, Italian tile production was being launched on the rapid growth that has characterized one of Italian industry's most dynamic districts – namely, the ceramics district of Sassuolo-Scandiano (in the provinces of Modena and Reggio Emilia in Emilia-Romagna region). The history of kervit, therefore, takes us up to the opening stages of a local

<sup>1</sup> The name kervit is an acronym composed of the first three letters of the Greek word *keramos* (ceramic) and the Latin word *vitrum* (glass).

productive system<sup>2</sup> and enables us to see how the process of training technical expertise within the firm that introduced the innovation gave origin to wide spillovers that allowed the sedimentation of massive tacit knowledge in the local production system. In particular, the kervit became a shining example of what to do in technical terms, but also an example of what not to do in economic and social terms.

Let us first of all consider the overall framework in which to locate the kervit story: the birth of the ceramics districts, a district strongly oriented towards exports and where interaction between producers and users of machines have played a central part in the development of the system (Russo, 1985). In the initial stage of development of the ceramics district, the main worldwide producers of ceramics machines were large German and British engineering firms. With the expansion of the market, concentrated in a very limited area, these firms were joined – and shortly replaced – by new firms born in Italy in the ceramics district in order to produce a vast range of machines and equipment devised *ad hoc*, with the aim of meeting the growing demand for automation in the tile-producing process, but also of extending the range of products, reducing energy consumption and satisfying the ever-increasing environmental regulations<sup>3</sup>. Even now, these engineering firms, mostly small<sup>4</sup>, generally specialize in individual performance of one or a few of the stages needed to produce a single type of machine, or have recourse to a complex network of engineering subcontractors for other engineering production present in the region – e.g. automobile engineering for sports cars and luxury models (produced by Ferrari, Bugatti, Maserati), tractors, machines for the food industry. The subcontractors for firms producing ceramics machines seldom do additional work for other sectors: the mechanical stages and components they produce generally occupy a lower band in terms of the tolerances requested. However, their proximity to engineering firms that are more exacting from the technical point of view represents a continual source of enrichment of technical skills, owing to the mobility of workers (Brusco, 1982; Russo, 1985; Bellandi, 1989).

In characterizing the Sassuolo ceramics district it is thus necessary to keep in mind not only the multiple interactions between the engineering firms producing ceramics equipment and between these and the ceramics firms that use them, but also the interactions between all these and other firms – operating in the vertically integrated sector of tile production – that specialize in graphics, or transport services or in the many other commercial, administrative, technical and financial services. The majority of these firms are located within the ceramics district, which comprises an area of about 50 sq.km.

The extraordinary complexity of the system we see today could hardly be conceived in the 1950s, when the kervit technology underwent its maximum expansion and Industria Ceramica

<sup>2</sup> On the notion of local production system, cf. Bellandi and Russo (1994).

<sup>3</sup> In a comparative analysis regarding Italy, Spain, France and Germany, the effects of environmental regulation on the competitiveness of the firms in the ceramic district are discussed by Russo *et al.* (1998).

<sup>4</sup> When kervit was invented there was no small business system; all there was were three firms. It was not until the early Sixties that a host of new tile producers and ceramics machinery manufacturers made their appearance, specializing in production and forming a tight network of sub-supplier relationships. The reference to «small» business should therefore be related to the phase in which kervit development reached its peak. As far as the size of the business is concerned, it should be understood in relation to the size of the market. In the absence of economies of scale of a different nature, the years 1930-1950 saw technical economies of scale in tile production which were influenced by the capacity of the kilns, which at that time was around 1000 square metres a day for firing pressed material and around 300 square metres a day for glazed material. It was hence a very small dimension compared with the size of the market and not prohibitive compared with the investment necessary to construct a plant of minimal efficiency dimensions. When the Sixties witnessed a dramatic increase in domestic demand, the absence of barriers meant that a lot of firms set up in the ceramics industry. Only in a few cases was there a marked increase in the size of the firms, since such an increase would have required a different organizational structure based on administrative, managerial, commercial and technical functions which were quite unlike existing ones and which new entrepreneurs were not yet in a position to envisage. From the end of 1970s, the size distribution of tile-producing firms was modified by continual mergers and takeovers, so that today it is largely characterised by the presence of some large groups (Russo 1996).

Veggia produced in-house not only all the intermediate goods needed to manufacture kervit tiles, but also the machines and equipment employed in the production process.

In tracing the history of kervit I shall show that the decision to abandon this production method was not due to the assumption that it had been economically and technically outgrown: the available documentation shows that it was remarkably competitive already in the 1950s (Vecchi, 1952) and recent estimates still assess it as a competitive technology<sup>5</sup>. The technology to produce kervit tiles contained some of the basic ideas that feature in the technical development of what, over the last twenty years, has become the leading technology at world level in the production of ceramic tiles: single-firing production. However, kervit was not abandoned owing to its being «way ahead of its time». I think that kervit was dropped as a result of the gradual reduction, in the 1960s, of the generative potential of the relations that, in the previous decade, revolved around the kervit technology: the mental closure of kervit's inventor with respect to the space in which he operated led him to underestimate the entity of the ongoing changes.

The historical analysis of the social and economic context in which the kervit technology emerges, is developed and subsequently discarded will shed light on the main actors and artifacts in the innovative process and will underline how interactions between actors change in time the environment in which they operate. It will further point out changes in attribution on the part of agents both of other agents and vis-à-vis the artifacts, and will highlight the endogenous and exogenous conditions that alter the generative potential of relationships, marking the demise of the innovation in question. It is by now widely recognized that the historical analysis of technologies which are abandoned demonstrates elements which are generally less visible when success stories are studied<sup>6</sup>. Here, the case study of a failure enables us to ascertain to what extent the lack of continuous monitoring of the generative potential of relationships can influence the dynamics within the innovative process.

In this paper, analysis of the generativeness of relationships becomes the key element for discussing the role of patents in assessing innovative activity in local production systems. The empirical analysis presented in this paper highlights that, even if there may be products and production methods whose original features make them suitable for patent registration, the full production and commercial exploitation of many patented innovations requires the construction of a network of relationships which are not only technical, productive and organizational, but also social and economic. Analysis of the social context in which the patented innovation has meaning for those who use it – an aspect generally overlooked in the economic analysis of patent registrations – thus becomes a crucial issue in the research<sup>7</sup> because such an analysis may actually turn out to be more conclusive than merely calculating the number of patents.

Economists by now tend to consider some of these aspects when observe that complementarity assets or capabilities must be utilized in conjunction with innovation (Teece, 1986; Antonelli, 1999). These complementarities are generally considered as already existing: to fully take advantage of the patent, the innovative agent has to decide whether to vertically integrate them with the innovation activity of the firm, or to implement partnerships with the owners of those complementarities (Teece, 1986). In this paper, instead, I link the role of these complementarities with the industrial dynamics and the dynamics of innovation in a local productive system. The basic idea is that a new product or a new production process nearly always needs to be accompanied by complementary innovations which are only developed if there is sufficient demand to sustain the effort needed to innovate. In these conditions, if the innovating firm patents the innovative product

<sup>5</sup> The hypothesis in this cost calculation is that production of kervit tiles uses present-day firing, glazing and movement techniques. In these conditions, the cost of kervit tiles would be competitive with that of tiles of similar porosity and thickness (Cf. Carnevali in 2DB, before 2DB47).

<sup>6</sup> This point was first pointed out by Hägerstrand (1965, 1968) and more recently restated in the work by Law and Callon (1992) on the TSR.2 airplane project. For a systematic enquiry into the conditions which accompanied the success or failure of a sample of over 200 innovations see the celebrated Sappho enquiry conducted in Great Britain in the early Seventies.

<sup>7</sup> Cf. Hughes (1971) and Carlson (1992).

or production process, but does not generate sufficient demand to induce other firms to develop necessary complementary innovations, and moreover lacks the expertise to develop them in house itself, then patent protection actually restricts expansion right the way through the innovative process. One reason for this restriction is explained in terms of "network externalities", generally associated with networks of consumer goods users (Katz and Shapiro, 1985 and Arthur, 1989).

But what the kervit story enables us to highlight is that such complementarities are also generated in the expansion stage of a new industry or new technology, when the increasing demand provokes the emergence of new actors specializing in one or more stages of the entire process of production of machinery, intermediate goods, semi-finished products, and services needed for the new technology (Bonifati, 1999). What we have, then, is complementarities of production associated with the growing roundaboutness of the production processes. In these conditions, if the patenting firm does not represent a sufficient source of demand, the patent protection may prevent the patenting firm from exchanging information with other agents who might otherwise contribute to solving technical problems which normally arise while the innovation is being fine tuned<sup>8</sup>.

In this context, we are interested in examining the complementarities emerging within the innovation dynamics (Rosenberg, 1996), and not only those already existing and that agents are ready to use; in other words, we are interested in the dynamic dimension of complementarities. The kervit story thus helps us to understand also in which particular ways the firms in a local productive system appropriate the benefits deriving from innovation – ways that require that the recourse to patenting be interpreted in an ampler perspective than economists have conventionally done.

### 3. *The method of data collection and analysis*

In section 3.1 I shall first briefly outline the analysis of generative relationships as put forward by David Lane and Robert Maxfield in their article «Foresight, Complexity and Strategy» (1997). In section 3.2 I shall describe the ethnographical method used to collect and analyze data relevant to the case under discussion.

#### 3.1 *Generative relationships and innovation: looking for an adequate language*

Any relationship between agents is made up of a multiplicity of interactions occurring at many levels (for example, personal as well as professional) and via many channels. Lane and Maxfield (1997) define as «generative» those relationships which can induce changes in the way in which those who participate in the relationship see their world and act within it, bringing about innovations which are generally characterized as new entities – such as, for example, new agents or new artifacts or new institutions. In these terms, the analysis put forward by Lane and Maxfield is consistent with the definition of innovation suggested by Schumpeter (1934), with the vision of space of action put forward by Perroux (1950) and with the notion of technological systems proposed by Hughes (1983)<sup>9</sup>. Lane and Maxfield's original contribution lies in their specifying what constitutes a «generative relationship» and in which ways such relationships can be created.

To outline these elements we must first introduce a major aspect of the analysis proposed by Lane and Maxfield – namely, the importance of the *interpretation* of the significance that agents ascribe to themselves, to other agents and to artifacts: what Lane and Maxfield call «attributions». The world in which agents operate is defined precisely in terms of their perception of the context in which they act. Within such a world the interactions between agents and between agents and artifacts define the structure of their space of action. Structural change in the agent/artifact space is thus mediated by new attributions as to the identity of the agents and the meaning of the artifacts. The identity of an agent is defined by what he does (his function), how he does it and with whom, and for whom (his character). The significance that agents ascribe to themselves, to their products,

<sup>8</sup> Rosenberg (1982) on learning by using.

<sup>9</sup> See also the works collected in the volumes edited by Bijker, Hughes and Pinch (1987), and by Bijker and Law (1992).



to their competitors and clients and to all the other actors present in their world determines the possible space in which they act and the way in which they act. The functions performed by the agent define the «zone» of a space whose structure the agent attempts to change. The character of an agent can be specified by the means (agents and artifacts) that the agent mobilizes to achieve the transformation that he is seeking, by the means and non-material resources with which the agent influences other agents and artifacts to achieve the desired mobilization.

The significance an agent gives to an artifact regards, firstly, the use the agents make of that artifact<sup>10</sup>. The identity of an artifact is thus defined by its use, by who uses it and for what purpose together with (or instead of) which other artifacts. For the person designing or producing the artifact its function alone is not a sufficient attribute: he must also consider the way in which the artifact relates to other artifacts which comprise it. This has also to do with attribution functionality.

Generative relationships are the result of interactions between agents: entire companies, but also between departments or individuals inside or outside those companies. This multi-level interaction between agents and artifacts (both inside and outside the company) does not necessarily mean that the result will be the creation of a generative relationship or its maintenance: it may be that within a firm there are departments which in their interaction with other agents and artifacts promote the formation of generative relationships while other departments stifle that formation.

In this framework, the changes which result from generative relationships cannot be predicted on the basis of the type of knowledge possessed by the agents involved in the relationship. Such changes are in fact the result of a process in which the technical, economic, social and institutional dimension are components which do not operate independently of one another. The interpretation of the result of this process thus requires a knowledge of the structure and the history of the interactions which make up the relationships between those agents<sup>11</sup>.

New generative relationships induce changes in attributions, and these changes, which are frequently of a cumulative nature, in turn create conditions for new generative relationships. This boot-strap dynamics is a major feature therefore of the structural change that takes place in agent and artifact space.

In order to assess which relationships have generative potential, Lane and Maxfield identify five preconditions.

1. Those involved in the relationship must share, in their activities, some artifact or agent providing a focus for their transformation of some particular zone of the space (*aligned directedness*);

2. The relationship must combine differences between the agents in terms of expertise, attributions or access to particular agents or artifacts (*heterogeneity of agents*). This can help to generate new expertise as a result of the relationship.

3. Agents must seek to develop a recurrent pattern of interactions from which a relationship can emerge (*mutual directedness*). Their willingness to do so depends on the attributions that each assigns to the identity of the other. In this context, mutual trust helps but is not a precondition. Actually, it may be the result of the interaction through which agents realize that they can derive benefits from the relationship that is being generated.

4. It is necessarily for those involved in the relationship to have discursive relationships (*permissions*). This must also happen outside the conventional exchanges which are generally confined to requests, orders, declarations. This condition is fostered by a company structure which envisages a distributed control<sup>12</sup>.

<sup>10</sup> This clarifies the sense in which an existing product can be considered an innovation, as Schumpeter, for example, asserted.

<sup>11</sup> This point is thoroughly discussed by Lane *et al.* (1996).

<sup>12</sup> On the notion of strategy as control see in particular the final part of Lane and Maxfield. As long as companies are reasonably well acquainted with the environment within which they operate, the traditional view can be accepted whereby a company strategy represents the outcome of a process of optimization between alternative choices. However, as Lane e Maxfield (1997) observe, if we consider an innovative process as one in which changes are as rapid as they are unpredictable, it becomes impossible to adopt this definition of strategy. Unpredictability of change

5. Discussing matters of common interest can prove more incisive if the agents have the chance to interact in an activity which sees them working together (*opportunity for common action*).

Lane and Maxfield stress the fact that these conditions must be constantly monitored because the agents must be in a position to interpret the changes that are the direct result of those relationships. Monitoring can suggest ways of feeding and maintaining generative potential of relationships, because as soon as an agent discovers that changes are occurring over a period of time in respect of attributions (assigned to himself and to other agents and artifacts), he will also try to identify the source of these changes in the various relationships he is involved in and may also discover a way of feeding those relationships which will possibly give rise, in turn, to further changes.

The notion of generative relationships was introduced by Lane and Maxfield to analyze complex situations, where continual and rapid changes take place in agent and artifact space. In this study, I shall make use of that notion because it provides an adequate language to describe the dynamics of change. In particular, I propose to investigate the five conditions which are a feature of generativeness in relationships in order to assess their efficiency in creating changes in agent and artifact attributes, in new relationships with other agents, and in common action to create changes in the agent and artifact space. This approach to the kervit story will enable us to recognize why it came to grief, pointing out the conditions which were lacking and the changes which were incorrectly interpreted by the agents.

### 3.2 *Ethnographic method to describe and interpret the dynamics of innovation*

As far as the empirical enquiry is concerned, in this line of research we need to analyze not only the agent characteristics but also the history of interactions between those agents: it is thus necessary to reconstruct the social, technical and economic processes within which the dynamics of change in the agent and artifact space brought about by the kervit innovation can be described and interpreted.

In this context, the methods of enquiry traditionally employed by economists in an empirical study of innovation prove inadequate to the task.

In collecting data relevant to the analysis of the kervit innovation I have favoured a method put forward by ethnographers, who, making use of open interviews, describe the subjects and the artifacts in the social and economic environment in which they operate, without imposing on the subject the conceptual categories of the person carrying out the study<sup>13</sup>. We seek, then, to «view the world through the eyes of the interviewees». In fact, if our objective is to understand innovation as a combination of changes both on the cognitive and on the structural level, ethnographic analysis can help in defining an enquiry method to understand how the actors in the innovation process perceive and categorize reality. Such a method enables us to perform a historical analysis of the interactions which constitute the relationships between the agents who initiated the innovation process.

Note that the ethnographic method entails using first-hand sources, study of which involves entering into relationship with whom is being studied, participating in what they do, and observing what happens. Obviously this has not been possible in the present paper. However, in reconstructing the events that took place between the 1920s and the 1960s, I have been able to draw on the first-hand experience of Antonino Dal Borgo, the kervit inventor, whose readiness to co-operate enabled us to compile a large part of the documentation needed for this case study. Around 8 hours of

requires that the company assess events, and, in their analysis continuously, Lane and Maxfield suggest that attention be turned to the way in which agents interact among themselves, and that company strategy be defined as the combination of actions performed with a view to improving all the interrelationships capable of generating new opportunities in response to changed conditions in the space in which they operate.

<sup>13</sup> One helpful reference for setting up this enquiry method is work done by Spradley (1979) who delineates a methodology for ethnographic research: it ranges from how to decide on who to interview to specifying the various phases of data collection and the elaboration of relevant information. For a discussion of the use of the ethnographic method in analyzing *situated actions* (in which the context the action develops in is modified by that action) see Suchman (1987). A wide overview on the characteristics of the ethnographic method is presented by the challenging new first chapter of the second edition of Agar's *Professional Stranger* (1996).

conversation were recorded during four different sittings. Following a preliminary literal transcription of the first two recorded interviews, the texts were reviewed and corrected by me, and subsequently revised by the interviewee and discussed in the two later sittings. These revisions were necessary in order to give greater definition to themes developed in later questioning. But they were also necessary in order to verify that in the literal interview transcriptions the punctuation had not altered the sense of the written text in respect of the spoken original. These revisions are given as annotations to complete the transcriptions of the first two interviews<sup>14</sup>.

The preliminary texts are an important part of the ethnographic work, as regards both method and ethical level.

Processing the material collected in the interviews brought out some unexpected elements (what ethnographers call «rich points») which improved our understanding of the context in which the kervit story unfolded and made it necessary to alter the working hypotheses. As well as Dal Borgo, it was also possible to have long interviews with Franco Carnevali, one of the first engineers to be hired by a ceramics firm. Following some years as consultant in an important office in Turin, Carnevali was called to the firm at Veggia by his brother-in-law (also a son of Dal Borgo) in order to lend a hand in «tidying up» the father's technical domain. The experience acquired by Carnevali in the subsequent decades as production manager in one of the main groups of the district makes him peculiarly able to assess the elements of continuity and discontinuity that gradually emerge in the kervit story.

As well as the aforesaid material and interviews with various technicians, attention has also focused on interviews, performed in a previous research into innovation<sup>15</sup>, where fleeting reference was made to kervit. Those very elements collected in previous interviews aroused my curiosity on a particular aspect of the growth of the district: kervit was cited as a technology that comprised *in nuce* essential elements of what became the currently dominant technology, but nobody gave a satisfactory explanation as to why kervit was abandoned. Here was a golden opportunity for me to investigate directly Dal Borgo's experience: the available technical documentation would have been quite inadequate, being very fragmentary and imprecise; suffice it to recall that even the patents regarding kervit cannot be found, for kervit has been overtaken by so many other matters in Dal Borgo's life that he has lost all trace of these patents

One critical aspect of the documentation, emerging from the interviews, concerns the unfolding of the kervit story as put forward by Dal Borgo and the role in it assigned by him to other actors involved in the development of this technology – first and foremost, Maurizio Korach, his mentor and collaborator in the theoretical formulation of the kervit technology, but also other producers, their employees, and the world of politics and society between the 1920s and 1960s. The interviews with Dal Borgo contain an extraordinary wealth of references to the *Weltanschauung* then investing not merely his technical decisions but also his social and, more generally speaking, his relational ones; these Dal Borgo describes with the detachment of one who has lucidly reflected on those events over the subsequent forty years during which he took a personal part in several of the changes occurring in the world in which he operated.

In the interviews, several themes are approached via «descriptive», «structural» and «contrast» questions in order to delineate the cultural context of the interviewees as they themselves perceive it. The «descriptive» questions ask the interviewees to describe people, artifacts, situations and experiences which they have had directly or observed. Such questions are helpful to our research in contextualizing the interviewees' personal and professional history inside the firm where they have worked. In these descriptions reference is made to people and artifacts for which it is necessary to specify the attributions assigned them by the interviewees. The description requires temporal and spatial rigour (when, in what order, where?). The «structural» questions are more technical than

<sup>14</sup> References to the first two interviews are indicated by the initials 1DB and 2DB, followed by a number which refers to the enumeration of Dal Borgo's replies. Other sources are cited in the text.

<sup>15</sup> This is the research performed in collaboration with Guido Cattani, partly documented in his degree thesis (cf. Cattani (1996) the appendix of which contains a transcription of the interviews).

those above and require the interviewees to specify technical and conceptual aspects which enable us to understand the meaning of the terms they use. In general, the structural questions are designed to focus on technical and economic aspects of the artifacts discussed, but also on aspects of the relationships between agents and artifacts which are mentioned in the descriptive part. These questions help to define the identity of the agents and the «attributions» that they assign to themselves, to other agents, and to the artifacts that populate their technical, economic and social space. The «contrast» questions are designed to highlight possible differences in the use of certain conceptual categories or expressions: they help to clarify the meaning of the terms used. That is the meaning of both technical terms, but also of the picture that emerges from the way the interviewee represents the agent and artifact space.

The history of kervit and its inventor, Antonino Dal Borgo, will provide the narrative device to describe my observations of how innovation comes about in a local production system. To understand the kervit story we must first abandon the idea of the inventor who solves each and every problem; he is rather somebody who formulates and solves problems which are compatible with his expertise and ideas<sup>16</sup>. This change of perspective is the key to understanding how it is precisely the combination of Dal Borgo's technical expertise and his ideas of the world which determined, both for better and for worse, kervit's development and demise.

Let me end this note on the ethnographic method adopted in this paper, by recalling a categorical challenge thrown down by Michael H. Agar to anyone who piques themselves on using this method. Agar (1996) sets two conditions that must be satisfied by any study intending to call itself «ethnographic».

1. "New concepts have to exist at the end of the study that didn't exist in the original research problem": no abduction no ethnographic, says Agar (p. 39)
2. An ethnographic analysis must utilize different types of data from several sources so as to have a "massive over-determination of pattern", without which it would be impossible to construct and interconnect the multiple «frames» (understood as «knowledge structures») needed for the analysis and interpretation of the phenomena of study. For, as Agar reminds us, ethnography is not merely description, but also analysis and interpretation.

In what follows, the reader may judge if the present paper substantially meets these two conditions.

#### 4. *Kervit technology: changes in artifact attributions*

When in January 1928 Antonio Dal Borgo arrived a Sant Antonino – an unknown backwater on the left bank of the river Secchia, in the province of Reggio Emilia – the Industria Ceramica Veggia S.A. had been operational for no more than four years. With little less than one hundred employees, it was flanked by two other tile factories, originally part of the Rubbiani firm, which had been in business for more than two centuries. He was called in by Ceramica Veggia to replace the factory foreman – a young chemist who, like himself, had studied at the Scuola d'Arte Ceramica in Faenza, no doubt qualified from the technical point of view, but not up to the task of co-ordinating and supervising the workforce. After only six months, the twenty-two year old was already making a name for himself when he introduced his first ceramic production innovation by substituting the age-old tradition tin glazes, then become expensive, with arsenic glazes. Just after graduation, Dal Borgo had gained work experience in a company in Ferrara and it was probably here that he learned that a chemist from Forlì had tried to use arsenic instead of tin. Following a brief series of experiments conducted in his small laboratory at Veggia, Dal Borgo began producing arsenic glazes, obtaining from the frit a white opaque product at a cost considerably lower than that of the tin glaze<sup>17</sup>, and this at a time when the glaze was the principle element of production cost. When in

<sup>16</sup> Cf. Hughes (1971) and Carlson (1992).

<sup>17</sup> «In the molten state, the frit spontaneously forms white crystals (lead arseniate) in the glass, thus replacing the tin oxide, which acted as a covering, and costing less. The idea was prompted by the fact that tin oxide was very expensive and difficult to get hold of. » [1DB20]; «unlike arsenic, tin has always been a rare and costly commodity and at that time tin oxide was used only in cold glazing.» [1DB21].

the Thirties he used zircon instead of arsenic, he created the glaze that became known as «Sassuolo white»: a glaze – used for many years in Italian tile production – which made it possible to obtain at low cost a tile with a white surface applied to the red tiles made of the local clays<sup>18</sup>.

From Dal Borgo's description of the way in which he discovered these new glazes it emerged that in some cases he simply applied existing techniques in new fields (the properties of arsenic or zirconium), in other cases he found solutions by breaking down the problem into its chemical components<sup>19</sup> and by exploiting the chemical and physical properties of the various compounds. The experimental conditions offered by the small chemistry laboratory he had at the factory were adequate; he availed himself of an assistant's help and – using rudimentary equipment for experimenting and measuring – he did everything himself. He was very young, and the expertise acquired at the Faenza school of ceramic technology could be used to experiment directly and create new things.<sup>20</sup>

This innovative spirit is the hallmark of everything Dal Borgo did<sup>21</sup>. However, his innovative approach was significantly different from that of many other chemists who, in the 1960s and in the 1970s, were to enter ceramics companies in Sassuolo and who developed new colours and surface glazing effects, at times drawing inspiration from production defects in order to obtain original decorative effects<sup>22</sup>. In Dal Borgo's case, he developed not so much a surface glazing effect, as a new production method – called «vital»<sup>23</sup> – by means of which the tile, instead of being a biscuit body with a vitrified surface, becomes simply the vitrified layer only a few millimetres thick.

In the case of first vital, and later kervit, Dal Borgo's idea stemmed from the combination of two spheres regarding, respectively, the production and the use of the ceramic wall tiles. With regard to the production sphere, Dal Borgo had to face what, at that time, was a common defect in tile production: the «scaling» which formed when the vitrified part came away from the biscuit body. The defective tiles were wasted and this increased production cost. This defect was due to the different dilatation coefficients of the glaze and the biscuit body it was applied to. With regard to the use of the tiles, Dal Borgo observed that, once fixed on a wall, the ceramic tile presented a smooth, easily washable and therefore hygienic, as well as aesthetically pleasing, surface. By focusing only on what he interpreted as the most relevant functionality of the tile, and not so much on improvements on the traditional production technique, he then created the technical conditions which made it possible to achieve the scaling effect over the entire surface of the tile, and in a systematically controlled way, thus obtaining a tile that was little more than a vitrified layer<sup>24</sup>.

To obtain this technical condition, Dal Borgo concentrated on the properties of the glazes and of an anti-adhesive (composed of 15% bentonite and 85% magnesite<sup>25</sup>) which was applied to the

<sup>18</sup> Cf. 2DB35.

<sup>19</sup> As when, in the Sixties, he invented «anticoagulants». Cf. 2DB32.

<sup>20</sup> A propos of the sources from which he drew technical information and updates, Dal Borgo cites chemistry books, specialist journals and technical profiles of various Montecatini products.

<sup>21</sup> He patented many of his inventions, the most recent, patented at over ninety years of age, was a device for the deaf, whose prototype he is using to his own personal satisfaction.

<sup>22</sup> Until the mid Sixties, the technical management of many ceramics firms was largely under the guidance of a chemist who was often the factory manager as well, widely thought of as a «hands on» figure, up to his elbows in glazes and newly invented paints. The practice of buying in glazes and paints from specialist producers is relatively recent. All ceramics firms produced glazes in house, and during a technical development phase in which a large proportion of processes were carried out manually, glaze production was the most technically complex part and required specific training acquired partly in vocational and technical schools and partly from working alongside the factory chemist as an apprentice or assistant. Cf. Russo (1996).

<sup>23</sup> This name was composed from the first four letters of the Latin word for glass (*vitrum*). The ending (*al*) added a touch of modernity coming, already in the 1930s, from the English-speaking world.

<sup>24</sup> It is observable in the history of many inventions that the intersection of two different planes marks a decisive step in the process which produces new entities. For a telling analysis of this process see Koestler (1975).

<sup>25</sup> Dal Borgo obtained this product by experimenting for about a ten day period. He knew the properties of the materials: a plastifier (bentonite), a refractory (magnesite, a dolomite easily located in the area since the stone is typical of the river Secchia). He knew he had to use only small quantities [1DB25 and note]. During the 1930s, scientific work on the characteristics of bentonite was very confused and imprecise (cf. Vecchi, 1952, p. 19). Employment of this clay,

surface of a refractory plate whose surface area was that of the tile he wished to produce<sup>26</sup>. A layer of glaze was then poured onto the anti-adhesive. Decorations were then applied, using stencils obtained by cutting up pieces of grease-proofed paper, as was the traditional practice in the production of majolica tiles. Only at the end of firing did the anti-adhesive react, causing the vitrified surface to come away from the refractory plate, which was then used again in further production.

This technique to produce vitral, which Dal Borgo patented in the spring of 1935, was thus based on a radical change in the molding procedure, using pouring rather than pressing. Pouring is, incidentally, a well-known technique in ceramics – one needs only to recall that sanitary furniture is produced in this way. The difference is that in the vitral technique the mold used in the pouring stage was no more than a refractory plate. The pouring technique generally makes use of chalk molds for their capacity to absorb the humidity of the preparation poured into them, but chalk would not have been suitable for the vitral procedure since it wouldn't have been usable during the firing phase. This is why Dal Borgo developed the system using a refractory cordierite plate which would be both porous (and hence able to absorb the humidity of the preparation poured onto it) and also resistant to the thermal shock involved in the use of several firing cycles<sup>27</sup>. These plates, used in about 100 production cycles<sup>28</sup>, were produced inside the firm using filter-presses for drying, friction presses for molding and small intermittent muffle kilns for firing. Thus a batch of plates was produced each time it was necessary to refurnish the stock depleted by use.

The vitral idea was decidedly innovative and the patent added much to Dal Borgo's growing reputation as an inventor.

However, the originality of the new technique met a serious setback when the materials were first positioned: the use of mortar-based products caused the tile to come away from the wall<sup>29</sup>; a problem which also arose in the case of other new products used in those years for cladding, for example Opaline, large, long opal glass plates 6-7 millimetres thick used as a wall covering in bathrooms<sup>30</sup>. While cladding materials agents welcomed the vitral innovation, those who had to put it in place, i.e. the tile fixers, were not quite so keen.

Alongside the traditional technique of tile production, over the centuries a laying technique had been developed using materials suitable for fixing to the wall a tile consisting of a robust body that «supported» the glazed part. Dal Borgo thought the development of a material more suitable for fixing vitral<sup>31</sup> a secondary consideration, preferring instead to work on a technical solution which would modify the product itself. Side by side with the traditional production of majolica, Dal Borgo thus continued his experiments to solve the problems regarding vitral, and after more than ten years of experimentation he proposed a new idea – kervit – which kept faith with his original idea in terms of the functional features of the tile and in terms of molding by pouring, but he added a

then, was certainly an element developed in an original way by Dal Borgo.

<sup>26</sup> The anti-adhesive – applied with a spray gun (a very thin layer was sufficient) – was absorbed by the refractory plate. [1DB41]

<sup>27</sup> Cordierite is a silicon aluminate of magnesium. In the early 1950s there was much animated scientific argument as to the employment of cordierite mixtures in industry. Although it had been tried in Italy in the mid-nineteenth century, Vecchi (1952, pp. 21-2) also recalls that in the 1930s Maurizio Korach and G. Fuschi developed the use of cordierite mixtures in order to improve resistance to the sudden temperature changes of electrical insulators. This use (covered by patents of 1932, 1933 and 1937) was also put forward by Korach at various meetings and in a 1934 article in the journal *Elettrotecnica*. Hence, in the 1930s, its only other industrial use seems to have been that made by Dal Borgo who, once again, anticipated the scientific debate that was to develop at the end of the 1940s. The link between Dal Borgo and Korach, of which we will speak later on, suggests that Dal Borgo knew about the research done by Korach and Fuschi, nonetheless Dal Borgo made original use of cordierite mixtures in the production of supporting plates used to produce vitral and later kervit tiles.

<sup>28</sup> Cf. 1DB37.

<sup>29</sup> Cf. 1DB30.

<sup>30</sup> Cf. 1DB67.

<sup>31</sup> Cf. 1DB31 33. It is worth remembering that in the Thirties the chemical industry had not yet developed synthetic glues, which were not introduced until the Fifties.

biscuit body for the vitrified part.

The kervit technology envisaged applying to the refractory plate, in sequence: first, the anti-adhesive layer; second, a mixture of ceramic preparation some three millimetres thick (which would form the *body*, as it was called, after firing); third, a layer of engobe and, finally, a layer of glaze. At the end of the firing cycle the refractory plate came away and the kervit tile had more body than vitral. It is worth noting that in ceramics technology the white clay referred to as engobe had been known since antiquity and was used to cover the coloured surface of bowls and drinking vessels. It was Dal Borgo who was the first to use engobe in the production of tiles since it enabled him to use ordinary materials for the *body* (as for example discarded tiles or glass fragments which came from Murano). Without the engobe – to keep the glaze white – it would have been necessary to use pure raw materials which were expensive<sup>32</sup>.

The technical literature of the time describes the kervit technology as technically and economically superior to the technique then in use: introduction of glass in the ceramic mixture provided better cohesion between mixture and glazes; the length of the entire line was only 170 metres as against the 250 of traditional majolica and 300 of terraglia production; the manufacturing process was simple and almost completely automatic. All of this enabled a lower cost as compared with majolica and terraglia (Vecchi, 1952, p. 22). As early as the Fifties, kervit worked out economically competitive. Suffice it to mention that, since kervit production costs were lower than those of majolica tiles, Dal Borgo had decided to sell it at a price which was proportionately lower, aiming at competitiveness based on price which would at all events have covered the cost of the licence (about 5% of turnover) of licensed kervit producers.

All this is partly confirmed by our research, except for two elements – the simplicity of the process and its level of automation – which were to be critical in the development of kervit.

##### *5. Relational aspects: continuity and discontinuity in the dynamics of change in the agent/artifact space*

The relational aspects are one of the keys to understanding what happened to kervit and the subsequent turns the history of Veggia was to take. The economic and cultural environment in which Dal Borgo operated since the 1920s was that of an Italian province considered a depressed area from the economic point of view. Agriculture was the chief economic activity and the few industrial companies that operated in the area astride the provinces of Modena and Reggio Emilia on the banks of the river Secchia were a handful of fruit conserve firms, the producer of Sassolino (a liqueur well known in the area) and three other ceramics firms which had set up beside the companies who had been first to arrive in the area.

###### *5.1 Maurizio Korach appears on the scene*

To develop the kervit procedure, Dal Borgo employed some of his sons as assistants, as well as resorting to the mechanical and woodworking skills of those who worked in the Veggia workshops. This meant a nucleus of around 25 carpenters and mechanics who helped in constructing the machinery and equipment necessary for production.

To this in-house staff must be added the collaboration<sup>33</sup> of Dal Borgo with Maurizio Korach<sup>33</sup>, a leading figure in chemical engineering, but also internationally prestigious in the field of literature. Born in 1888 in Miskolc (Hungary), into a Jewish family of Hungarian extraction, Maurus Korach got his degree in chemical engineering in 1911 at the Polytechnic of Budapest, under the supervision of Vincent Wartha, who was deeply learned in ceramic technology. In order to avoid the oath of loyalty to the Austro-Hungarian monarchy, in 1912 he fled to Italy, where, thanks to his excellent technical culture, he became assistant of Professor Panebianco, teacher of Merceology at

<sup>32</sup> Cf. 1DB36. The engobe was subsequently used in the single-fire process.

<sup>33</sup> The biographical information about Maurizio Korach was collected during the interviews with Dal Borgo, and in the papers by Vecchi (1952), Biavati (1976), Polinszky (1976), Vecchi (1988). Autobiographical notes can be found in Korach (1964).

the University of Padua. In 1914 he was summoned by Gaetano Ballardini, then director of the Scuola d'Arte Ceramica recently set up at Faenza, and together they commenced a successful collaboration<sup>34</sup>. On the outbreak of the First World War Korach volunteered for service in the Italian army and took nationality, but he was stationed behind the lines and there met Riccardo Bacchelli, with whom he cooperated in the antifascist literary periodical «La Ronda»<sup>35</sup>. In the 1920s he directed the Experimental Ceramics Laboratory at Faenza and taught at the Scuola d'Arte. He left this job at Faenza in 1929-30 when he became privat dozent in Chemical Engineering Equipment and Machines at the University of Bologna. Only a few years later, he left off teaching in order to escape persecution by the fascists<sup>36</sup>. Changing his name to Marcello Cora enabled him to continue with his work as consultant to Italian chemical firms until the race laws came into force in 1938, whereupon he decided to leave Italy. He returned to take part in the war of liberation, but was arrested and imprisoned at San Vittore. After the liberation, he resumed his academic activity, but his possibilities in Italy were limited by his connections with support for the Communist Party and his scientific ambitions, so he accepted to cooperate with the Hungarian government in the creation of the Central Institute for Building Materials which, thanks also to his work, was for decades the leading research centre in Europe in this field.<sup>37</sup>

Korach is important in the kervit story for two at least two reasons: firstly with regard to patent activity, secondly concerning the use of the "a passo di pellegrino" kiln (to which we shall make only marginal reference).

As he had done previously for the vitral process, Dal Borgo entirely entrusted to his master and friend Maurizio Korach the task of preparing the technical specifications to be included in the kervit patent registration documents. He described in detail the technical procedures he had refined during the long period of experimentation and Korach couched them in the formal language required for a patent application. Since he was heavily engaged in the running of the Veggia factory, Dal Borgo also delegated to Korach the task of publicizing the features of the patented kervit system<sup>38</sup>. His academic position held before the War together with his fame as brilliant research scientist and intellectual with a wide network of international acquaintances opened up numerous opportunities for Korach to sell the kervit licence abroad. Korach, who was well connected in the university world and frequented writers, painters and intellectuals, was put into contact via Swiss friends with

<sup>34</sup> At the Esposizione Torricelliana in Faenza, 1908, Ballardini had admired the «polished» products of the Hungarian factory at Zolnay, of which Wartha was consultant; at that time Wartha was considered the leading world expert in ceramic chemistry. This was therefore an important opportunity for Ballardini to involve Korach, Wartha's pupil («the wizard of Budapest» as Korach calls Wartha, 1964) in the projects concerning the art school that had just been set up (Biavati, 1976).

Korach (1964) recalls how the collaboration between himself and Ballardini was a happy encounter between the historical-artistic view of production, Ballardini's, and his own technical background. From that encounter, made possible by their common «humanistic ideal», arose the Experimental Chemistry Laboratory of the Scuola d'Arte Ceramica at Faenza that Korach directed for ten years and contributed to making a research centre at international level.

<sup>35</sup> Cf. Bacchelli (1976). On Korach's contribution to this periodical see the book by Carmine di Biase, *Maurizio Korach (Marcello Cora). La Ronda e la letteratura tedesca*, published, with a preface by Bacchelli, by Società editrice napoletana in 1978. Korach's literary contributions had already been noted in a book of 1930 by E. Falqui and E. Vittorini (*Scrittori nuovi*, Lanciano, Carabba). Between 1910 and 1975 Korach published more than 200 items of technical-scientific character (see bibliography in SIC, 1976), but no less important was his literary production, consisting of «24 stories, 10 poems in prose, 49 fables, 10 dialogues, a play, 12 polemics, 8 literary essays, two articles of aesthetic popularization, 37 articles on economics and politics, 5 political articles, as well as 28 critiques and reviews and 24 translations» (Polinszky, 1976, p. 13).

<sup>36</sup> Already when he worked in Faenza, his dissent vis-à-vis Fascism was well known enough for the local Fascists to make him drink castor oil at the entrance of the School. Later, when he was in Bologna, he was advised by a friend that fascists were plotting to kill him (cf. 1DB95 and Biavati, 1976).

<sup>37</sup> The invitation came from his sister-in-law, leading figure in the Russian revolution and minister in the first post-war Hungarian government. In 1975, Korach died in Budapest.

<sup>38</sup> In the previous experience with vitral, it had been Korach who made contact with Swiss, French and Dutch firms in order to sell the vitral licence. In 1955 Korach also published a series of articles in technical journals (in German, Hungarian and French) in which he described the kervit technology (cf. Vecchi, 1952; 1988; Korach, 1955).



Mackenzie, a Scottish nobleman who taught parapsychology in Geneva and who had a wide network of business relations at an international level. Mackenzie became a key figure in the distribution of the kervit patent in the 1950s. Apart from Switzerland, Germany, France and Great Britain, the kervit licence was also sold in Israel, Venezuela and Brazil. The sole licensee and producer in Italy was Ilsa of Albissola in the province of Savona.

Even after his return to Hungary, Korach remained in contact with Dal Borgo and for several years took part in the international meetings that were held annually to diffuse the improvements introduced by Dal Borgo to the kervit licensees.

### *5.2 The failure of Ceramica Veggia*

The long period of experimentation had allowed Dal Borgo to develop a procedure that could be used on an industrial scale and Dal Borgo intended to take advantage of the financial benefits which would result from his invention: in 1947 he patented the kervit process and obtained a new contract with Veggia in order to insert a clause which, apart from recognizing his right to benefit personally from the patent protection, also gave him a minority shareholding in the company. Nine years later Industria Ceramica Veggia dismissed Dal Borgo, accusing him of exploiting for personal gain a patent which, according to legislation then in force, should have belonged to the company of which he was an employee. He made counter claims against the Veggia majority shareholder, because the special clause inserted in the contract would have secured a verdict in his favour. However, the matter never came to court: without his vital technical guidance, within the space of several months the company was on the verge of bankruptcy and, seven months after being dismissed, the old proprietors withdrew the accusations and Dal Borgo returned to Veggia in 1957 as Chairman and major shareholder<sup>39</sup>.

Dal Borgo retained that position until 1967, when the Modena court declared Ceramica Veggia bankrupt.<sup>40</sup>

While involved in the technical management of the firm, had engaged in illegal accounting practices – which were, however, very widespread at that time. Official inspection revealed that a sum of more than 500 million lire was unaccounted for, and Ceramica Veggia was put in receivership. Summoned before the bankruptcy court, Dal Borgo requested a stay of 15 days in order to give kervit's British licensees time to weigh up a takeover of Ceramica Veggia, but the request was turned down by the court. Whereupon Dal Borgo – who had no doubts of the firm's technical solidity – appealed and offered to repay the creditors 50% of what they were owed (and, indeed, in the following year the firm's management recovered an amount exceeding 100% of their loans). The appeal, too, was refused, but the bankruptcy, declared on 21 April 1967, was not paid off till nearly twenty years later, with a mere 10-11% to the creditors.

Following the bankruptcy, Ceramica Veggia still went on producing tiles for a year, but soon changed its activity to the manufacture of colours, without Dal Borgo.

The bankruptcy was due mainly to bad management, but the economic and administrative elements alone are not enough to explain the vehemence shown by the receivers in this case. To provide a convincing explanation it would be necessary to adduce much fuller documentation relative to the bankruptcy proceedings, as well as conducting a historical analysis of the political and social context of those years. This all lies outside the area of this study. Here I want to point out two aspects of the Veggia closure that are relevant to our analysis.

<sup>39</sup> A third of the shares were acquired by his friends at the Ilsa plant in Albissola in the province of Savona. [Cf. 1DB112]. Albissola was another of the ceramics districts, in addition to those of Vietri, Faenza and Porto Potenza Picena. Dal Borgo met the owners of Ilsa via a mutual friend, a socialist, who managed a shop of Ilsa pottery in Sassuolo. To flee from political persecution during the war, one of the two brothers who owned Ilsa took refuge in France, whereas the other brother, an ex-navy officer, was taken in with his wife by Dal Borgo at his Sassuolo home. During his six month stay, a deep friendship, based on reciprocal respect, developed between them, and this helps explain why he was so ready to finance Dal Borgo in acquiring the Veggia shares.

<sup>40</sup> Cf. 1DB113÷116.

The first aspect takes us into a context widely discussed in economic literature inspired by Schumpeter, where the economic figure of the innovator is seen as analytically distinct from that of the inventor and stress is laid on the importance of the economic aspects of innovative activity. Though authoritative and extremely clever, Dal Borgo found it very difficult to face the request for bankruptcy; his technical capabilities – which for forty years had enabled him to manage and then to buy a flourishing firm in continual expansion – suddenly appeared insufficient<sup>41</sup>. While still remaining an irrepressible inventor, Dal Borgo failed to completely become an entrepreneur, precisely because he was unable to take account of the multiple changes (including the economic ones) that resulted from his inventions.

The second aspect I wish to recall is how the fact that Dal Borgo centralized in himself all the technical decisions, together with the poor economic control, gave latitude for opportunistic behaviour at the limits of legality – to the point where Dal Borgo himself was forced to intervene, dismissing 16 workers who had removed materials and equipment belonging to Ceramica Veggia that were subsequently used in other ceramics firms set up by its employees.<sup>42</sup> Aside from these workers, against whom incontestable evidence was brought, there had been other cases in the early 1960s of employees who had profited from Dal Borgo's negligence in day-to-day economic and administrative matters.

These two aspects – centralization of technical decisions and opportunistic behaviour by workers – help to explain how the bankruptcy of Ceramica Veggia failed to lead to its takeover by other local actors.

### 5.3. *Small improvements within the firm vs. collective invention in the local system*

The fact that Dal Borgo remained prisoner, so to speak, of his factory, was a choice imposed on him by the lack of opportunities offered by the environment in which his work attitude had been shaped. In the interviews, Dal Borgo often justifies the choice by challenging autarchy<sup>43</sup>, which was to become a cultural model vis-à-vis the outside world<sup>44</sup>, but which was also to become the organizational and economic model at individual company level. And it was inside the factory that a generation of technicians, mechanics and carpenters was trained, as well as foremen and department heads<sup>45</sup> who subsequently became entrepreneurs or plant managers in ceramics firms (or machine tool firms) which in the course of the Sixties sprang up all over the area. Being cloistered away inside the factory was part and parcel of a great innovative project, the vitral and kervit process<sup>46</sup>.

<sup>41</sup> Not that hints of the need to change tack were lacking. Suffice it to think that his sons, close collaborators in the management of the firm, were aware of the need for a management that should add economic consistency to the extraordinary technical capacity of the inventor. That is why they suggested he hire Gianfranco Carnevali, a young engineer with good experience of industrial organization in the metal engineering sector and strongly concerned to remain working at Sassuolo. Carnevali enthusiastically accepted the opportunity to apply his methods of industrial organization to a completely virgin territory; at that time, in the ceramics firms there were only three other engineers, all at Marazzi. But his enthusiasm soon waned before the constant necessity to change the production programmes as they went up in smoke owing to the continual alterations in the glazes suggested and imposed by Dal Borgo. To be sure, these alterations improved the product, but they made programming of the whole production process, and thus fulfilment of the orders, extremely unstable (cf. Carnevali 25).

<sup>42</sup> Cf. 1DB113 and Carnevali 27÷31

<sup>43</sup> Cf. 2DB7.

<sup>44</sup> Although concrete performance of the autarchy plan was modest, it was successful from an ideological and propaganda point of view, because many technicians and scientists interpreted autarchy as the manifestation of a plan for altering society based on the canons of scientific rationality. On this interpretation of autarchy see Maiocchi (1998).

<sup>45</sup> In tile production, all the operations were carried out manually and Veggia reached a point during the Fifties of having as many as 600 workers. Although this went down to some 300 by 1966, Veggia's dimensions were those of a firm with a multi-level hierarchy in terms of the organizational control of work and factory discipline.

<sup>46</sup> This project was to become a technical model so inbred as not to be recognizable as such even by the technicians who formed it. In the hundreds of interviews to technicians and experts on ceramic tile technologies – which I conducted in the last twenty-five years –, I never noted a mention of kervit technology. The first mention of it made to me was by the engineer Franco Carnevali two years ago (and in a detailed way in the interview of October 1998), but not

Compared with the traditional production technique used for majolica tiles, what distinguished kervit was essentially the fact that, apart from the molding/pouring procedure, which we shall discuss further below, it needed only one firing during which the thin layer known as *body*, the layer of engobe and the glaze were thus all fired together. The firing cycle was considerably reduced (by about two and a half hours) in kilns which fired one layer of tiles at a time<sup>47</sup>. Stated briefly in these terms, kervit technology appears analogous with the rapid single-firing technology which was widely adopted in the ceramics district during the Eighties. And to some extent it is, even if marked differences and discontinuities are apparent in the transition from one technology to the other. The interpretation of these discontinuities once again requires consideration of the relational aspects of the case.

In the course of over twenty years, Dal Borgo developed numerous devices and tools for the kervit production system<sup>48</sup>, but the only one which was widely used, and is still used to day, is what is known as «the bell». As far as traditional twice-fire production is concerned, a process began in the early Sixties whereby moving operations were mechanized, and this process went on for over ten years. These were years in which a process of collective invention<sup>49</sup> emerged. This process was

during the several discussions on the development of ceramic technology, which we had had in the previous twenty years. I spoke of this technology with a degree student of mine, Guido Cattani, who was conducting interviews on the innovation process in low porosity single-firing. We decided to collect the documentation that we gradually turned up on kervit. From the analysis of the transcriptions (cf. Cattani, 1996), I found four in which kervit was cited; in the first interview the reference to kervit was made spontaneously by the interviewee, in the others it was Cattani who introduced the reference to kervit. The kervit story resurfaced in the memory of the technicians interviewed when they were referring to a single-fire, low porosity product arriving on the market that was recalled as having the technical properties of the kervit product. All four technicians indicated kervit as a technology that had anticipated the main technical developments thereafter established in the 1980s. And it is no accident that those technicians belonged, like Carnevali, to the generation that had been able directly to interface with the kervit technology; because they had been employees of Ceramic Veggia or competing firms.

<sup>47</sup> Initially, the tubular kilns used for firing majolica were also used in firing kervit. Some eight metres in length, these had 32 to 48 channels. The mouth of the kiln resembled so many little windows, all of which were channels. The tiles moved forward because one pushed the other. The daily output of a tubular kiln was about 400-500 tiles. In the early Fifties, kilns designed by the engineer Drago in collaboration with Korach e Battistin (known as «*a passo di pellegrino*») had a production capacity similar to the tubular kilns. From the late Fifties on, however, tunnel kilns were used that Dal Borgo had had built by the German firm Kerabedarf: they used small trolleys (approx. 66x66 cm) on which a single layer of tiles was placed, and their production capacity was around 300 square metres per day [1DB56-62]. In the Sixties a similar kiln, with a trolley for single layer firing, was proposed by Poppi for rapid single-firing.

<sup>48</sup> «At one point it emerged that with the pouring process the tile did not come out flat, and this was due to the fact that the tool we were using was the old orifice of the glazing machine which was made of a hopper which had an adjustable aperture at the bottom, which meant that a veil was formed – for the simple reason that pouring was slightly delayed – but in the middle it was slightly raised and overflowed towards the sides. Well, I solved the problem in two ways. First using an instrument – the bell – which they still use today. It was I who invented the bell to solve this very problem. Because, being curved, less went into the middle and more went to the sides. But the problem of the edge remained, so I invented a little device: I applied a disc which acted like knives and cut away 4 to 5 millimetres from a tile 15x15 cm or 20x20 cm, from each side in such a way that the tile was trimmed straight at the edges.» [1DB 44].

But the production of formats such as the mosaic also made it necessary to develop suitable tools. «The formats were basically 15x15 and 10,8x10,8 cm (4x4 inches, the American format); then when I started to think about the mosaic, I started to produce 20x20 cm (it was clearly a little larger because the edges were later trimmed). The idea of the mosaic occurred to me like this: how do you cut a tile? how do you cut glass? If you cut glass you use a diamond which makes a mark you then break. So I had this idea: I fitted very thin discs which had extremely sharp blades and are supported by springs strong enough to exert the required pressure to make a diamond incision in the unfired tile. These discs were positioned on the glazing line, and were stood on points so they could be dragged along: the tile passed by and the incision was made, that is, the line was traced in it». [1DB 49]. When firing was over the various pieces that made up the mosaic were broken off.

But the belts themselves also needed to be modified. In particular: «the belts on which the material was transported along the pouring and glazing lines easily got dirty and I had nails inserted in them to hold the tiles up higher » [1DB 104].

<sup>49</sup> The notion of «collective invention» is discussed by Robert Allen (1983). In a situation where the majority of firms

made possible by a continuous flow of information between technicians and production experts, who moved from one firm to another, who were often personally acquainted and who shared in the common adventure of bringing to life Sassuolo's new ceramics industry.

Veggia, however, seemed excluded from this process: the kervit patent concerned a procedure which was not easy to imitate by introducing alterations so as to circumvent the patent protection, because *inter alia* employment of the kervit technology relied greatly on the tacit knowledge acquired by Dal Borgo during the long stage of experimentation and production on industrial scale<sup>50</sup>. Moreover, as is the case with many technologies, it was a question of developing complementary technologies, a requirement which was to an extent amply fulfilled by Dal Borgo's personal qualities, since he personally led the group of mechanics and carpenters who worked under him at Veggia. Nevertheless, the spread of automatic devices for moving operations in the traditional production process represented a challenge, both technical and economic, to which Veggia was unable to respond: the technical insularity which had developed inside the factory precluded the possibility of exchange with the outside world, and this acted against the interests of the kervit system.

#### 5.4 Enterprise organization models and social relations

Veggia's organizational model – as was the case with other ceramics firms operational at the time – envisaged a strategy of centralized control. But this condition alone is not enough to explain the state of isolation in which Veggia found itself. In order to understand the extent of this isolation, it might be helpful to examine another organizational and social relationship model, that which prevailed at Marazzi, a ceramics firm which came into being in 1936 in Sassuolo, whose dimensions were comparable to those at Veggia. Filippo Marazzi, the firm's owner, was an entrepreneur with previous commercial experience on a local scale. Marazzi made up for a lack of specific technical training by taking on young technicians and giving a chance to those with flair and zeal to have a go, tucked away in a corner of the factory, at inventing something of use for the industry. This was the case with Leo Morandi who, during the Fifties, thanks in part to the experience gained with Marazzi, went from being a respected bicycle repair man to become one of the most prolific inventors of devices for glazing equipment<sup>51</sup>. The Marazzi microcosm also aspired to being a model of social and religious integration: witness the building of an infant school for the children of company employees, the medical clinic and even a chapel where mass was celebrated<sup>52</sup>. But Pietro Marazzi (who had assumed his father's position in managing the company) also set up a research and development unit inside the factory which became, from the Fifties on, an important centre for the innovation process which then spread throughout the district. Unlike Veggia, Marazzi actively sought interchange with the outside world.

In the early 1960s, the technical and economic – not to mention the social – environment had come a long way from the days when the kervit system was developed. There were now numerous firms producing majolica tiles which were a source of growing demand for specific mechanical innovations, not simply kervit adaptations. And this is one of the factors – the other being the difficulty of imitating the process – which explains the oblivion into which kervit fell following the closure of the Veggia plant.

did not allocate resources to research and development, collective invention was an efficient innovation process even for the individual firm.

<sup>50</sup> «They were patents which covered the entire method and procedure throughout its development, nobody could have copied the technology, the invention was protected» [1DB122].

<sup>51</sup> But in subsequent decades various firms were set up by former Marazzi employees, as for example the firm that produced engineer Mario Poppi's kilns, or System, whose owner Franco Stefani had produced the serigraphic machine at Marazzi and from there went into business on his own, creating one of the most dynamic machinery producers in the ceramics industry. Cf. Russo (1996).

<sup>52</sup> It is as well to remark that, although there are no systematic studies of these events, from the information I have managed to collect the paternalistic model adopted by Marazzi seems no different from that of other large firms that were operating in North Italy, e.g. Falk at Sesto San Giovanni, Milan (cf. Bertucelli 1997).

### 5.5 *Technical knowledge and industrial dynamics*

«Oblivion» here means that kervit technology was no longer adopted. Nonetheless, the kervit experience left its mark precisely because it brought together a vast quantity of technicians and a model of technical innovation which was decidedly different from anything else in the district. It moreover introduced them to alternatives to traditional methods in two vital areas of the production process: molding and firing.

Molding via pouring as used in the kervit system is perhaps the most crucial innovative aspect of this production process since it ran radically counter to the technical and economic interests of the press manufacturers<sup>53</sup>. These were firms much larger than other machinery producers with a product far more complex in terms of the components and the technical expertise required to manufacture them. The presses had always been produced by specialist firms, and by the end of the Fifties several Italian producers were making important headway in foreign markets, outstripping even the Germans, the original European market leaders. This was all thanks to production expansion within the Sassuolo district: Ceppelli (in Sassuolo), Welko (whose head office was in Milan but which manufactured in Sassuolo) and Sacmi (of Imola) were the press producers who initiated a lot of the innovations related to the movement of material in various phases of the manufacturing process which they developed during the early Sixties as techniques complementary to pressing. These innovations were produced either in house or by small engineering sub-suppliers from the district.

In the Thirties, when vitral was being developed, the two molding processes – pouring at the glazing line phase and pressing – both had the same degree of mechanization<sup>54</sup>. Molding by pouring increased the use of the glazing line: a piece of equipment consisting of a metal frame which supported the belt on which the tiles passed between one application and another. The presses filled the mold and activated the head which compressed the clay manually, and had therefore a limited capacity, producing only small format tiles.

During the twenty years that saw the development of kervit, the refinement of the various machines involved in the pouring and glazing line resulted in higher product quality but did not substantially change the production capacity of that line, nor the degree of automation in the loading and unloading of the line, which was still done manually. Press production, on the contrary, underwent considerable transformation, leading to the development of powerful friction presses, which were completely automatic and in use in the early Sixties. The increase in the level of mechanization had increased potential in terms of the capacity to press tiles larger in format than those available through the use of manual presses. Above all, it had increased production capacity, by thus requiring the development of semi-automatic and automatic devices for the extraction of pressed material and for loading the trolleys<sup>55</sup>.

The search for solutions to various technical imbalances<sup>56</sup> between the various operations connected with the pressing phase was a key opportunity seized upon by press producers to activate the all-important information exchange mechanism – with tile and components manufacturers – which was conspicuous in its absence from the kervit environment.

The other innovative dimension in the kervit case-history is clearly the single firing of the biscuit support and glaze: one of the vital ingredients of subsequent single-fire technology<sup>57</sup>. In the case of vitral and later that of kervit, Dal Borgo relied on firing techniques used for glazed majolica tiles

<sup>53</sup> Kervit production certainly did not sweep away press production because, at all events, it continued to use refractory plates, the mold onto which the preparation was poured, and which were produced by a molding process using a press. Every plate was used in 80 or 100 production cycles and therefore the potential development of press production would have been reduced to one hundredth.

<sup>54</sup> The notion of mechanization level referred to in the text is that developed by Bright (1958).

<sup>55</sup> The increase in press production capacity showed up the inefficiency of manual performance of operations to do with unloading the materials because a larger number of workers would have been necessary for each press, and this was practically impossible owing to the physical space available at the end of the press.

<sup>56</sup> The role of technical disequilibrium between the components of a machine and the process is highlighted by Rosenberg (1969) as being an important device in focusing on innovative activity.

<sup>57</sup> Cf. 1DB121.

which were then fired at maximum temperatures of between 960 and 980 degrees centigrade. To achieve the required resistance in the body at these temperatures, Dal Borgo employed vitreous based clay preparations<sup>58</sup>. However, he used firing times of around two and a half hours, thus much shorter than those then used in firing majolica tiles: this was technically possible and led to a marked reduction in production costs. Reduced firing time was a considerable new departure from techniques then in use: in a tubular kiln, which was then the fastest, firing times were never less than eight hours, while in the tunnel kiln which was subsequently used, firing glazed tiles required around sixteen hours. In another kind of kiln, where saggars of glazed tiles were transported on sliding batts, firing times were initially around twelve hours and, though they came down to five or six hours, were much longer than those used in firing by kervit<sup>59</sup>. In interviews, Dal Borgo stresses that firing times in majolica tile production were fixed by convention rather than by technical demands. The change he introduced was not the result of specific experimentation but rather the «natural»<sup>60</sup> result of what he had theretofore intended: he was using theoretical knowledge and experience which he had probably never even verbalized, but which were implicitly present in his mental apparatus. This knowledge emerged when he concentrated his attention on the specific firing technique to be used for a product which differed from traditional products. At this point he discovered that a firing time of no more than two and a half hours was sufficient because, as Koestler has taught us, «discovery often means revealing something that has always been there, but which was hidden from our eyes by the blinkers of habit»<sup>61</sup>.

When in the early Sixties he worked as a consultant for the firm which had taken over Veggia, Dal Borgo used the experience he had gained with kervit by personally contributing to the production of the first single-fire wall tiles. But – though there are several key features which suggest continuity with kervit – the developments in this production technique, which from the Eighties on has become the most widespread in the district, are also linked to other innovative contexts<sup>62</sup>.

## 6. *Monitoring and fostering generative relationships: the missing conditions*

Why did no other company decide to buy the kervit licence and produce with kervit technology after the closure of Veggia? And why did the process of imitation that has been a fundamental factor in the spread of many techniques in the ceramics district not occur in this case?

A recurrent reply to this question which is echoed in some of the interviews carried out with experts in ceramics<sup>63</sup> is that the main reason for abandoning kervit technology was the increase in labour costs during the Sixties. Reconstructing the dynamics of the kervit innovation process, as we have done for this study, shows that the economic assessment remains generally valid, but it is insufficient to explain why kervit was abandoned. My interpretation of the kervit story draws on what Lane and Maxfield have indicated as a decisive element in the innovation dynamics – i.e. the need to monitor and fuel the generative potential of relations in agents' and artifacts' space. I should therefore like to conclude by focusing attention on three main problems around which to sum up this interpretation.

### 6.1 *Internal relations: the lack of heterogeneity and right permissions*

When he began his career as inventor in the Thirties and later as entrepreneur in the Fifties, Dal Borgo used his own technical ability to build around him a technology which was difficult to imitate and of which he intended to remain the sole user. From the supply side, there were few other

<sup>58</sup> Cf. 1DB37.

<sup>59</sup> Cf. 1DB63.

<sup>60</sup> Referring to how he obtained this result, Dal Borgo replies that «it's one of those things that just happens like the way wheat grows » [Cf. 1DB63 and note] precisely because, with hindsight, discoveries seem obvious.

<sup>61</sup> Cf. Koestler (1975), p. 98.

<sup>62</sup> For an analysis of the technical and economic conditions in which single-firing developed see Russo (1996).

<sup>63</sup> Cf. Cattani (1997).

companies which produced wall tiles using traditional production techniques and sold mainly to the Italian market. At the end of the Fifties, changes on the demand side brought about the growth of numerous firms which were soon to face the 1963-64 slump: dozens of firms closed, but those which managed to weather the storm gained momentum in the wake of the introduction of the tunnel kiln, high-output presses and the dramatic expansion in demand for floor tiles. In the Sixties, the economic and social climate was radically different from that in which Dal Borgo had started developing the kervit technology: alongside the hundreds of firms producing tiles there were now numerous manufacturers of specialist machinery and equipment. Though other ceramics firms also produced machinery used in the production process in house, the fact that Veggia continued to produce all of the kervit specific equipment in house throughout the Sixties was certainly an exceptional situation. But this was no longer a choice vis-à-vis an environment which did not offer technical opportunities. Rather, it was the result of the absence of generative relationships. Dal Borgo did not take account of changes which had taken place in the environment in which he was operating: he had always wanted to work alone and he thought it would be possible to continue doing so, without links with other technicians. Dal Borgo is quite clear on this point: according to him there were no other technicians in the firm with whom he could interface<sup>64</sup>. Nor did he seek contacts with outside: like every artisan, he felt himself to be in possession of a fundamental secret for «making a finer, less expensive product». This view hindered him from taking up organizational hints even though they came from within the factory; and, basically, even the periodic meetings with kervit licensees acted as a means of transmitting to them the solutions he had adopted, but were never used to focus upon a joint initiative to bring about changes in kervit's position vis-à-vis other, rival products. His overriding technical genius and his fixed view of ceramic production as artisanal production prevented him from understanding that exchange of his with others' experiences could be fruitful. His centralization of technical decisions and authoritarian single-mindedness left others no time and space to talk, nor freedom of action («right permissions»). When agents interact, all these are essential conditions facilitating their understanding of their respective expertise and identity. And the possibilities which emerge from their joint activities will be enhanced when their relationships are interwoven with a network of other relationships (Lane and Maxfield, 1997). The absence of permissions had a negative effect on Dal Borgo's understanding of ongoing changes and helped to alienate him from the control of the technical and economic space he himself had created.

## 6.2 Technical and social dimension of the imitation process

What emerged from kervit story is not only that kervit made it possible to manufacture a wall tile that was difficult to produce, but also that it was difficult to come up with anything similar, «inventing around» the cover offered by patent protection. The difficulty in using this production method lay in the considerable variability of the technical parameters – due to the use of natural raw materials whose composition varied – which were subject to a transformation process in which environmental parameters (temperature and humidity) significantly alter the outcome of the process. The adjustments needed to achieve good results (in terms of a low reject percentage and uniformity of product quality) required a practical knowledge which could be acquired only with a great deal of production experience. This tacit knowledge certainly helps explain why kervit was abandoned, but other techniques had similar problems in subsequent years. In the case of kervit technology, we come nearer to an explanation if we also consider the technical and social isolation at Veggia: it is in this context that considerations of cost and an assessment of the technical difficulty appear relevant.

Kervit's isolation was actually worsened by *inter alia* the impossibility of imitating it. From the kervit case history (but a similar case is that of Enduro technology patented by Marazzi in the mid Eighties) it would appear that imitation is, however, a crucial factor for the success of an

<sup>64</sup> Cf. 1DB69÷70 and footnote.

innovation: «many actors win, only one loses». An innovation, even if it is far-reaching, cannot manage to assert itself because the monopoly position of its inventor proves a condition of weakness when the other producers are able to form an alliance against the monopolist, discrediting the reputed superiority of the proposed innovation. Moreover, potential users perceive the fact that there is only one supplier of the innovative product as a sign that «something must be wrong, otherwise the others would have done it». These two factors, which were to kervit's disadvantage, help describe the technical and social isolation in which this technology found itself as compared with other alternatives which emerged in the Sixties.

The twenty years during which kervit production took place on an industrial scale have nevertheless left a legacy of knowledge which permeates the entire local production system. This is not only because Veggia trained large numbers of technicians, not only because kervit technology contained the essential ingredients for the technical development of the following forty years, but also because it actually provided an economic model to be avoided. Let us consider, for example, another case which occurred in the Seventies. Marazzi developed a single-fire production process which featured the use of a roller kiln. At first the technicians working on the new kiln were quarantined at the Fornovo factory, and the kiln was patented. Then, Filippo Marazzi threw open the doors of the Sassuolo factory to whoever wanted to see what was going on. It was not patenting the process, but its maximum accessibility which became the necessary condition for taking full economic advantage of the innovation. Because it is through imitation that conditions could be created for the development of complementary techniques.

This imitative process does not involve all agents globally – rather, it is a local process: you only imitate what is being done by your «neighbour». Proximity, here, is defined in spatial terms (you have to see it with your own eyes), but also in technical terms (you have to have similar skills to those of the person you are imitating), and relational terms. The latter means that the particular interaction in which observation of the artifact or of the process used by another agent takes place is made possible by the fact that between those agents there are other interactions on the personal and economic level. The general result of this imitation process is a repositioning of the overall system. This takes place because to imitate it is necessary to have similar skills, but agents are not identical and the imitator has specific competences and specific relationships with agents and artifacts. Such relationships can trigger new entities (new agents or artifacts), but also new competences: this is the outcome of the imitation process that has characterized the innovation dynamics and the industrial dynamics in the ceramic tile district.

## *6.2 The social dimension of patents*

When Dal Borgo explains his decision to patent the procedures and devices he had invented, he highlights two basic reasons. The first is personal pride – the pleasure of being recognized as an inventor<sup>65</sup>. The second is a strictly economic reason. Dal Borgo believed that the patent would guarantee a financial gain deriving from the invention. And yet he did not deal directly with the matter since this required relational skills and international connections. Dal Borgo delegated this side to Korach, who was well connected in a variety of settings. Until halfway through the Fifties, all five conditions necessary to describe a relationship as generative of change in the space in which they operate were present in the relationship between Dal Borgo and Korach. However, differences in expertise and fields of activity that had positively marked the two actors' heterogeneity became a

<sup>65</sup> Although the technical and scientific community recognized his original contribution as the author of kervit (cf. Vecchi, 1952; Korach, 1955), in the local community Korach's fame was predominant. In this respect, it must have been very galling to acknowledge over the years that the pleasure of being recognized as kervit inventor was denied him because he wanted to share the patent with his friend and master Maurizio Korach.

In the first interview, Dal Borgo recalled that at the end of the war, Korach came into contact with the Reggio Emilia federation of the Communist Party. It was in this environment that the rumour spread that Korach was the true inventor of the kervit system, a misconception abetted by the fact that Korach, apart from his fame as an intellectual, was involved in preparing the patent registration documents and in selling the licence. Dal Borgo asked him to publish a denial in the local communist party magazine, but the article had little effect.



disadvantage because there was no longer mutual directedness. Korach, who took care of the commercial aspects of overseas licence sales, did not mobilize the technical and production linkages which might have been able to generate the development of kervit-related complementary techniques – not just movement operations and firing techniques, but also technologies and materials for fixing kervit tiles. Dal Borgo, who only dealt with technical and operative matters, assessed the impact of endogenous change in demand on the economic environment in which he operated as secondary for his own activity. Other agents, however, saw those changes as the opportunity to modify the space relevant to their action, albeit within the limits of their technical ability. It was precisely these limits which guided the choice towards developing techniques easier to use than those in the kervit system, but decidedly more remunerative in terms of the profit rate they were to make possible<sup>66</sup>.

We have seen in the case of kervit that patenting the production method can considerably influence the potential spread of the technology involved, but it might be objected that, basically, there is clearly also a question of scale involved in this story. If kervit production had not been a thousand square metres a day, but fifty thousand, then it might well have necessitated the development of complementary techniques inside the firm or on the part of outside specialist producers. And this is one of the reasons why it does not seem opportune to consider the patents as a reliable indicator of innovations achieved within a small business production system: the individual firm is not big enough to develop in house all the complementary technologies which prove indispensable if its full potential is to be exploited, and neither does it always prove possible to find solutions to technical problems which arise with the use of a new technology. In such a context, by limiting the circulation of technical information, the patent does not therefore offer the chance of interaction between agents and artifacts which could bring about the changes (new artifacts, new agents and new entities) required for the development of new technology. The importance of links with the outside world has been recognized as a crucial factor for the success of an innovation since Carter and Williams published their studies in the late Fifties<sup>67</sup>. However, what has emerged from our research is that the key factor is not what is usually highlighted in such studies, i.e. the link with the scientific world of the particular field in which the innovation is developed<sup>68</sup>; the key factor is the links which should have been created with the network of potential innovators of all the complementary technologies. It was the absence of these links which prevented kervit from becoming an alternative to the traditional majolica production system.

<sup>66</sup> An economic assessment of the techniques in use in the Sixties has shown that ceramics firms have achieved profits as high as 200%. (See the degree theses of Ezio Cervi and Gabriele Canotti, Faculty of Economics and Commerce, Modena, 1972-73).

<sup>67</sup> Cf. Carter and Williams (1959).

<sup>68</sup> Cf. for example Freeman and Soete (1997, p. 216).

## Bibliographical references

- Agar M. H. (1996), *The professional Stranger. An informal Introduction to Ethnography*, San Diego, Academic Press
- Akrich M. and B. Latour (1992), A summary on conventional vocabulary for the semiotics of human and non human assemblies, in Bijker and Law (1992), pp. 259-64
- Allen R. C. (1983), Collective invention, *Journal of Economic Behavior and Organization*, pp. 1-24
- Antonelli C. (1999), Communication and innovation: the evidence within technological districts, *mimeo*
- Arthur W. B. (1989), Competing technologies, increasing returns and lock-in by historical events, *Economic Journal*, pp.116-31
- Bacchelli R. (1976), Ricordo di Maurizio Korach. L'ultimo desiderio di un italo-ungherese, *Corriere della Sera*, 5 febbraio
- Bellandi M. (1989), Capacità innovativa diffusa e sistemi locali di impresa, in G. Becattini (ed.), *Modelli locali di sviluppo*, Bologna, il Mulino, pp.149-72
- Bellandi M. and M. Russo (eds.) (1994), *Distretti industriale e cambiamento economico locale*, Torino, Rosenberg & Sellier
- Bertucelli L. (1997), Paternalismo, appartenenza aziendale e culture operaie nell'Italia repubblicana, *Passato e presente*, n. 41
- Biavati E. (1976), Il mio maestro, in Società Italiana della Ceramica (1976)
- Bijker W. E., T. P. Hughes and T. Pinch (eds.) (1987), *The Social Construction of Technological Systems*, Cambridge, Mass., Mit Press
- Bijker W. E. and J. Law (eds.) (1992), *Shaping Technology/Building Society. Studies in Sociotechnical Change*, Cambridge, Mass., Mit Press
- Bonifati G. (1999), The capacity to generate investment. An analysis of the long-term determinants of investment, *Materiali di discussione n. 266*, Dipartimento di Economia Politica, Università di Modena
- Bowker G. (1992), What's in a patent?, in Bijker e Law (1992), pp. 53-74
- Bright J. R. (1958), *Automation and Management*, Norwood, Mass., Plimpton Press
- Brusco S. (1982), The Emilian model: Productive decentralization and social integration, *Cambridge Journal of Economics*, 6, 167-180
- Carlson W. B. (1992), Artifacts and frame of meaning: Thomas A. Edison, his managers, and his cultural construction of motion pictures, in Bijker and Law (1992), pp. 175-98
- Carter C. F. e Williams B. R. (1959), The characteristics of technically progressive firms, *Journal of Industrial Economics*, vol. 7, n. 2, pp. 87-104
- Cattani G. (1996), Innovazioni e relazioni tra imprese nel distretto ceramico di Sassuolo-Scandiano, dissertation at the Faculty of Economics, University of Modena
- Edwards J. and M. D. Lampert (eds.) (1993), *Talking Data: Transcription and Coding in Discourse Research*, Hillsdale, NJ, Lawrence Erlbaum
- Freeman C. and L. Soete (1997), *The Economics of Industrial Innovation. Third Edition*, London, Pinter
- Hägerstrand T. (1965), Quantitative techniques for analysis of the speed of information technology, in C. A. Anderson and M. J. Bowman (eds.), *Education and Economic Development*, Chicago, Aldine Publ. Co., pp. 244-80
- Hägerstrand T. (1968), The diffusion of innovation, in D. L. Sillis (eds.), *International Encyclopedia of Social Sciences*, vol. 4, London, Macmillan Co. & Free Press, pp. 174-8
- Hughes T. P. (1971), *Elmer Sperry*, Baltimore, Johns Hopkins University Press
- Hughes T. P. (1983), *Network of Power, Electrification in Western Society, 1880-1930*, Baltimore, Johns Hopkins University Press
- Hughes T. P. (1987), The evolution of large technological systems, in Bijker, Hughes and Pinch (eds.) (1987), pp. 51-82
- Iacobucci D. (ed.), *Networks in marketing*, Thousand Oaks, CA, Sage Publications
- Katz M. and C. Shapiro (1985), Network externalities, competition and compatibility, *American economic Review*, pp.44-62
- Koestler A. (1975), *L'atto della creazione*, Roma, Ubaldini Editore
- Korach M. (1955), Die technologie Kervit-Platten-Herstellung, *Silikattechnik*, n. 12, pp. 521-28
- Korach M. (1964), Gaetano Ballardini. Nel decennale della scomparsa, *Faenza, Bollettino del Museo Internazionale delle Ceramiche*, n. 4-5
- Lane D. A., F. Malerba, R. Maxfield and L. Orsenigo (1996), Choice and action, *Journal of Evolutionary Economics*, pp. 43-76

- Lane D. A. and R. Maxfield (1997), Strategy under complexity: fostering generative relationships, in B. Arthur, S. Durlauf and D. Lane (eds.), *Economy as an Evolving Complex System II*, (Reader, Mass., Addison-Wesley)
- Latour B. (1992), Where are the missing masses? The sociology of a few mundane artifacts, in Bijker and Law (1992), pp. 225-58
- Law J. and M. Callon (1992), The life and death of an aircraft: a network analysis of technical change, in Bijker e Law (1992), pp. 21-52
- Maiocchi R. (1998), Gli istituti di ricerca scientifica in Italia durante il fascismo, in R. Simili (ed.), *Ricerca e istituzioni scientifiche in Italia*, Bari, Laterza, pp. 182-212
- Misa (1992), Controversy and closure in technological change: Constructing "Steel", in Bijker and law (1992), pp.109-39
- Perroux F.(1950), *L'economia del XX secolo*, Milano, Edizioni di Comunità, 1966.
- Polinszki K. (1976), La vita e l'attività di Maurizio Cora nel campo della tecnica chimica, in Società Italiana della Ceramica (1976), pp.11-14
- Rosenberg N. (1969), The direction of technological change: inducement mechanisms and focusing devices, *Economic Development and Cultural Change*, pp. 1-24
- Rosenberg N. (1982), Learning by using, in N. Rosenberg , *Inside the Black Box: Technology and Economics*, Cambridge, Cambridge University Press, pp. 120-40
- Rosenberg N. (1996), Uncertainty and technological change, in R. Landau, T. Taylor and G. Wright (eds.), *The mosaic of economic growth*, Stanford, Stanford University Press, pp.
- Russo M. (1985), Technical change and industrial district: The role of interfirm relations in the growth and transformation of ceramic tile production in Italy, *Research Policy*, pp.329-43
- Russo M. (1996), *Cambiamento tecnico e relazioni tra imprese*, Torino, Rosenberg & Sellier
- Russo M. (in collaboration with Peter Börkey, Emilio Cubel, François Lévêque e Francisco Mas), *Local sustainability and competitiveness: the case of the ceramic tile industry*, European Foundation for the improvement of living and working conditions, Louxembourg, Office for the Official Publications of the European Communities, 1998
- Schumpeter J. (1934), *The Theory of Economic Development*, Cambridge, Mass., Harvard University Press
- Società Italiana della Ceramica (1976), *Scritti di Maurizio Korach*, Faenza, Faenza editrice
- Spradley J. P. (1979), *The ethnographic interview*, Harcourt Brace Jovanovich College Publ., New York
- Suchman L. A. (1987), *Plans and situated actions. The problem of human-machine communication*, Cambridge University Press, Cambridge
- Teece D. (1986), Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy, *Research Policy*, pp. 285-305
- Vecchi G. (1952), Contributo dell'Italia alle innovazioni ceramiche nel primo mezzo secolo, in Società Italiana della Ceramica (1976)
- Vecchi G. (1988), Maurizio Korach: scienziato e tecnologo, in Comune di Faenza-Istituto Statale d'Arte per la Ceramica, di Faenza, *Maurizio Korach nel centenario della nascita 1888-1988*, Faenza, Faenza editrice



1. Maria Cristina Marcuzzo [1985] "Joan Violet Robinson (1903-1983)", pp. 134
2. Sergio Lugaresi [1986] "Le imposte nelle teorie del sovrappiù", pp. 26
3. Massimo D'Angelillo e Leonardo Paggi [1986] "PCI e socialdemocrazie europee. Quale riformismo?", pp. 158
4. Gian Paolo Caselli e Gabriele Pastrello [1986] "Un suggerimento hobsoniano su terziario ed occupazione: il caso degli Stati Uniti 1960/1983", pp. 52
5. Paolo Bosi e Paolo Silvestri [1986] "La distribuzione per aree disciplinari dei fondi destinati ai Dipartimenti, Istituti e Centri dell'Università di Modena: una proposta di riforma", pp. 25
6. Marco Lippi [1986] "Aggregations and Dynamic in One-Equation Econometric Models", pp. 64
7. Paolo Silvestri [1986] "Le tasse scolastiche e universitarie nella Legge Finanziaria 1986", pp. 41
8. Mario Forni [1986] "Storie familiari e storie di proprietà. Itinerari sociali nell'agricoltura italiana del dopoguerra", pp. 165
9. Sergio Paba [1986] "Gruppi strategici e concentrazione nell'industria europea degli elettrodomestici bianchi", pp. 56
10. Nerio Naldi [1986] "L'efficienza marginale del capitale nel breve periodo", pp. 54
11. Fernando Vianello [1986] "Labour Theory of Value", pp. 31
12. Piero Ganugi [1986] "Risparmio forzato e politica monetaria negli economisti italiani tra le due guerre", pp. 40
13. Maria Cristina Marcuzzo e Annalisa Rosselli [1986] "The Theory of the Gold Standard and Ricardo's Standard Comodity", pp. 30
14. Giovanni Solinas [1986] "Mercati del lavoro locali e carriere di lavoro giovanili", pp. 66
15. Giovanni Bonifati [1986] "Saggio dell'interesse e domanda effettiva. Osservazioni sul cap. 17 della General Theory", pp. 42
16. Marina Murat [1986] "Betwin old and new classical macroeconomics: notes on Lejonhufvud's notion of full information equilibrium", pp. 20
17. Sebastiano Brusco e Giovanni Solinas [1986] "Mobilità occupazionale e disoccupazione in Emilia Romagna", pp. 48
18. Mario Forni [1986] "Aggregazione ed esogeneità", pp. 13
19. Sergio Lugaresi [1987] "Redistribuzione del reddito, consumi e occupazione", pp. 17
20. Fiorenzo Sperotto [1987] "L'immagine neopopulista di mercato debole nel primo dibattito sovietico sulla pianificazione", pp. 34
21. M. Cecilia Guerra [1987] "Benefici tributari nel regime misto per i dividendi proposto dalla commissione Sarcinelli: una nota critica", pp. 9
22. Leonardo Paggi [1987] "Contemporary Europe and Modern America: Theories of Modernity in Comparative Perspective", pp. 38
23. Fernando Vianello [1987] "A Critique of Professor Goodwin's 'Critique of Sraffa'", pp. 12
24. Fernando Vianello [1987] "Effective Demand and the Rate of Profits. Some Thoughts on Marx, Kalecki and Sraffa", pp. 41
25. Anna Maria Sala [1987] "Banche e territorio. Approccio ad un tema geografico-economico", pp. 40
26. Enzo Mingione e Giovanni Mottura [1987] "Fattori di trasformazione e nuovi profili sociali nell'agricoltura italiana: qualche elemento di discussione", pp. 36
27. Giovanna Procacci [1988] "The State and Social Control in Italy During the First World War", pp. 18
28. Massimo Matteuzzi e Annamaria Simonazzi [1988] "Il debito pubblico", pp. 62
29. Maria Cristina Marcuzzo (a cura di) [1988] "Richard F. Kahn. A discipline of Keynes", pp. 118
30. Paolo Bosi [1988] "MICROMOD. Un modello dell'economia italiana per la didattica della politica fiscale", pp. 34
31. Paolo Bosi [1988] "Indicatori della politica fiscale. Una rassegna e un confronto con l'aiuto di MICROMOD", pp. 25
32. Giovanna Procacci [1988] "Protesta popolare e agitazioni operaie in Italia 1915-1918", pp. 45
33. Margherita Russo [1988] "Distretto Industriale e servizi. Uno studio dei trasporti nella produzione e nella vendita delle piastrelle", pp. 157
34. Margherita Russo [1988] "The effect of technical change on skill requirements: an empirical analysis", pp. 28
35. Carlo Grillenzoni [1988] "Identification, estimations of multivariate transfer functions", pp. 33
36. Nerio Naldi [1988] "Keynes' concept of capital", pp. 40
37. Andrea Ginzburg [1988] "locomotiva Italia?", pp. 30
38. Giovanni Mottura [1988] "La 'persistenza' secolare. Appunti su agricoltura contadina ed agricoltura familiare nelle società industriali", pp. 40
39. Giovanni Mottura [1988] "L'anticamera dell'esodo. I contadini italiani della 'restaurazione contrattuale' fascista alla riforma fondiaria", pp. 40
40. Leonardo Paggi [1988] "Americanismo e riformismo. La socialdemocrazia europea nell'economia mondiale aperta", pp. 120
41. Annamaria Simonazzi [1988] "Fenomeni di isteresi nella spiegazione degli alti tassi di interesse reale", pp. 44
42. Antonietta Bassetti [1989] "Analisi dell'andamento e della casualità della borsa valori", pp. 12
43. Giovanna Procacci [1989] "State coercion and worker solidarity in Italy (1915-1918): the moral and political content of social unrest", pp. 41
44. Carlo Alberto Magni [1989] "Reputazione e credibilità di una minaccia in un gioco bargaining", pp. 56
45. Giovanni Mottura [1989] "Agricoltura familiare e sistema agroalimentare in Italia", pp. 84
46. Mario Forni [1989] "Trend, Cycle and 'Fortuitous cancellation': a Note on a Paper by Nelson and Plosser", pp. 4
47. Paolo Bosi, Roberto Golinelli, Anna Stagni [1989] "Le origini del debito pubblico e il costo della stabilizzazione", pp. 26
48. Roberto Golinelli [1989] "Note sulla struttura e sull'impiego dei modelli macroeconomici", pp. 21
49. Marco Lippi [1989] "A Short Note on Cointegration and Aggregation", pp. 11
50. Gian Paolo Caselli e Gabriele Pastrello [1989] "The Linkage between Tertiary and Industrial Sector in the Italian Economy: 1951-1988. From an External Dependence to an International One", pp. 40
51. Gabriele Pastrello [1989] "Francois quesnay: dal Tableau Zig-zag al Tableau Formule: una ricostruzione", pp. 48
52. Paolo Silvestri [1989] "Il bilancio dello stato", pp. 34
53. Tim Mason [1990] "Tre seminari di storia sociale contemporanea", pp. 26
54. Michele Lalla [1990] "The Aggregate Escape Rate Analysed through the Queueing Model", pp. 23
55. Paolo Silvestri [1990] "Sull'autonomia finanziaria dell'università", pp. 11
56. Paola Bertolini, Enrico Giovannetti [1990] "Uno studio di 'filiera' nell'agroindustria. Il caso del Parmigiano Reggiano", pp. 164

57. Paolo Bosi, Roberto Golinelli, Anna Stagni [1990] "Effetti macroeconomici, settoriali e distributivi dell'armonizzazione dell'IVA", pp. 24
58. Michele Lalla [1990] "Modelling Employment Spells from Emilia Labour Force Data", pp. 18
59. Andrea Ginzburg [1990] "Politica Nazionale e commercio internazionale", pp. 22
60. Andrea Giommi [1990] "La probabilità individuale di risposta nel trattamento dei dati mancanti", pp. 13
61. Gian Paolo Caselli e Gabriele Pastrello [1990] "The service sector in planned economies. Past experiences and future perspectives", pp. 32
62. Giovanni Solinas [1990] "Competenze, grandi industrie e distretti industriali. Il caso Magneti Marelli", pp. 23
63. Andrea Ginzburg [1990] "Debito pubblico, teorie monetarie e tradizione civica nell'Inghilterra del Settecento", pp. 30
64. Mario Forni [1990] "Incertezza, informazione e mercati assicurativi: una rassegna", pp. 37
65. Mario Forni [1990] "Misspecification in Dynamic Models", pp. 19
66. Gian Paolo Caselli e Gabriele Pastrello [1990] "Service Sector Growth in CPE's: An Unsolved Dilemma", pp. 28
67. Paola Bertolini [1990] "La situazione agro-alimentare nei paesi ad economia avanzata", pp. 20
68. Paola Bertolini [1990] "Sistema agro-alimentare in Emilia Romagna ed occupazione", pp. 65
69. Enrico Giovannetti [1990] "Efficienza ed innovazione: il modello "fondi e flussi" applicato ad una filiera agro-industriale", pp. 38
70. Margherita Russo [1990] "Cambiamento tecnico e distretto industriale. una verifica empirica", pp. 115
71. Margherita Russo [1990] "Distretti industriali in teoria e in pratica: una raccolta di saggi", pp. 119
72. Paolo Silvestri [1990] "La Legge Finanziaria. Voce dell'enciclopedia Europea Garzanti", pp. 8
73. Rita Paltrinieri [1990] "La popolazione italiana: problemi di oggi e di domani", pp. 57
74. Enrico Giovannetti [1990] "Illusioni ottiche negli andamenti delle Grandezze distributive: la scala mobile e l'appiattimento delle retribuzioni in una ricerca", pp. 120
75. Enrico Giovannetti [1990] "Crisi e mercato del lavoro in un distretto industriale: il bacino delle ceramiche. Sez. I", pp. 150
76. Enrico Giovannetti [1990] "Crisi e mercato del lavoro in un distretto industriale: il bacino delle ceramiche. Sez. II", pp. 145
78. Antonietta Bassetti e Costanza Torricelli [1990] "Una riqualificazione dell'approccio bargaining alla selezioni di portafoglio", pp. 4
77. Antonietta Bassetti e Costanza Torricelli [1990] "Il portafoglio ottimo come soluzione di un gioco bargaining", pp. 15
79. Mario Forni [1990] "Una nota sull'errore di aggregazione", pp. 6
80. Francesca Bergamini [1991] "Alcune considerazioni sulle soluzioni di un gioco bargaining", pp. 21
81. Michele Grillo e Michele Polo [1991] "Political Exchange and the allocation of surplus: a Model of Two-party competition", pp. 34
82. Gian Paolo Caselli e Gabriele Pastrello [1991] "The 1990 Polish Recession: a Case of Truncated Multiplier Process", pp. 26
83. Gian Paolo Caselli e Gabriele Pastrello [1991] "Polish firms: Pricate Vices Pubblis Virtues", pp. 20
84. Sebastiano Brusco e Sergio Paba [1991] "Connessioni, competenze e capacità concorrenziale nell'industria della Sardegna", pp. 25
85. Claudio Grimaldi, Rony Hamoui, Nicola Rossi [1991] "Non Marketable assets and households' Portfolio Choice: a Case of Study of Italy", pp. 38
86. Giulio Righi, Massimo Baldini, Alessandra Brambilla [1991] "Le misure degli effetti redistributivi delle imposte indirette: confronto tra modelli alternativi", pp. 47
87. Roberto Fanfani, Luca Lanini [1991] "Innovazione e servizi nello sviluppo della meccanizzazione agricola in Italia", pp. 35
88. Antonella Caiumi e Roberto Golinelli [1992] "Stima e applicazioni di un sistema di domanda Almost Ideal per l'economia italiana", pp. 34
89. Maria Cristina Marcuzzo [1992] "La relazione salari-occupazione tra rigidità reali e rigidità nominali", pp. 30
90. Mario Biagioli [1992] "Employee financial participation in enterprise results in Italy", pp. 50
91. Mario Biagioli [1992] "Wage structure, relative prices and international competitiveness", pp. 50
92. Paolo Silvestri e Giovanni Solinas [1993] "Abbandoni, esiti e carriera scolastica. Uno studio sugli studenti iscritti alla Facoltà di Economia e Commercio dell'Università di Modena nell'anno accademico 1990/1991", pp. 30
93. Gian Paolo Caselli e Luca Martinelli [1993] "Italian GPN growth 1890-1992: a unit root or segmented trend representatin?", pp. 30
94. Angela Politi [1993] "La rivoluzione fraintesa. I partigiani emiliani tra liberazione e guerra fredda, 1945-1955", pp. 55
95. Alberto Rinaldi [1993] "Lo sviluppo dell'industria metalmeccanica in provincia di Modena: 1945-1990", pp. 70
96. Paolo Emilio Mistrulli [1993] "Debito pubblico, intermediari finanziari e tassi d'interesse: il caso italiano", pp. 30
97. Barbara Pistoresi [1993] "Modelling disaggregate and aggregate labour demand equations. Cointegration analysis of a labour demand function for the Main Sectors of the Italian Economy: 1950-1990", pp. 45
98. Giovanni Bonifati [1993] "Progresso tecnico e accumulazione di conoscenza nella teoria neoclassica della crescita endogena. Una analisi critica del modello di Romer", pp. 50
99. Marcello D'Amato e Barbara Pistoresi [1994] "The relationship(s) among Wages, Prices, Unemployment and Productivity in Italy", pp. 30
100. Mario Forni [1994] "Consumption Volatility and Income Persistence in the Permanent Income Model", pp. 30
101. Barbara Pistoresi [1994] "Using a VECM to characterise the relative importance of permanent and transitory components", pp. 28
102. Gian Paolo Caselli and Gabriele Pastrello [1994] "Polish recovery form the slump to an old dilemma", pp. 20
103. Sergio Paba [1994] "Imprese visibili, accesso al mercato e organizzazione della produzione", pp. 20
104. Giovanni Bonifati [1994] "Progresso tecnico, investimenti e capacità produttiva", pp. 30
105. Giuseppe Marotta [1994] "Credit view and trade credit: evidence from Italy", pp. 20
106. Margherita Russo [1994] "Unit of investigation for local economic development policies", pp. 25
107. Luigi Brighi [1995] "Monotonicity and the demand theory of the weak axioms", pp. 20
108. Mario Forni e Lucrezia Reichlin [1995] "Modelling the impact of technological change across sectors and over time in manufacturing", pp. 25
109. Marcello D'Amato and Barbara Pistoresi [1995] "Modelling wage growth dynamics in Italy: 1960-1990", pp. 38
110. Massimo Baldini [1995] "INDIMOD. Un modello di microsimulazione per lo studio delle imposte indirette", pp. 37

111. Paolo Bosi [1995] "Regionalismo fiscale e autonomia tributaria: l'emersione di un modello di consenso", pp. 38
112. Massimo Baldini [1995] "Aggregation Factors and Aggregation Bias in Consumer Demand", pp. 33
113. Costanza Torricelli [1995] "The information in the term structure of interest rates. Can stochastic models help in resolving the puzzle?" pp. 25
114. Margherita Russo [1995] "Industrial complex, pôle de développement, distretto industriale. Alcune questioni sulle unità di indagine nell'analisi dello sviluppo." pp. 45
115. Angelika Moryson [1995] "50 Jahre Deutschland. 1945 - 1995" pp. 21
116. Paolo Bosi [1995] "Un punto di vista macroeconomico sulle caratteristiche di lungo periodo del nuovo sistema pensionistico italiano." pp. 32
117. Gian Paolo Caselli e Salvatore Curatolo [1995] "Esistono relazioni stimabili fra dimensione ed efficienza delle istituzioni e crescita produttiva? Un esercizio nello spirito di D.C. North." pp. 11
118. Mario Forni e Marco Lippi [1995] "Permanent income, heterogeneity and the error correction mechanism." pp. 21
119. Barbara Pistoresi [1995] "Co-movements and convergence in international output. A Dynamic Principal Components Analysis" pp. 14
120. Mario Forni e Lucrezia Reichlin [1995] "Dynamic common factors in large cross-section" pp. 17
121. Giuseppe Marotta [1995] "Il credito commerciale in Italia: una nota su alcuni aspetti strutturali e sulle implicazioni di politica monetaria" pp. 20
122. Giovanni Bonifati [1995] "Progresso tecnico, concorrenza e decisioni di investimento: una analisi delle determinanti di lungo periodo degli investimenti" pp. 25
123. Giovanni Bonifati [1995] "Cambiamento tecnico e crescita endogena: una valutazione critica delle ipotesi del modello di Romer" pp. 21
124. Barbara Pistoresi e Marcello D'Amato [1995] "La riservatezza del banchiere centrale è un bene o un male? Effetti dell'informazione incompleta sul benessere in un modello di politica monetaria." pp. 32
125. Barbara Pistoresi [1995] "Radici unitarie e persistenza: l'analisi univariata delle fluttuazioni economiche." pp. 33
126. Barbara Pistoresi e Marcello D'Amato [1995] "Co-movements in European real outputs" pp. 20
127. Antonio Ribba [1996] "Ciclo economico, modello lineare-stocastico, forma dello spettro delle variabili macroeconomiche" pp. 31
128. Carlo Alberto Magni [1996] "Repeatable and a tantum real options a dynamic programming approach" pp. 23
129. Carlo Alberto Magni [1996] "Opzioni reali d'investimento e interazione competitiva: programmazione dinamica stocastica in optimal stopping" pp. 26
130. Carlo Alberto Magni [1996] "Vaghezza e logica fuzzy nella valutazione di un'opzione reale" pp. 20
131. Giuseppe Marotta [1996] "Does trade credit redistribution thwart monetary policy? Evidence from Italy" pp. 20
132. Mauro Dell'Amico e Marco Trubian [1996] "Almost-optimal solution of large weighted equicut problems" pp. 30
133. Carlo Alberto Magni [1996] "Un esempio di investimento industriale con interazione competitiva e avversione al rischio" pp. 20
134. Margherita Russo, Peter Börkey, Emilio Cubel, François Lévêque, Francisco Mas [1996] "Local sustainability and competitiveness: the case of the ceramic tile industry" pp. 66
135. Margherita Russo [1996] "Camionetto tecnico e relazioni tra imprese" pp. 190
136. David Avra Lane, Irene Poli, Michele Lalla, Alberto Roverato [1996] "Lezioni di probabilità e inferenza statistica" pp. 288
137. David Avra Lane, Irene Poli, Michele Lalla, Alberto Roverato [1996] "Lezioni di probabilità e inferenza statistica - Esercizi svolti -" pp. 302
138. Barbara Pistoresi [1996] "Is an Aggregate Error Correction Model Representative of Disaggregate Behaviours? An Example" pp. 24
139. Luisa Malaguti e Costanza Torricelli [1996] "Monetary policy and the term structure of interest rates", pp. 30
140. Mauro Dell'Amico, Martine Labbé, Francesco Maffioli [1996] "Exact solution of the SONET Ring Loading Problem". pp. 20
141. Mauro Dell'Amico, R.J.M. Vaessens [1996] "Flow and open shop scheduling on two machines with transportation times and machine-independent processing times in NP-hard, pp. 10
142. M. Dell'Amico, F. Maffioli, A. Sciomechen [1996] "A Lagrangean Heuristic for the Pirze Collecting Travelling Salesman Problem", pp. 14
143. Massimo Baldini [1996] "Inequality Decomposition by Income Source in Italy - 1987 - 1993". pp. 20
144. Graziella Bertocchi [1996] "Trade, Wages, and the Persistence of Underdevelopment" pp. 20
145. Graziella Bertocchi and Fabio Canova [1996] "Did Colonization matter for Growth? An Empirical Exploration into the Historical Causes of Africa's Underdevelopment" pp. 32
146. Paola Bertolini [1996] "La modernization de l'agriculture italienne et le cas de l'Emilie Romagne" pp. 20
147. Enrico Giovannetti [1996] "Organisation industrielle et développement local: le cas de l'agroindustrie in Emilie Romagne" pp. 18
148. Maria Elena Bontempi e Roberto Golinelli [1996] "Le determinanti del leverage delle imprese: una applicazione empirica ai settori industriali dell'economia italiana" pp. 31
149. Paola Bertolini [1996] "L'agriculture et la politique agricole italienne face aux recents scenarios", pp. 20
150. Enrico Giovannetti [1996] "Il grado di utilizzo della capacità produttiva come misura dei costi di transazione: una rilettura di 'Nature of the Firm' di R. Coase", pp. 75
151. Enrico Giovannetti [1996] "Il 1° ciclo del Diploma Universitario Economia e Amministrazione delle Imprese", pp. 25
152. Paola Bertolini, Enrico Giovannetti, Giulia Santacaterina [1996] "Il Settore del Verde Pubblico. Analisi della domanda e valutazione economica dei benefici", pp. 35
153. Giovanni Solinas [1996] "Sistemi produttivi del Centro-Nord e del Mezzogiorno. L'industria delle calzature", pp. 55
154. Tindara Addabbo [1996] "Married Women's Labour Supply in Italy in a Regional Perspective", pp. 85
155. Paolo Silvestri, Giuseppe Catalano, Cristina Bevilacqua [1996] "Le tasse universitarie e gli interventi per il diritto allo studio: la prima fase di applicazione di una nuova normativa" pp. 159
156. Sebastiano Brusco, Paolo Bertossi, Margherita Russo [1996] "L'industria dei rifiuti urbani in Italia", pp. 25
157. Paolo Silvestri, Giuseppe Catalano [1996] "Le risorse del sistema universitario italiano: finanziamento e governo" pp. 400
158. Carlo Alberto Magni [1996] "Un semplice modello di opzione di differimento e di vendita in ambito discreto", pp. 10
159. Tito Pietra, Paolo Siconolfi [1996] "Fully Revealing Equilibria in Sequential Economies with Asset Markets" pp. 17
160. Tito Pietra, Paolo Siconolfi [1996] "Extrinsic Uncertainty and the Informational Role of Prices" pp. 42
161. Paolo Bertella Farnetti [1996] "Il negro e il rosso. Un precedente non esplorato dell'integrazione afroamericana negli Stati Uniti" pp. 26
162. David Lane [1996] "Is what is good for each best for all? Learning from others in the information contagion model" pp. 18

163. Antonio Ribba [1996] "A note on the equivalence of long-run and short-run identifying restrictions in cointegrated systems" pp. 10
164. Antonio Ribba [1996] "Scomposizioni permanenti-transitorie in sistemi cointegrati con una applicazione a dati italiani" pp. 23
165. Mario Forni, Sergio Paba [1996] "Economic Growth, Social Cohesion and Crime" pp. 20
166. Mario Forni, Lucrezia Reichlin [1996] "Let's get real: a factor analytical approach to disaggregated business cycle dynamics" pp. 25
167. Marcello D'Amato e Barbara Pistoresi [1996] "So many Italies: Statistical Evidence on Regional Cohesion" pp. 31
168. Elena Bonfiglioli, Paolo Bosi, Stefano Toso [1996] "L'equità del contributo straordinario per l'Europa" pp. 20
169. Graziella Bertocchi, Michael Spagat [1996] "Il ruolo dei licei e delle scuole tecnico-professionali tra progresso tecnologico, conflitto sociale e sviluppo economico" pp. 37
170. Gianna Boero, Costanza Torricelli [1997] "The Expectations Hypothesis of the Term Structure of Interest Rates: Evidence for Germany" pp. 15
171. Mario Forni, Lucrezia Reichlin [1997] "National Policies and Local Economies: Europe and the US" pp. 22
172. Carlo Alberto Magni [1997] "La trappola del Roe e la tridimensionalità del Van in un approccio sistemico", pp. 16
173. Mauro Dell'Amico [1997] "A Linear Time Algorithm for Scheduling Outforests with Communication Delays on Two or Three Processor" pp. 18
174. Paolo Bosi [1997] "Aumentare l'età pensionabile fa diminuire la spesa pensionistica? Ancora sulle caratteristiche di lungo periodo della riforma Dini" pp. 13
175. Paolo Bosi e Massimo Matteuzzi [1997] "Nuovi strumenti per l'assistenza sociale" pp. 31
176. Mauro Dell'Amico, Francesco Maffioli e Marco Trubian [1997] "New bounds for optimum traffic assignment in satellite communication" pp. 21
177. Carlo Alberto Magni [1997] "Paradossi, inverosimiglianze e contraddizioni del Van: operazioni certe" pp. 9
178. Barbara Pistoresi e Marcello D'Amato [1997] "Persistence of relative unemployment rates across italian regions" pp. 25
179. Margherita Russo, Franco Cavedoni e Riccardo Pianesani [1997] "Le spese ambientali dei Comuni in provincia di Modena, 1993-1995" pp. 23
180. Gabriele Pastrello [1997] "Time and Equilibrium, Two Elusive Guests in the Keynes-Hawtrey-Robertson Debate in the Thirties" pp. 25
181. Luisa Malaguti e Costanza Torricelli [1997] "The Interaction Between Monetary Policy and the Expectation Hypothesis of the Term Structure of Interest rates in a N-Period Rational Expectation Model" pp. 27
182. Mauro Dell'Amico [1997] "On the Continuous Relaxation of Packing Problems - Technical Note" pp. 8
183. Stefano Bordini [1997] "Prova di Idoneità di Informatica Dispensa Esercizi Excel 5" pp. 49
184. Francesca Bergamini e Stefano Bordini [1997] "Una verifica empirica di un nuovo metodo di selezione ottima di portafoglio" pp. 22
185. Gian Paolo Caselli e Maurizio Battini [1997] "Following the tracks of atkinson and micklewright the changing distribution of income and earnings in poland from 1989 to 1995" pp. 21
186. Mauro Dell'Amico e Francesco Maffioli [1997] "Combining Linear and Non-Linear Objectives in Spanning Tree Problems" pp. 21
187. Gianni Ricci e Vanessa Debbia [1997] "Una soluzione evolutiva in un gioco differenziale di lotta di classe" pp. 14
188. Fabio Canova e Eva Ortega [1997] "Testing Calibrated General Equilibrium Model" pp. 34
189. Fabio Canova [1997] "Does Detrending Matter for the Determination of the Reference Cycle and the Selection of Turning Points?" pp. 35
190. Fabio Canova e Gianni De Nicolò [1997] "The Equity Premium and the Risk Free Rate: A Cross Country, Cross Maturity Examination" pp. 41
191. Fabio Canova e Angel J. Ubide [1997] "International Business Cycles, Financial Market and Household Production" pp. 32
192. Fabio Canova e Gianni De Nicolò [1997] "Stock Returns, Term Structure, Inflation and Real Activity: An International Perspective" pp. 33
193. Fabio Canova e Morten Ravn [1997] "The Macroeconomic Effects of German Unification: Real Adjustments and the Welfare State" pp. 34
194. Fabio Canova [1997] "Detrending and Business Cycle Facts" pp. 40
195. Fabio Canova e Morten O. Ravn [1997] "Crossing the Rio Grande: Migrations, Business Cycle and the Welfare State" pp. 37
196. Fabio Canova e Jane Marrinan [1997] "Sources and Propagation of International Output Cycles: Common Shocks or Transmission?" pp. 41
197. Fabio Canova e Albert Marcet [1997] "The Poor Stay Poor: Non-Convergence Across Countries and Regions" pp. 44
198. Carlo Alberto Magni [1997] "Un Criterio Strutturalista per la Valutazione di Investimenti" pp. 17
199. Stefano Bordini [1997] "Elaborazione Automatica dei Dati" pp. 60
200. Paolo Bertella Farnetti [1997] "The United States and the Origins of European Integration" pp. 19
201. Paolo Bosi [1997] "Sul Controllo Dinamico di un Sistema Pensionistico a Ripartizione di Tipo Contributivo" pp. 17
202. Paola Bertolini [1997] "European Union Agricultural Policy: Problems and Perspectives" pp. 18
203. Stefano Bordini [1997] "Supporti Informatici per la Ricerca delle soluzioni di Problemi Decisionali" pp. 30
204. Carlo Alberto Magni [1997] "Paradossi, Inverosimiglianze e Contraddizioni del Van: Operazioni Aleatorie" pp. 10
205. Carlo Alberto Magni [1997] "Tir, Roe e Van: Distorsioni linguistiche e Cognitive nella Valutazione degli Investimenti" pp. 17
206. Gisella Facchinetti, Roberto Ghiselli Ricci e Silvia Muzzioli [1997] "New Methods For Ranking Triangular Fuzzy Numbers: An Investment Choice" pp. 9
207. Mauro Dell'Amico e Silvano Martello [1997] "Reduction of the Three-Partition Problem" pp. 16
208. Carlo Alberto Magni [1997] "IRR, ROE and NPV: a Systemic Approach" pp. 20
209. Mauro Dell'Amico, Andrea Lodi e Francesco Maffioli [1997] "Solution of the cumulative assignment problem with a well-structured tabu search method" pp. 25
210. Carlo Alberto Magni [1997] "La definizione di investimento e criterio del Tir ovvero: la realtà inventata" pp. 16
211. Carlo Alberto Magni [1997] "Critica alla definizione classica di investimento: un approccio sistemico" pp. 17
212. Alberto Roverato [1997] "Asymptotic prior to posterior analysis for graphical gaussian models" pp. 8
213. Tindara Addabbo [1997] "Povertà nel 1995 analisi statica e dinamica sui redditi familiari" pp. 64
214. Gian Paolo Caselli e Franca Manghi [1997] "La transizione da piano a mercato e il modello di Ising" pp. 15
215. Tindara Addabbo [1998] "Lavoro non pagato e reddito esteso: un'applicazione alle famiglie italiane in cui entrambi i coniugi sono lavoratori dipendenti" pp. 54



216. Tindara Addabbo [1998] "Probabilità di occupazione e aspettative individuali" pp 36
217. Lara Magnani [1998] "Transazioni, contratti e organizzazioni: una chiave di lettura della teoria economica dell'organizzazione" pp 39
218. Michele Lalla, Rosella Molinari e Maria Grazia Modena [1998] "La progressione delle carriere: i percorsi in cardiologia" pp 46
219. Lara Magnani [1998] "L'organizzazione delle transazioni di subfornitura nel distretto industriale" pp 40
220. Antonio Ribba [1998] "Recursive VAR orderings and identification of permanent and transitory shocks" pp 12
221. Antonio Ribba [1998] "Granger-causality and exogeneity in cointegrated Var models" pp 5
222. Luigi Brighi e Marcello D'Amato [1998] "Optimal Procurement in Multiproduct Monopoly" pp 25
223. Paolo Bosi, Maria Cecilia Guerra e Paolo Silvestri [1998] "La spesa sociale nel comune Modena" Rapporto intermedio pp 37
224. Mario Forni e Marco Lippi [1998] "On the Microfoundations of Dynamic Macroeconomics" pp 22
225. Roberto Ghiselli Ricci [1998] "Nuove Proposte di Ordinamento di Numeri Fuzzy. Una Applicazione ad un Problema di Finanziamento" pp 7
226. Tommaso Minerva [1998] "Internet Domande e Risposte" pp 183
227. Tommaso Minerva [1998] "Elementi di Statistica Computazione. Parte Prima: Il Sistema Operativo Unix ed il Linguaggio C" pp. 57
228. Tommaso Minerva and Irene Poli [1998] "A Genetic Algorithms Selection Method for Predictive Neural Nets and Linear Models" pp. 60
229. Tommaso Minerva and Irene Poli [1998] "Building an ARMA Model by using a Genetic Algorithm" pp. 60
230. Mauro Dell'Amico e Paolo Toth [1998] "Algorithms and Codes for Dense Assignment Problems: the State of the Art" pp 35
231. Ennio Cavazzuti e Nicoletta Pacchiarotti [1998] "How to play an hotelling game in a square town" pp 12
232. Alberto Roverato e Irene Poli [1998] "Un algoritmo genetico per la selezione di modelli grafici" pp 11
233. Marcello D'Amato e Barbara Pistoresi [1998] "Delegation of Monetary Policy to a Central Banker with Private Information" pp 15.
234. Graziella Bertocchi e Michael Spagat [1998] "The Evolution of Modern Educational Systems. Technical vs. General Education, Distributional Conflict, and Growth" pp 31
235. André Dumas [1998] "Le système monétaire Européen" pp 24.
236. Gianna Boero, Gianluca Di Lorenzo e Costanza Torricelli [1998] "The influence of short rate predictability and monetary policy on tests of the expectations hypothesis: some comparative evidence" pp 30
237. Carlo Alberto Magni [1998] "A systemic rule for investment decisions: generalizations of the traditional DCF criteria and new conceptions" pp 30
238. Marcello D'Amato e Barbara Pistoresi [1998] "Interest Rate Spreads Between Italy and Germany: 1995-1997" pp 16
239. Paola Bertolini e Alberto Bertacchini [1998] "Il distretto di lavorazioni carni suine in provincia di Modena" pp 29
240. Costanza Torricelli e Gianluca Di Lorenzo [1998] "Una nota sui fondamenti matematico-finanziari della teoria delle aspettative della struttura della scadenza" pp. 15
241. Christophe Croux, Mario Forni e Lucrezia Reichlin [1998] "A Measure of Comovement for Economic Indicators: Theory and Empirics" pp 23.
242. Carlo Alberto Magni [1998] "Note sparse sul dilemma del prigioniero (e non solo) pp 13.
243. Gian Paolo Caselli [1998] The future of mass consumption society in the former planned economies: a macro approach pp 21.
244. Mario Forni, Marc Hallin, Marco Lippi e Lucrezia Reichlin [1998] "The generalized dynamic factor model: identification and estimation pp 35.
245. Carlo Alberto Magni [1998] "Pictures, language and research: the case of finance and financial mathematics" pp 35.
246. Luigi Brighi [1998] "Demand and generalized monotonicity" pp 21.
247. Mario Forni e Lucrezia Reichlin [1998] "Risk and potential insurance in Europe" pp 20.
248. Tommaso Minerva, Sandra Paterlini e Irene Poli [1998] "A Genetic Algorithm for predictive Neural Network Design (GANND). A Financial Application" pp 12.
249. Gian Paolo Caselli Maurizio Battini [1998] "The Changing Distribution of Earnings in Poland from 1989 to 1996 pp. 9.
250. Mario Forni, Sergio Paba [1998] "Industrial Districts. Social Environment and Local Growth" Evidence from Italy pp. 27.
251. Lara Magnani [1998] "Un'analisi del distretto industriale fondata sulla moderna teoria economica dell'organizzazione" pp. 46.
252. Mario Forni, Lucrezia Reichlin [1998] "Federal Policies and Local Economies: Europe and the US" pp. 24.
253. Luigi Brighi [1998] "A Case of Optimal Regulation whit Multidimensional Private Information" pp 20.
254. Barbara Pistoresi, Stefania Luppi [1998] "Gli investimenti diretti esteri nell'America Latina e nel Sud Est Asiatico: 1982-1995" pp 27.
255. Paola Mengoli, Margherita Russo [1998] "Technical and Vocational Education and Training in Italy: Structure and Changes at National and Regional Level" pp 25.
256. Tindara Addabbo [1998] "On-the-Job Search a Microeconomic Analysis on Italian Data" pp. 29.
257. Lorenzo Bertucelli [1999] "Il paternalismo industriale: una discussione storiografica" pp.21.
258. Mario Forni e Marco Lippi [1999] "The generalized dynamic factor model: representation theory" pp. 25.
259. Andrea Ginzburg e Annamaria Simonazzi [1999] "Foreign debt cycles and the 'Gibson Paradox': an interpretative hypothesis" pp. 38.
260. Paolo Bosi [1999] "La riforma della spesa per assistenza dalla Commissione Onofri ad oggi: una valutazione in corso d'opera" pp. 56.
261. Marcello D'Amato e Barbara Pistoresi [1999] "Go and soothe the row. Delegation of monetary policy under private information" pp. 23.
262. Michele Lalla [1999] "Sampling, Maintenance, and Weighting Schemes for Longitudinal Surveys: a Case Study of the Textile and Clothing Industry" pp. 27.
263. Pederzoli Chiara e Torricelli Costanza [1999] "Una rassegna sui metodi di stima del Value at Risk (Var)".
264. Paolo Bosi, Maria Cecilia Guerra e Paolo Silvestri [1999] "La spesa sociale di Modena. La valutazione della condizione economica" pp 74.
265. Graziella Bertocchi e Michael Spagat [1999] "The Politics Co-optation" pp 14.
266. Giovanni Bonifati [1999] "The Capacity to Generate Investment. An analysis of the long-term determinants of investment" pp.22.
267. Tindara Addabbo e Antonella Caiumi [1999] "Extended Income and Inequality by Gender in Italy" pp. 40.
268. Antonella Caiumi e Federico Perali [1999] "Children and Intrahousehold Distribution of Resources: An Estimate of the Sharing Rule of Italian Households" pp.24
269. Vincenzo Atella, Antonella Caiumi e Federico Perali [1999] "Una scala di equivalenza non vale l'altra" pp.23.

- 270 .Tito Pietra e Paolo Siconolfi [1999] "Volume of Trade and Revelation of Information" pp. 33.
- 271 Antonella Picchio [1999] "La questione del lavoro non pagato nella produzione di servizi nel nucleo domestico (Household)" pp.58.