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INNOVATION IN SERVICES*

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Abstract:

The purpose of this article is to lay the foundations of a theory that can be used to interpret innovation processes in the service sector. The hypothesis underpinning this article is based on Lancaster's definition of the product (in both manufacturing and services) as a set of service characteristics. The article follows the example of those who have sought to apply Lancaster's work to technological phenomena. Various modes of innovation in the service sectors are highlighted and illustrated.

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INNOVATION IN SERVICES*

1. Introduction

The importance of innovation processes, widely recognised on both the empirical and theoretical levels, and the increasingly prominent role being played by service activities in productive systems have combined to make innovation in the service sector an issue of great importance. However, analysis of innovation in service industries is difficult from two standpoints. On the one hand, innovation theory has been developed essentially on the basis of analysis of *technological* innovation in *manufacturing* activities (which, incidentally, represents a diminution of the scope of Schumpeter's pioneering analyses). On the other hand, the specific properties of service activities, and particularly the analytically "fuzzy" nature of their output, make it particularly difficult to measure them by the traditional economic methods (productivity) and to detect improvement or change (on the qualitative level).

These two difficulties constitute the starting point for two complementary groups of studies on innovation in services (which can be only briefly outlined here)[1] :

— The first group focuses on analysis of the introduction of technical equipment and systems in service firms and industries. It includes a very large number of studies of the impact of technologies (particularly information technologies) on services, as well as attempts to construct taxonomies of technological trajectories specific to services [38]. Barras' work ([3], [4]) merits particular attention by virtue of its theoretical ambition. In certain services (banking, insurance, accounting, administration), Barras has observed a product life cycle that is the converse of the traditional industrial cycle. The basic element of this so-called "reverse product cycle" theory is the adoption of an item of computer equipment by a service activity that triggers what might be called a "natural technological trajectory". This leads, in the first instance, to the emergence of incremental process innovations, the purpose of which is to improve the efficiency of the service being provided, secondly to an improvement in service quality through more radical process innovations and finally, in the last phase of cycle, to the emergence of product innovations. Thus innovation is not viewed in isolation from the

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[1] For a more detailed survey cf. F. Gallouj [25] and C. Gallouj and F. Gallouj [22].

technological potentialities, and Barras' model is less a theory of innovation in services than a theory of the diffusion within the service sector of technological innovations derived from manufacturing industry.

— The starting point for the second set of studies is the notion that innovation can exist where the "technologist" gaze perceives nothing. Without ignoring the technological dimension, these "service-oriented" approaches focus on non-technological forms of innovation ; in this respect, they are following the precedent set by Schumpeter, whose definition of innovation was particularly broad and open[2]. Consultancy services, for example, are an interesting area for empirical analysis of service-oriented innovation. In his study of consultancy firms, Gallouj [23] highlights in particular the existence of ad hoc forms of innovation that are not immediately reproducible and of institutional "formalisation" trajectories (i.e. the search for a certain degree of formalisation, though not necessarily, or even predominantely, in tangible form). The latter trajectory was also recently highlighted in the field of catering and related services by Callon [7] and Dubuisson [13]. The studies by Van der Aa and Elfring [43], Gadrey et al. [21] and Sundbo [39], [40] also take a broad, Schumpeterian view of innovation. According to Sundbo [39], [40] innovations in services do not follow a technological trajectory (in Dosi's sense [12]) but rather "service-professional trajectories" (e.g. a certain number of ideas on management, banking, etc.) in which technologies are only one vector among several others.

The purpose of this article is to lay the foundations of a theory that can be used to interpret innovation processes in the service sector. In order to achieve this objective, it did not seem to us appropriate to make an a priori distinction between innovation in service activities and innovation in manufacturing and to attempt to construct a specific "theory of innovation in services". Rather, it is our intention to investigate how taking the specificities of service activities as a starting point might lead to a reformulation of the analysis of innovation and a clear definition of the possible forms it might take. Such an approach, which seems to us both more realistic and more productive, is in line with the hypothesis of a convergence between manufacturing and services.

The construction of a general description of innovation is essential for an understanding of what the notion of innovation might encompass, in both services and manufacturing industry, and the basic forms it might take. The standard analysis of technological innovation tends to focus on the effects of innovation rather than on its actual content and characteristics. As a result, study of the various forms of innovation has centred on two lines of inquiry, with the

[2] Schumpeter identified several different forms of innovation: the introduction of a new good, the introduction of a new means of production, the discovery of a new source of raw material or semi-finished product, the conquest of a new market and the establishment of a new organisation.

first distinguishing product innovation from process innovation (to which might be added other forms, such as organisational innovation and the various types considered by Schumpeter) and the second contrasting major (or radical) innovations with secondary (or incremental) innovations. However important these aspects may be, it is essential to delve deeper into the "black box" of innovative processes in order to understand both their content and the forces that drive them. This can be achieved through a formalisation derived from Lancaster's work [32], in which a product is defined as a set of characteristics. The approach adopted in this article follows the example of those who have sought to apply Lancaster's approach to technological phenomena (Saviotti and Metcalfe [36], cf. also Saviotti [37]). It seems to us possible, with a certain number of changes, to extend the application of this formalisation to the analysis of innovation in the service sector, by taking due account of the intangible nature of the "product" and the interaction between agents that often characterise this type of activity.

The characteristics approach, which it is our intention to develop here, is integrative. Firstly, it encompasses both goods and services. Secondly, it applies both to technological innovation itself and to the non-technological forms of innovation. It can be seen as a way of clarifying and making more operational functional approaches[3] which have proved to be too general.

This article is divided into three sections. The first section is given over to an attempt to extend the Lancasterian representation of products and processes suggested by Saviotti and Metcalfe to services (§2). The various modes and models of innovation derived from this approach are then outlined and illustrated[4] as they apply to services (§3). The conclusion is given over to an examination of some of the theoretical implications of an approach to products and innovation based on charts of characteristics.

2. The search for a general formalisation of the product (good or service)

[3] Barcet, Bonamy and Mayère [2] adopt such an approach and categorise innovations according to whether they relate to function, specification or the production process. The first category encompasses the emergence of new, undifferentiated, abstract functions ; the second involves the concrete realisation and differentiation of the functional innovation, while the third corresponds to a cost-cutting trajectory (as a result of standardisation, the use of new technical instruments, etc.).

[4] The illustrations in this paper are drawn from two main sources: on the one hand, the economic and management literature and, on the other, an empirical study carried out by the authors in collaboration with Jean Gadrey, Thierry Ribault and Stéphane Lhuillery for the French Ministry of Higher Education and Research on the subject of R&D and innovation in services. In the course of the project, studies were conducted in the insurance and banking, consultancy and electronic information services industries. The article has also benefited from empirical and theoretical material derived from two other research projects carried out in collaboration with Faridah Djellal and Camal Gallouj, one for the Commissariat Général du Plan, the other for the European Commission.. In the course of these projects, investigations were carried out in other areas of the service sector, namely retailing, hotels and catering, transport and cleaning.

We shall begin here by outlining the way in which Saviotti and Metcalfe [36] and Saviotti [37], taking Lancaster's work as a starting point but, paradoxically, adopting an evolutionary perspective, advance the notion of modelling a product (i.e., from Saviotti and Metcalfe's point of view, a "material" artefact) as a means of measuring technical change. This notion is examined in the light of the principal defining characteristics of services and proposals drawn up for adapting it to service activities.

Nevertheless, an approach such as the one favoured here, which takes products as its starting point, does not mean that process innovations or technlogies are ignored. As far as services are concerned, distinguishing between these two categories is more problematic than in the case of goods. The approach outlined here will have to take this into account.

2.1. The product as a set of technical and service characteristics

According to Saviotti and Metcalfe [36] the provision of any type of "product" can be described in terms of a set of characteristics that reflect, on the one hand, the internal structure of the product in question and, on the other, its external properties, i.e. the type of service being offered to users. Saviotti and Metcalfe divide these characteristics into three main types:

(a) *The final (or use) characteristics of the good or service (Y)* - Saviotti and Metcalfe speak of *"service characteristics"*. These are the characteristics of the product seen from the point of view of the end user, e.g., in the case of a car, its size, performance, comfort, safety features, etc. (cf. Saviotti and Metcalfe [36]). In general terms, they constitute a definition of the services, of the utility being performed by a given good.

A hierarchy of service characteristics can be introduced by making a distinction between *main* characteristics, *complementary* characteristics and *externalities* (i.e. the undesired characteristics associated with the product - in the case of the motor car these would include pollution, noise, danger, etc.).

(b) *The "internal", technical characteristics of the good or service (X)* describe the internal characteristics of the technology i.e. the characteristics of the various technical mechanisms used to obtain the final characteristics. In the case of a manufacturing product, these characteristics are clearly defined. In a motor car, for example, they would include the type of engine (internal combustion, petrol or diesel, electric engine...), transmission, suspension and so on.

(c) *Process characteristics (Z)*, finally, relate to the methods by which the good or service in question is produced, and the technologies and modes of organisation involved (the materials used, the ways in which they are processed, the forms of energy, the organisation of the process, etc.). Thus they include all the technologies (in the usual sense of the term) used in the design, production and marketing of products. In the case of the motor car, for example, the assembly line is a process characteristic. Although they are mentioned and defined by Saviotti and Metcalfe, these process characteristics are rapidly abandoned in their analysis[5]. Indeed, as far as goods are concerned, Saviotti et Metcalfe [36] take the view that "the separability of product and process technology is not complete but is a reasonable approximation in many situations". In fact, the notion of the product they adopt incorporates only technical and service characteristics.

2.2 The specificities of services

Some experts on services have made considerable efforts in recent years to stress that goods are also defined by the "services they provide" (Zarifian [45] ; Bressand and Nicolaïdis [6], etc.). However, while goods do indeed provide services, it should not be forgotten that services also provide services. Our hypothesis is that the absence of technical specifications (in the traditional sense) certainly makes the task more difficult, but does not make it impossible to extend and adapt Saviotti and Metcalfe's approach to services. Before embarking upon this task, let us remind ourselves briefly what the (relative) specificity of services consists of.

Once produced, a good usually acquires an autonomous physical existence. It has a high degree of exteriority relative to the individual who produced it and the person who is going to consume it[6] (the anonymity principle, as neo-classical theory has it). Generally speaking, a service is intangible and does not have the same exteriority. It is identical in substance with those who produce it and with those who consume it (it cannot, therefore, be held in stock). It seldom exists outside of them. It is not a given result, but an act or process. By developing the metaphor of the "service triangle", Gadrey [18], following on from Hill [30], has helped to bring into general use the definition of a service as a set of processing operations (...) carried out by a service provider (B) on behalf of a client (A), in a medium (C) held by A, and intended to bring about a change of state in the medium C.

This definition conceals a certain number of analytical difficulties that will have to be taken into consideration in attempting to adapt Lancaster's approach to goods in order to use it for the analysis of services. Most of the difficulties outlined below are linked. Nevertheless, they are presented separately in order to facilitate the analysis and to allow certain slight

[5] They are completely absent from Saviotti's latest work on this subject [37].

[6] unless it is a good custom-made for someone and not readily transferable to anyone else (e.g. spectacles, machine tools, customised software etc.).

differences to be pointed up.

2.2.1 The problems of product standardisationt

Since a product is not always perfectly "formatted" and codified, and in some cases the final characteristics are to a certain extent socially constructed during the actual process of providing the product, the vector of characteristics $[Y_i]$ may not be precisely determined a priori. However, this also applies to certain custom-made tangible goods: spectacles, for example, are usually made to a set of highly personal specifications.

Each service transaction may give rise to a particular set of characteristics $[Y_i]$ in situations where there is production on demand or a response to a specific, not standardisable problem (which may apply equally well to some manufacturing production). In these cases, it may seem difficult to say for certain whether or not innovation has taken place. If a simple definition of product innovation is retained (with innovation being said to occur as soon as there is a new product), it would be necessary to consider innovation to have taken place in all these cases, which seems to defy common sense; this would suggest that a "custom-made product" frequently requires little imagination or creativity. In order to resolve this dilemma, the focus of attention needs to shift upstream, towards the conditions under which the product is designed.

2.2.2 A product that manifests itself through its effects over time

The “product” supplied by a service provider may manifest itself through the effects it produces over a longer or shorter period of time (although this is also true, to a certain extent of spectacles). In order to take account of this characteristic, Gadrey [18] proposes that a distinction should be made between :

- the direct or immediate "product" (the actual delivery of the service) : e.g. a consultation with a doctor or lawyer, a visit to a garage, etc.
- and the indirect "product" (the subsequent results, whether expected or not) : change in the state of health, legal position, working order of vehicle, etc.

2.2.3 The question of the service relationship

One of the fundamental characteristics of service activities, particularly "knowledge-intensive" ones, is client participation (in various forms) in the production of the service. Various concepts have been developed in order to account for this client involvement. These concepts, which are sometimes used as synonyms, are summarised in Figure 1. In reality, they denote different aspects of the same phenomenon, and can be differentiated from each other by their theoretical substance.

Whatever term is used, (interface, interaction, co-production, "servuction", socially regulated service relationship, service relationship), this link between service provider and client is the most important element missing from the notion of the product put forward by Saviotti and Metcalfe, if it is to embrace services and, more generally, the rise in the real power (or at least awareness) of the service relationship in the economic system as a whole (including the manufacture of industrial goods).

Figure 1 : Various ways of expressing customer involvement in the provision of services

2.2.4 The difficulty of distinguishing between product and process in services

In the case of goods, the distinction between product and process, which is a useful analytical tool, though sometimes difficult to use, is widely accepted. The same is certainly not true of services. Here, the term "product" frequently denotes a process: a service package, a set of procedures and protocols, an "act". In reality, this use of the term depends on the concept of product tacitly accepted by the protagonists in question. If they understand the product to be analogous with the immediate act of providing a service, then it is more or less synonymous with it.

2.2.5 The correspondences between vectors of characteristics

Even though they may be very complex, the correspondences between the technical characteristics [X] and service characteristics [Y] of goods are well known. They figure in the handbooks or user manuals that accompany manufactured products. They may be the subject of laboratory experiments. Even though they may not be evident to the user, they are well known to experts. They constitute the very foundation of any attempt to repair a good, the aim being to detect failings in the service characteristics of the good and to trace right back along the correspondence between technical and service characteristics until the faulty technical system is identified.

In the case of services, and particularly those in which the intangible and relational aspects are important, the correspondences between the competences brought to bear by the service provider and the "product" certainly exist (one simply has to compare the effect on [X] of a competent service provider with that of an incompetent provider), but they are generally much hazier and much more difficult to codify : they are to a large extent tacit and subject to the difficulties caused by informational asymmetry. For these reasons (and others), it is not always possible to restore a service that has been provided to its proper or former state. In some cases, however, it is possible. Indeed, if the service provided can be regarded as a maintenance or repair service (in Goffman's sense), then it may be that an inadequate service can be "repaired" by a second intervention (e.g. by the mechanic to whom one entrusts one's car).

2.3 Services as a set of characteristics: an extended notion

In order to take account of the specific characteristics of services, we intend to adopt two different approaches. One involves an attempt to transpose to services the concepts developed solely for analysis of goods, while the other seeks to add new elements to the theoretical framework.

2.3.1 Extending the notion of service characteristics to services

As we have already noted, extending the notion of service characteristics to services does not pose any conceptual problems. Just like goods, services provide services (or service characteristics). The difficulty lies in the designation and evaluation of these characteristics. While we undoubtedly have to accept that the extended notion should be implemented more flexibly (by distinguishing between various scenarios, or by dealing individually with particular categories of services), it nevertheless remains a very productive heuristic tool, as we shall see.

This can be readily applied to services as well, whether it be an insurance product, a consultancy service, a database or information services in general. The characteristics of a database service, for example, will include features relating to the quantitative and qualitative content of the supply of information, the mode of access to the information and the conditions and quality of that access. The characteristics of an automated telling machine service in a bank will reflect in particular the various uses to which it can be put (deposits, withdrawals, balance enquiries, ordering cheque books, etc.) and the ease with which it can be used ("user-friendliness"). In the case of monetary and financial instruments, Tobin[7], for example, suggests that the main characteristics of a service constitute a finite set in which liquidity, divisibility, reversibility/substitutability, yield, income, predictable final value, ease of exchange, risk, etc. feature prominently. In more general terms, it can be said that a significant proportion of financial services innovation theory has been based on the final characteristics

[7] Unpublished manuscript on monetary theory, Chapter II, "Properties of Assets", cited in Greenbaum and Haywood [26].

of the product or service (cf. Greenbaum and Haywood [26], Hardouin [27], Desai and Low [10]). The service characteristics of consultancy activities are more difficult to define. While they might appear at first sight to be consistent with the principal objectives contained in the schedule of conditions, in reality there is often a discrepancy between these characteristics and those finally obtained, which has to be considered a major feature of certain types of services and one inherent in the nature of the "products" on offer.

2.3.2 Technical characteristics, process characteristics

The technical characteristics of goods are those *internal* characteristics of tangible systems that *directly* provide a service. In the case of services, they are both 1) the *tangible* technical characteristics (particularly of information technologies, but also of logistical technologies, chemical products, e.g. in cleaning services, etc.) used to produce the service characteristics, and 2) what we shall call the *intangible* technical characteristics : legal or financial expertise, mathematical instruments (economic and financial modelling, operational research methods), consultants' methods or the (adaptable) standard contracts used by legal advisers, for example.

The technical characteristics of services (with the exception, to some extent, of transactions that make use of self-service equipment, such as ATMs in banks) cannot claim the *interiority* that is a feature of those of tangible systems. One of the major features of service activities is undoubtedly the fact that the "technologies" involved usually take the form of knowledge and skills embodied in individuals (or teams) and implemented directly when each transaction occurs, rather than in physical plant or equipment. Section 2.3.3 below is given over to the question of the distinction between competences and intangible technical characteristics. Similarly, it is difficult to separate technical characteristics from process characteristics. Nevertheless, there is no question of excluding them from the conceptual framework, as Saviotti [37] decided to do. It is possible to envisage two different ways of getting round the problem of distinguishing between technical and process characteristics :

1) the view can be taken that, in services, they are one and the same thing, in other words that the processes in all their tangible and intangible forms are, as it were, (partial) replacements for internal technical specifications. This amounts to an assumption that, while the distinction between product and process can be considered a reasonable approximation in the case of goods, as Saviotti and Metcalfe suggest, this is not true of services.

2) the reference to the interface can be used as an instrument of discrimination. Thus the technical characteristics will be those of the (tangible and intangible) front-office technologies (i.e. that part of the organisation in direct contact with customers) and the (tangible and

intangible) back-office technologies will be described as process characteristics. This solution seems to us more satisfactory than the first one, for several reasons. Firstly, of course, it goes beyond a mere acknowledgement of impotence. Secondly, and more importantly, its discriminatory power is based on the notion of service relationship which, as we have already stated, is of fundamental importance to our approach. It is the proximity of the technology in question to the customer that is the basis for the distinction between technical characteristic and process characteristic. These interface or front-office technologies, mobilised by the service provider, by the client or, more generally, by both at the same time, supply certain service characteristics directly to the customer, and in that respect have something in common with the internal technical specifications of goods. Home banking is undoubtedly the archetypal example of this scenario, in which all the customer has to do is "press a few buttons" in order to obtain the service he or she requires. ATMs, an insurance salesman's computerised simulator, self-service franking machines and the various methods used by consultants are other examples. On the other hand, the mainframe servicing an insurance company or bank or postal sorting systems fall more within the sphere of process characteristics. Despite its pertinence, this solution does not resolve all the difficulties in practice, and particularly not those located on the boundary between front and back office, especially in the current situation in which some service firms are trying to eliminate that boundary altogether.

For the sake of convenience, however, we shall adopt the first solution in the rest of this paper. Whatever approach is adopted, processes lie at the heart of product analysis. As we shall see, this finding is of the utmost importance for the study of innovation (in services).

To summarise, what is termed here a technical characteristic (denoted as [X] or [X-Z]) differs in content from the term used by Saviotti and Metcalfe. It embraces tangible front-office technical characteristics (which are fairly close to technical characteristics in Saviotti and Metcalfe's sense), tangible back-office technical characteristics (which are fairly close to Saviotti and Metcalfe's process characteristics), intangible back-office or front-office technical characteristics (which do not exist in Saviotti and Metcalfe's framework) and possibly, organisational and spatial characteristics.

2.3.3 Adding in the competences mobilised (by the service provider)

For goods as for services, technical characteristics are knowledge, *competences* embodied in tangible (or intangible) systems. However, the provision of a service (i.e. of service characteristics) is generally the result of a combination of the following two mechanisms: the utilisation of (tangible or intangible) technical characteristics that are themselves based on competences, and the *direct* mobilisation of competences (i.e. without any technological mediation). We propose adding to Saviotti and Metcalfe's framework all the competences [C] mobilised by the service provider (cf. Figure 2).

A product (good or service) is therefore represented by a set of final (or service) characteristics (Y_i). Each Y_i indicates the "level" of a characteristic i. These final characteristics are obtained by a certain combination of technical characteristics (X_j), with each Y_i being obtained by a certain subset of the X_j. Similarly, each technical characteristic mobilises the competences Ck (certain competences may involve the ability to combine different technologies); in certain situations, those same competences may be mobilised directly.

Figure 2: a representation of a product or service as a system of characteristics and competences Source: based on Saviotti and Metcalfe [36]

The specific characteristic of service activities (or of some of them at least) is that the provision of the service may take place without a good or set of goods (material artefact) being supplied, or at least it cannot be reduced solely to the provision of a good or goods. Knowledge and competences may be mobilised in order to obtain a certain set of final characteristics, which leads to the model in Figure 2 being replaced by that in Figure 3. Figure 3 constitutes a particular case of Figure 2, and depicts the ideal-type configuration of a "pure", "intangible" service (whether it be an intellectual service, such as consultancy, or a manual one, such as some aspects of cleaning that merely involve emptying waste-paper baskets or even remedial massage, when the masseur uses only his hands). In this type of configuration, the ability to provide a service [Y_i], and the quality of that service, depend crucially on the ability to implement and organise the various competences required, which is why, in certain services[8], the design of organisational systems, and innovation in that area, is extremely important. The strategic importance of the vector [C_k] in the case of "knowledge-based" services is obvious, since it is the greater ability to mobilise competences that is the main argument in favour of using the external service provider.

Figure 3 : The case of a "pure", "intangible" service

The "vector" [C] of competences mobilised in the provision of a service relates only to *individual* competences or to a clearly delimited group, i.e. the team involved in providing the service in question. It does not include *organisational* competences, which fall within the scope of intangible technical characteristics [X].

[8] Those described in a recent book by Jacques de Bandt [8] as "informational services".

These competences [C] are derived from various sources: initial education, continuing training, experience and, more generally, interaction. They can be codified, that is they can be reduced to messages that can be diffused at zero cost (Foray [17]), but in many cases, and particularly in services they are also tacit, i.e. not easily transferable and indissociable from the individual. Whether codified or tacit, these competences can be roughly classified into several types : scientific and technical competences (cognitive competences); internal and external relational competences (depending on whether the relations in question are those within the team or those with the customer or other players in the provision of the service), combinatory[9] or creative competences (i.e. those that combine technical characteristics into coherent sets and subsets) and operational (or manual) competences.

As we have already stressed, it is important to distinguish the vector of competences from that of intangible technical characteristics. Intangible technical characteristics [X] are (systems of) codified and formalised competences. They are used by the individual (or group), and thus require the mobilisation of individual competences [C], but are independent of them. They exist independently of individuals and constitute the various elements that make up organisational memory.

In the terminology adopted by Nelson and Winter [35], and in evolutionary theory, competences [C] are the equivalent of "skills" and intangible technical characteristics [X] equate to a certain extent to "routines", or at least to the more codified of these routines.

In the case of recruitment consultancy, for example, knowledge of psychology, knowledge of the firm, know-who, etc. are all components of the vector of competences [C], whereas job analysis methods, selection tests, candidates' or clients' files etc. are intangible technical characteristics, the organisational routines that ensure the survival of the consultancy company independently of the individual consultants (who may leave at some time in the future).

In a static model, competences and intangible technical characteristics are linked by a relationship already alluded to above, namely the mobilisation of competences in order to bring technical characteristics into play.

In a dynamic model (and we shall return to this point when discussing models of innovation), another relationship emerges, one that equates to the change of state in certain C or combinations of C. These competences undergo a socialised process of codification, through which they come to form the organisation's "cognitive maps" (Argyris and Schön [1]); this

[9] What Henderson and Clark [28] call architectural competences.

formalisation shifts them away from the level of individual competence towards that of organisational competence. In this way, they become intangible techniques of which all members of the organisation can avail themselves.

2.3.4 Adding customer competences in order to take account of the service relationship

The customer is absent from both Figure 2 and Figure 3. However, as has already been noted, the customer's participation, in one way or another, in the production of a service (co-production, service relationship) is one of the major characteristics of service provision (and is increasingly shared with the production of certain goods).

Thus we propose to introduce into our diagrammatic representation a distinction between two types of competence: those of the service provider (column vector [C_k]) and those of the client (linear vector [C'_k]). The co-production relationship, therefore, is represented by the combination of the terms of the two vectors (figure 4). Thus demand theory is present not only on the side of the service characteristics (in accordance with Lancaster's analysis) but also on the side of the customer competences mobilised through the service relationship.

There are several reasons for taking account of this client/provider interface. Firstly, it may itself be the subject of innovations (organisational changes, interface management methods, etc.); secondly, it is the "laboratory" where a form of innovation often neglected in economic analysis, ad hoc innovation (cf. § 3.4), is initiated; finally, the quality of the client firm's competences (C'_1 C'_2....C'_k) is one criterion for the success of innovations and technology transfer (in the broadest sense). In this respect, it may be useful to make a distinction within the vector [C'_k] between the technological competences of the client firm (i.e. the areas of knowledge in which it has expertise) and its capacity to absorb and assimilate new competences. This also applies to certain services to households (health, training). The management of this interface, i.e. of the combination or conjunction of [C'_k] and [C_k], may offer a solution to the awkward question of protecting innovation in services. A service provider may in fact be able to develop highly complementary combinations of [C'_k] and [C_k] that encourage a form of dependency known as "customer lock-in", which is relatively common in the computer services field.

Figure 4 : The case of a "pure" service (including the co-production relationship)

2.3.5 The most general representation

The most general and most significant representation is the one shown in Figure 5. Provision of a service requires both the direct implementation of knowledge and competences (embodied in individual members not only of the provider firm but also of the client company) and the mobilisation of "technical" factors (the X_j). These factors consist of knowledge that is codified and formalised in such a way that they can be used repeatedly for the provision of similar services or of services of different kinds (depending on whether they are more or less generic or specific). They may be tangible (computer or telecommunications systems) or intangible (modelling methods, legal expertise, etc.). They may be already in existence (use of widely diffused techniques) or be designed or adapted for a specific "product". Finally, it should be noted that the system $\{[C'_k], [X_j], [Y_i]\}$ through which the consumer makes direct use of his knowledge and competences represents in particular the various ways in which the client himself is "put to work" within the service firm: self-service situations (super/hypermarkets, fast-food restaurants, self-service banking, etc.), hiring of various equipment (such as vehicles, for example).

Figure 5 : The general form

3. Modes and models of innovation

If the representation of the product (good or service) outlined above is accepted, innovation can be defined as any change affecting one or more terms of one or more vectors of characteristics (of whatever kind - technical, service or competence).

These changes are brought about by a range of basic mechanisms: evolution or variation, disappearance, appearance, association, dissociation. They may be "programmed", i.e. intentional, the product of R & D, design and innovation activity, or "emergent", i.e. the fruit of natural learning mechanisms.

The representation of the "product" put forward here has the advantage, as we have already noted, of not excluding processes (and thus analysis of process innovation process). Nevertheless, the models of innovation outlined here are not articulated around the problematic dichotomy of product and process innovation. The representation adopted here has a further advantage: it breaks with the distinction between radical and non-radical innovations by introducing different modes of product improvement (learning, or the addition of characteristics).

3.1 Radical innovation

The term “radical innovation” denotes the creation of a totally new product, i.e. one defined in terms of characteristics unconnected with those of an old product. The entire system {[C'], [C], [X], [Y]} is transformed or, more precisely, *a new system {[C'*], [C*], [X*, [Y*]} is created*. The final and technical characteristics of the new product, [X*], [Y*], have no elements in common with the characteristics [X] and [Y] of an old product, while the set of competences [C*] contains new elements that did not exist in the sets [C] associated with any old products. The customer's competences [C'], it should be noted, are also renewed, since the more radical the innovation is, the more necessary it is to teach the client to adopt and use it. This is a mode of innovation that Tushman and Anderson [42] describe as "competence destroying".

This definition is the narrowest and most exacting. In many cases, the term "radical innovation" is also applied to those innovations that replace all the {C', C, X}, i.e. the "internal structure" or its equivalent, even if it leaves the Y (the service characteristics) unchanged (to a certain extent), at least in absolute terms (it is rare for the "levels" not to change at all). The transition from horse-drawn carriages to motor vehicles was a radical innovation, even though to a certain extent the service characteristics remained the same, i.e. individuals were still transported with certain degrees of comfort, safety and speed…

The design and marketing by insurance companies of care and assistance products (e.g Europ Assistance) may, for example, be seen as a radical innovation that has changed the entire system. Companies offering these products are no longer selling life insurance, savings or damage insurance products but are actually providing services. The technologies used are different (alarm, monitoring, communications and transport systems, social networks, specific commercial networks), and the service characteristics are different : it is no longer a case of making a money payment when a specified event has taken place, but rather of providing a more or less complex service (housing, health care, transport, etc.). The vector of competences is also, of course, modified as a result.

In insurance itself, radical innovations would be, for example, policies offering cover for totally new risks: the emergence of new vehicles requiring insurance (electric vehicles), the identification or, more precisely, the social construction of new events to be insured against (therapeutic risk).

In the sphere of legal consultancy, a radical innovation would be, for example, the identification of and entry into a new area of expertise (by various means, including the accumulation and exploitation of expertise and the perfection of new methods). Examples might include, in their time, patent law and the law on IT, space, environmental protection etc.

The cleaning industry has also seen a radical innovation, described as “computer cleaning”; the term denotes not the use of IT in the provision of cleaning services, but rather the cleaning of computer systems. This new service, which constitutes an entry into an unusual area of activity for cleaning companies (strategic materials), has required a multiplicity of changes that amount to the development of a new set of characteristics and competences: recruitment and training of technicians (professionals of a good level, with adequate communication skills), changes in working hours (the service is provided inside of office hours) and the development by the company’s technical department not only of a trolley suited to this kind of cleaning service but also of special chemicals, techniques for spraying air and sucking up dust, cleaning methods, etc.

3.2 "Improvement Innovation"

The exact definition of such innovation is not actually self-evident, since an "improvement" to a product or procedure may take a wide range of different forms that vary greatly in scope. According to the strictest definition, this type of innovation consists simply of improving certain characteristics, without any change to the structure of the system; the value of certain Y_i is increased either directly, by improving certain C_p, or by improving certain X_j. Certain qualities of the product or process are improved, without any change to its characteristics. This is a "competence enhancing" form of innovation, to use Tushman and Henderson’s term [42], which is a result more of the learning effects that normally accompany any activity than of innovation in the strict sense of the term (“joint product learning process”, in the words of D. Foray [16]). Nevertheless, this type of innovation cannot be ignored : the extent and cumulative nature of its effect on overall productivity are widely recognised.

In our view the studies of Desai and Low [10], which are well known in financial economics, offer an illustration of this model of improvement (although learning phenomena play no role in them). These authors are concerned with financial assets and define them in terms of two characteristics, namely access (liquidity) (A) and return (yield) (R). The diagram thus constituted (Figure 6) makes it possible to locate and describe existing assets:

Figure 6 : Representation of financial products in a diagram of characteristics Source: After Desai and Low [10]

Since reference assets A and B are characterised by a low return and high liquidity and a higher return and low liquidity respectively, Desai and Low consider the development of asset C as a *"trivial innovation"*, since the distance between A and C in terms of characteristics, as measured by the angle (OA, OC), is small. On the other hand, asset D is an *"important* *innovation"*, since it fills an "empty space" between the two reference assets.

3.3 Incremental innovation (innovation by substitution or addition of characteristics)

The general structure of the system {[C'], [C], [X], [Y]} remains the same, but the system is changed marginally through the addition of new elements to [X] and/or [Y] or through the substitution of elements (Figure 7). This may involve, for example, the addition of one or two new characteristics to a certain type of product, either by directly mobilising certain competences or by adding new technical characteristics. It may also involve the improvement of certain final characteristics (increasing certain Y_i), or a reduction in production costs by adding or changing certain technical characteristics X_j. Thus it can be seen that innovations based on improvements, whose great importance in practice is widely recognised, can take a variety of forms, and may or *may not* be based on technical advances in the usual sense of the term. It is certainly difficult clearly to define the boundary between incremental innovation and "improvement" innovation, i.e. to distinguish the moment at which a new characteristic is added (e.g. the addition of a guarantee to meet deadlines) from the one at which a simple improvement is made (reduction in deadlines or delivery times). It is often the desire to formalise the improvement as a new *specification* that makes the difference: the transition from improvement mode to incremental mode can therefore be interpreted as a social construction.

In the insurance industry (cf. Gadrey, Gallouj, [20]), incremental innovations are commonplace. The basic form of the contract remains unchanged, but certain specifications or options can be added or taken away. Thus there are always opportunities to introduce new guarantees, to diversify the product by grafting a range of options on to the same stem.

Comparable examples can be found in the cleaning industry, where optional service characteristics can be added on to or taken away from the basic service (frequency of vacuum cleaning, washing office floors or simply dusting) (Sundbo, [41]). As the firm evolves, new service characteristics (or modules) are added to the basic service.

Checkout packing services in supermarkets and the introduction by car-hire companies of computer-aided route selection services can be regarded as incremental innovations. There are plentiful examples of this type in the hotel and air transport industries, among others.

Figure 7 : S2: incremental innovation through the addition of characteristics (Y_5) ; S3: incremental innovation through substitution of characteristics (substitution of Y_5 for Y_4)

Staying with improvement and incremental innovation categories, the argument can be advanced even further, firstly by introducing the distinction already noted above between improvements to or the addition of main or complementary characteristics.

3.4 Ad hoc innovation

Ad hoc innovation can be defined in general terms as the interactive (social) construction of a solution to a particular problem posed by a given client. It is a very important form of innovation in consultancy services[10], where the available knowledge and experience accumulated over time are harnessed and put to work synergistically in order to create fresh solutions and new knowledge that changes the client's situation in a positive and original way. Mention can be made, by way of example, of the many new legal arrangements that can be accommodated in the gaps in the system, or the development by various categories of consultants of especially novel strategies that give their customers a certain competitive advantage.

It is at the client/provider interface that this form of innovation is mainly produced. In fact, ad hoc innovations are often produced jointly by the service provider and the client. They usually appear during the normal process of delivering the service and are frequently not recognised as innovations until after the service has been provided. Thus they are a form of "non-programmed" innovation (Zaltman et al. [44]) that might be described as "emergent" (in the sense that they arise out of the unpredictable rearrangement of existing knowledge and experience).

The service characteristics [Y_i] (output) of an ad hoc innovation can be seen as an original solution, or a set of original solutions, of an organisational, strategic, legal, fiscal, social or human nature that emerges in response to a (partially new) problem. From the point of view of the service provider, an ad hoc innovation helps to produce new knowledge and competences that have to be codified and formalised in order that they might be re-used in different circumstances. There is thus a significant change in the vector of competences [Ck], and particularly in the intangible elements of the technical characteristics [Xj]. This a posteriori codification and formalisation of certain elements of a given solution in order that it may be partially and indirectly reproduced is what distinguishes ad hoc innovation from the ad hoc nature of many service transactions. The difference between ad hoc innovation and the kind of change inherent in many service transactions is that the former constitutes a

[10] The following observations on ad hoc innovation relate largely to this area of activity. However, the same applies to most "informational services", as defined by De Bandt [8], and to other services involving a high level of interaction between provider and client.

permanent, non-random change of state produced by the codification of accumulated experience and, in many cases, an expansion of the firm's organisational memory. This clearly distinguishes it from random changes in the configuration of the service (caused by changes in the external environment, in customers etc.).

Ad hoc innovation is closely linked to cumulative learning processes. It is the product of a non-optimising procedural rationality (innovation takes place, but is not reproducible in the traditional sense of the term). It triggers a process of knowledge codification, i.e. the production of routines (search routine or dynamic routine).

As a product of the client/provider interface, ad hoc innovation, particularly in consultancy activities, depends on the nature of that interface and the various elements that go to make it up.

Thus interfaces of the "sparring" type (co-production) are more conducive than those of the "jobbing" type (subcontracting) (Gadrey et al. [19]) to the creation and success of this form of innovation, since they enable the innovation to be better understood and accepted (legitimated). Moreover, problems of a strategic nature, which are potential sources of innovation, are usually tackled in interfaces of the "sparring" type: they are seldom subcontracted. It should not be concluded from this, however, that only "creative problems" (to use Kubr's terminology [31]), where the aim is to create a totally new situation, can lead to the emergence of ad hoc innovations. "Corrective problems", in which the consultant's role is more curative, and "progressive problems", in which the consultant is expected to improve a given situation that it is feared might deteriorate, can also do so. And the opportunities for ad hoc innovations seem to increase with the size of the provider organisation and that of their clients, i.e. as the range of possible interfaces increases both qualitatively and quantitatively. Finally, the actual emergence of an ad hoc innovation depends also on the quality of the professionals in the client organisation involved in the interface (vector $[C'_k]$).

In particular, the existence of this interface helps to limit the reproducibility of an ad hoc innovation in its original form. However, the knowledge, the experience (whether codifiable or not) and the unformulated, idiosyncratic techniques that emerge from practical experience and the methods used to produce and transfer them can be reproduced. Ad hoc innovations are profitable, even if they are not reproducible, since they are based on an informational and cognitive input that can be transferred in part to other ad hoc situations.

What is generally known as **customised innovation** can be included in both incremental and ad hoc modes of innovation. In the case of the insurance industry, for example, (Gadrey and

Gallouj [27])*"adapted customised" innovations*, in which a standard contract is tailored to suit a particular client (or often a whole market segment) by changing the rates or introducing certain additional clauses, could be included in incremental category. On the other hand, *"fully customised" innovations*, in which a genuinely new contract is drawn up for a specific client (often a large company), and *"cover for special risks"*, in which insurance is provided against a risk that might affect very small populations (for which no statistics are available) would be included in the ad hoc category, since the ad hoc element is much more significant.

3.5 Recombinative innovation

Another and major mode of innovation frequent in services but also in microelectronics and biotechnologies is what might be called recombinative (cf. Foray [15][11]) or architectural innovation (Henderson and Clark [28]), a notion that means much the same. Innovation of this kind exploits the possibilities opened up by new combinations of various final and technical characteristics, derived from an established stock of knowledge and a given technological base or existing within a defined technological trajectory. Taking as its starting point the final and technical characteristics of an existing family of products and technologies, it forms the basis for a relatively routine method of producing innovation through the systematic re-utilisation of certain "elements" or "components". This does not mean that the creation of a new product through a new combination of characteristics does not require specific competences, considerable development work and a not insignificant amount of creativity. Innovation based on the addition of characteristics can be considered as a form of recombinative innovation, particularly when the characteristics added have their origins in pre-existing products.

There are two other possible forms[12] which, in the field of services, have been particularly highlighted by Bressand and Nicolaïdis [6]. The first involves the creation of a new product by combining the characteristics of two or more existing products (Figure 8), while the second involves the creation of new products by splitting up an existing product, separating out various characteristics and turning certain elements into autonomous products (Figure 9).

This twin notion of bundling and unbundling is deliberately oversimplified: the new system is regarded simply as the sum of the two old ones or as the product of fragmentation. In reality,

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[11] As early as 1912, in fact, Schumpeter defined innovation as a new combination of existing knowledge: "To produce other things or the same things by a different methods means to combine these materials and forces differently ... Development in our sense is then defined by the carrying out of new combinations" (Schumpeter [1934], p. 65-66, *The Theory of Economic Development*, Cambridge MA Harvard University Press (first edition 1912)

[12] However, a distinction should be made between combinations of characteristics and combinations of modules (which is one of the technical forms in which architectural innovation commonly manifests itself).

recombination and fragmentation techniques should also be brought into play (together with the corresponding technical characteristics) (cf. Bressand et Nicolaïdis [6]). According to Henderson et Clark, architectural innovations "destroy the utility of a firm's architectural knowledge, but preserve the utility of its knowledge of the product's individual components". Thus, as Bressand and Nicolaïdis emphasise, the processes of bundling and unbundling should not be reduced to a simple engineering exercise, involving the mere assembly of spare parts.

There are numerous illustrations of this model. Broadly speaking, a recruitment service provides the service characteristics inherent in four types of sequential activities: the analysis of the client organisation's needs, the choice of a method of approach (direct, through advertisements, etc.), the selection of candidates, their monitoring and the assistance in integrating them into the firm. In accordance with the principle of architectural innovation, consultancy companies have split up this generic service in such a way as to provide perhaps only that set of service characteristics specific to one or more phases of the combination outlined above. Recombinative innovation can go further by creating a totally new product through a combination of existing technical characteristics and elements, since the mere fact of combining certain characteristics in different ways or adding certain others might be sufficient to make possible totally new modes of use[13]. It should also be pointed out that recombinative innovation may also manifest itself through the implementation of a new technology, such as the use of a new medium (e.g. CD-ROM) in order to provide an information service.

According to Bressand and Nicolaïdis [6], charter air services emerged from this process of fragmenting or splitting up an air travel service made up of a combination of different elements: the travel itself, baggage handling, catering and reservations. The emergence of fast-food restaurants, brokerage and publishing (proliferation of photocopying companies) can be interpreted in the same way.

Conversely, examples of innovation based on the recombination of existing elements are provided by the recovery services originally conceived by Europe Assistance (thus the recombination model can lead to radical innovations, as defined above). The concept of "club" as devised by Club Med or the "fitness centres" invented by Viatrop are further examples. Moreover, transport services can be combined in the same package with a hotel reservation service, car hire etc., leading ultimately to a comprehensive tourist service. Similarly, "teleshopping" and mail order services combine retailing, transport and informational services. The French firm J.C. Decaux combines various activities that

[13] This is the basis of "multimedia" systems.

previously existed independently : the manufacture of bus shelters, cleaning and maintenance services for them, advertising services, information services, city maps etc.

Figure 8 : A new service (S3) produced by recombining the characteristics of two existing services (S1 and S2)

Figure 9 : Two autonomous new services (S2 and S3) produced by splitting up the characteristics of an existing service (S1)[14]

Recombinative innovation has now become *a fundamental mode of creating innovations*. As innovations become increasingly "systemic", some authors have suggested that it constitutes a new model of innovation (Foray [15]) that operates particularly in the informational and biotechnology industries. As we shall see, it also lies at the heart of the innovation and R & D mechanisms in services. It should be added that this form can be considered a normal form of innovation: when a problem arises, the first step, naturally, is to seek to solve it by using knowledge, methods and techniques already available and assimilated or known to be readily obtainable. In other respects, recombinative innovation may pose problems: (i) does the innovating agent himself possess the required competences and elements (the innovation process may remain purely internal) or do they have to be acquired from external sources and assimilated, which may be more or less difficult; (ii) does the process of recombination involve significant changes or adaptations to certain elements? (iii) are there certain elements that offer great potential for innovation of this type?

This model has certain fundamental implications, particularly for services:

1) The capacity for innovation depends on the ability to explore and mobilise an extended set of knowledge and techniques. This has major implications for the role of the social forms of the flow and appropriation of information and knowledge (cf. on this point Foray [15])[15] and for the modes of organisation and innovation within firms. Although this point cannot be developed here, the specificity of the position of service firms should be noted.

The organisational innovation dimension (including technical media) is particularly strong in services, whereas there is relatively little research or innovation relating to components or materials[16] that draws upon the natural and life sciences. The main disciplines involved are

[14] In reality, the "autonomous" existence of S2 and S3 (and, in Figure 8, the existence of S3 as a combination of S1 and S2) constitutes an additional service characteristic that has to be incorporated into the vectors.

[15] Some service providers, notably consultancy firms, play an essential role as diffusers of "elements" or as the medium through which they are combined (cf. Gallouj [24], Djellal [11], Bessant and Rush [5]).

[16] Except in those services such as transport and telecommunications that are highly capital-intensive.

the social sciences, computer science and sometimes mathematics (in banking and insurance, for example) and new disciplines located on the boundary between the social sciences and the "hard" sciences, such as linguistics, cognitive sciences and operational research methods.

2) The second implication of the recombinative innovation model is the need to design a certain type of modular architecture for both products and production systems in which products and systems are readily divisible. It is not difficult to imagine what this type of architecture might represent in manufacturing industry, where it is not really new. Things are less obvious in the case of services. Recombinative innovation obviously occurs in services, as we shall see in the next section, and in services of very different kinds (banking and insurance, hotels, information services, etc.). However, the implementation of this form of innovation in services is based on some important presuppositions. It is assumed that the "product" can be broken down into clearly identified and defined elements, in other words that the service characteristics and access to them can be rigorously specified. This may lead to a greater formalisation of existing activities, i.e. to the development of "standardised" products and modulization of service production (Sundbo [39]). In terms of the general representation shown in Figure 5, this means defining Y_i more precisely and, in certain cases, allocating a bigger role to X_j. In the case of services, in other words, it can be hypothesised that *innovation through formalisation* is an important aspect of the establishment of "innovation routines". This is connected in part to the impact of computerisation in service industries.

3) The third implication of the recombinative model is located at industry level. Clusters of innovations emerging from different service industries are combined in such a way as to constitute systems. "What we are dealing with is a group of initially independent services that then forge links with each other and thus develop into a system. Examples of this process would include the systems that tend to develop around supermarkets, insurance, banking, consultancy services, etc., or even those that are beginning to emerge around the various forms of transport, catering services, hotels, tourism, leisure services, etc." (Gallouj [24]).

4) More generally, as soon as the question of (re)combination is raised, questions should also be asked about what it is that is being combined: knowledge, characteristics (which ones?), goods and services, human resources or institutions. This amounts to a shift away from analysis of cognitive processes towards notions of networks and local innovation systems. For example, when it comes to the organisation of R&D processes in services, new combinations of competences or characteristics may mean new combinations of individuals (particularly when expertise is highly tacit). This observation helps to explain the trend towards the establishment of flexible project groups to manage innovation in service firms.

The recombination model of innovation can shed new light on certain characteristics generally attributed to innovation and research in the service sector.

1.The unspectacular nature of product innovation. Defined in terms of "the routine use of a technological base", the recombination model does not operate through ruptures, but rather through the continuous and cumulative production of knowledge.
2. The difficulty of evaluating R&D. Traditional measures elaborately developed by national and international institutions are in fact based on criteria of novelty which are not relevant within the framework of the recombination model.
3. The low cost of innovation. If research or innovation rarely requires substantial investment, this is perhaps due to the process of recombination and the "systematic re-utilization" of components to enable major resource savings.
4. The relative lack of research in the classical sense: the production of new knowledge. The recombination model produces and also demands more in terms of "architectural knowledge" (as in engineering) than of knowledge of the components themselves.
5. No prototype perfection. Innovation consists of assembling existing components which have been proven in practice.
6. The difficulty of protecting innovations, which can be imitated relatively easily. If the validity of the recombination model is accepted, the important thing is not so much to protect innovation and impede imitation as to facilitate recombinations.

3.6 Formalisation innovation

The various models of innovation outlined above are based on qualitative or quantitative variation in technical or service characteristics or competences (addition, elimination, improvement, bundling, unbundling). There is a final model in which it is not quantity or quality that varies, but rather the “visibility” and the degree of standardisation of the various characteristics.

This model, which we shall call the formalisation model, consists of putting the service characteristics “into order”, specifying them, making them less hazy, making them concrete, giving them a shape.

This objective is often achieved by putting in place technical characteristics, whether tangible (equipment, software, etc.) or intangible (e.g. methods, organisation, toolboxes).

This formalisation model also constitutes an attempt to clarify the correspondences between these technical characteristics and the service characteristics.

Putting the service characteristics "into order" frequently involves the transformation of a general function into sub-functions or service characteristics. This general process makes it possible to understand why this formalisation model often precedes the recombination model.

In many services, including knowledge-intensive ones, this formalisation model constitutes a genuine "natural trajectory", in the sense of the term adopted by Nelson and Winter.

There are plenty of examples of this model. They are found in the cleaning industry, where Sundbo [41] highlights the growing importance of what he calls modulisation. They are also found in the fast-food industry (cf. the organisation of work at McDonald's, analysed by Levitt [33]). Legal consultancy also provides examples. The service known as "legal audit", for example, has always been provided by consultants more or less automatically and always informally. The formalisation process consisted of finding a name for the service and establishing (following the model of financial auditing) reference points or methodological markers by which it could be defined. In this case, as in the other, the various elements can be said to have "existed" implicitly beforehand: they are rendered explicit through a process of social construction. It should be noted that this process of formalisation innovation was followed by implementation of the recombination model, in which the general legal audit is broken down into a number of specific audits: contract audits, patent audits, etc., all of them "products" that can be given an independent existence and be sold as such. The same can be said of all the examples cited in the case of recombinative innovation, to the extent that they had to be formalised beforehand (charter flights, recovery services, etc.).

The ultimate configuration of this formalisation model is the one that leads to the production of a real object that can be reduced to Saviotti and Metcalffe's original representation. This is the case, for example, with the development of expert systems. The substitution of ATMs for transactions over the counter falls within the scope of this model.

4. The theoretical implications of a characteristics approach to innovation

As we have just shown, an approach to products in terms of final, technical and process characteristics offers a stimulating starting point for the study of innovation in services. Such an approach is sufficiently flexible to include both goods and services without sacrificing any of the specific aspects of innovation in services. Various modes of innovation are highlighted (radical innovation, innovation based on improvement, innovation involving the addition of new characteristics, ad hoc innovation, recombinative innovation, innovation through formalisation) and interpreted in terms of a characteristics dynamic.

This approach has implications for traditional theories of innovation, some aspects of which have already been mentioned and to which we now return by way of conclusion.

Description of a product in terms of characteristics clearly reconciles the "science-push" and "demand-pull" approaches to innovation: science, denoted by the vectors [C] and/or [X], and the demand for service characteristics, denoted by the vector [Y], constitute the two facets of the product (good or service). An innovation may use one of these two points of entry, or both at the same time. The "science-push" determinant, it should be noted, cannot be limited solely to the physical sciences, however: it also takes account of progress in the social sciences. [X] and [C] respectively encompass not only technologies in the narrow sense of the term and the competences relating to those technologies, but also the "technologies" specific to services (legal, financial, commercial, etc.) and the competences corresponding to them.

This has consequences for the definition and content of technological trajectories in services. In Saviotti and Metcalfe's approach [36], the "technological regime" (in Nelson and Winter's sense) or the "dominant design" (in Abernathy and Utterback's sense) correspond to a given list of technical characteristics X_j. A "technological trajectory" is a path of gradual improvement in the X_j. In the case of services, the term takes on a particular meaning, since it can refer as well (or indeed exclusively) to service "technologies" (financial, actuarial, human resource management etc.). These technologies are also characterised by "lock-in" phenomena: it is difficult to envisage a return to Taylorism in areas where other techniques of work organisation have been tested. It is also possible in the "purest" services to introduce cognitive trajectories: the accumulation of expertise, individual and collective learning processes, gradual improvement of the C_k. In this case, the technological regime can be renamed the cognitive regime, thus constituting a general frame of competence formalised by a list of cognitive characteristics (C_k).

Even though certain modes of innovation (such as recombinative innovation) are particularly important today, it does not seem possible to articulate the various modes of innovation over the course of a product's life cycle. Barras' attempt to do so (cf. §1) is interesting but reductionist in terms of modes of innovations. Indeed, from the point of view of a characteristics approach, Barras' model can be said to be technologist, to the extent that it sees innovation as having only one point of entry: either [Z], the vector of process characteristics, or [X], the vector of technical characteristics; as we have already stressed, it is difficult to distinguish between the two. Taking as its starting point a service defined as the set {[Z], [X], [Y]}, the "reverse product cycle" theory envisages the following dynamic, which corresponds to the three phases of the cycle:

1) {[Z'], [X'], [Y]}: the introduction of new process characteristics (linked to mainframe introduction in banks, for example), which gives rise to new technical characteristics (computerisation of the back office) but no real change in final characteristics: [Y] is not altered (even if its cost falls).

2) {Z''], [X''], [Y'']}: the introduction of new process characteristics (mini-computers), which gives rise to new sets of technical characteristics (ATMs in banks) and a certain improvement in the service characteristics (improved quality of service).

3) {[Z'''], [X'''], [Y''']}: the introduction of new process characteristics (network technologies), which give rise to new technical characteristics (home banking) and a multiplicity of new service characteristics.

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CONCEPT	MEANING
Interface	(physical or virtual) point of contact between customer and service provider (or his technical systems)
Interaction	exchanges of information, knowledge and civilities, performance of repair/rectification tasks
Co-production	extensive and balanced interaction (essentially operational)
Servuction [14]	the process of creating a service by linking up various elements: the customer, the physical medium, contact personnel, the service, the system of internal organisation, other customers
Socially regulated service relationship [18]	manifestation of new forms of the social regulation of relationships between producers and consumers
Service relationship [9]	"mode of coordinating the actors on the supply and demand sides" for services or for goods. Operational relationships (co-production) + social relationships for the control and regulation of action programme

Figure 1 : Various ways of expressing customer involvement in the provision of services

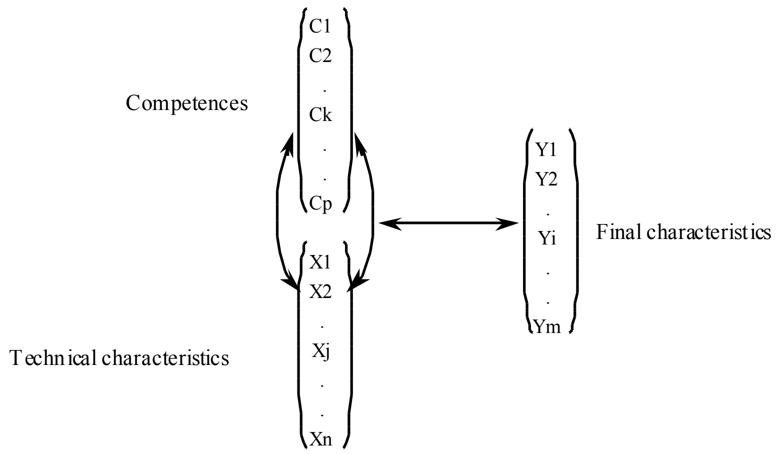

Figure 2 : a representation of a product or service as a system of characteristics and competences Source: based on Saviotti and Metcalfe [36]

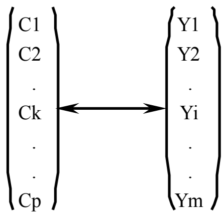

Figure 3 : The case of a "pure", "intangible" service

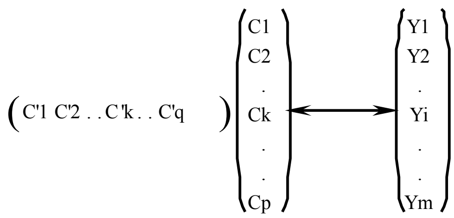

Figure 4 : The case of a "pure" service (including the coproduction relationship)

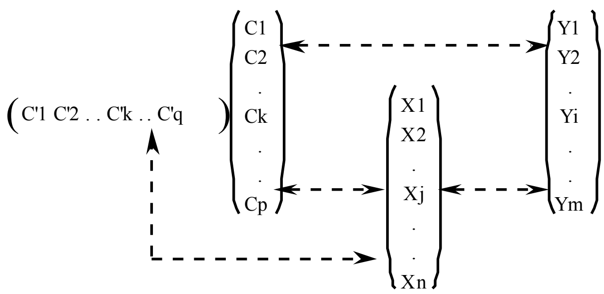

Figure 5 : The general form

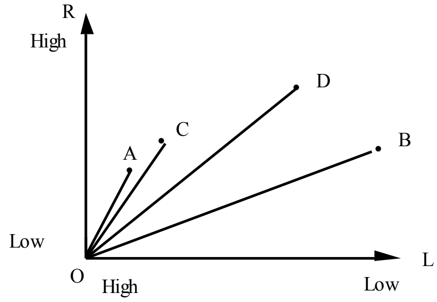

Figure 6: Representation of financial products in a diagram of characteristics Source: After Desai and Low [10]

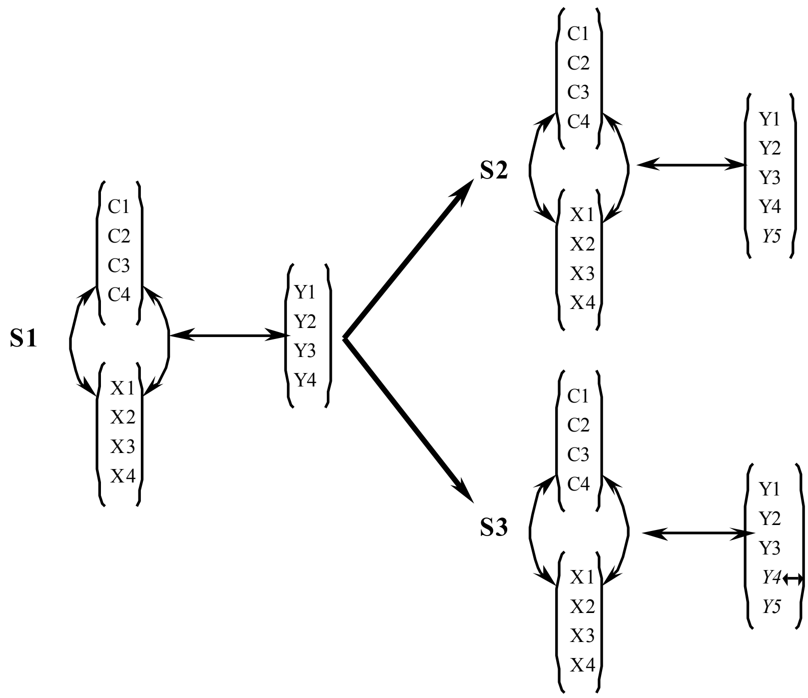

Figure 7 : S2: incremental innovation through the addition of characteristics (Y_5); S3: incremental innovation through substitution of characteristics (substitution of Y_5 for Y_4)

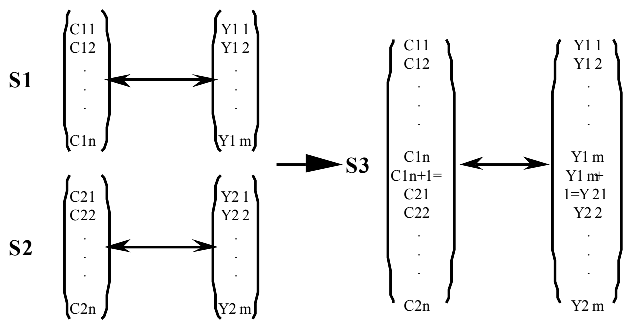

Figure 8 : A new service (S3) produced by recombining the characteristics of two existing services (S1 and S2)

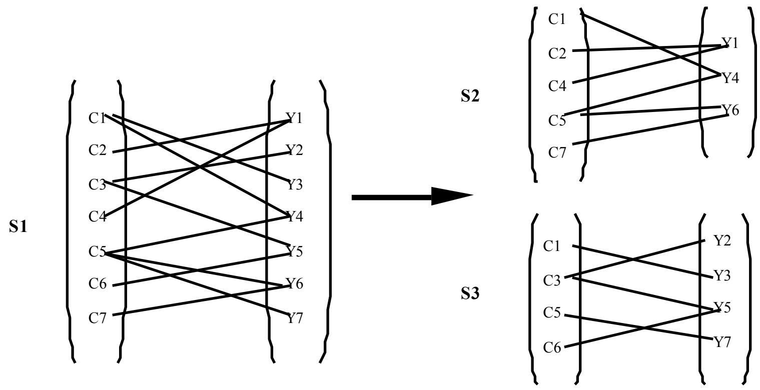

Figure 9 : Two autonomous new services (S2 and S3) produced by splitting up the characteristics of an existing service (S1)