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Innovation in Buildings: a Socio-Eco-Technical Approach

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ABSTRACT

In an evolutionary perspective, innovation is the engine of the evolution of the economy. A building can be seen as a product with technical characteristics and service characteristics. Innovation is a significant improvement of the service characteristics of buildings, created by a significant change of the technical characteristics and of the competences of the builders.
The builders belong to a cluster, the built environment cluster, characterised by a lack of dominant actor and the importance of local supply and demand. In the cluster, where site process firms, manufacturing firms and services firms coexist, innovation is not only technical, but also service, commercial and organisational.
This socio-eco-technical innovation approach is illustrated by the analysis of two green innovations: the failure of the French solar houses programme in the eighties and the success of the Swiss Minergie® concept in the nineties.

Keywords: Evolutionary theory, innovation, energy, construction industry, human and social sciences

1. INTRODUCTION

How to analyse and promote innovation in the construction industry? Technical innovation process, based on the improvement of the technical characteristics of the buildings, is often emphasized.

But buildings have not only technical characteristics but also service characteristics for the end user. Innovation may then be defined as an improvement of the service characteristics, obtained with technical innovations as well as service, organisational and commercial innovations.

In such a case, the analysis highlights a socio-eco-technical approach of the innovation process.

2. THE EVOLUTIONARY FRAMEWORK

According to Schumpeter, innovation is the engine of the evolution of economy. The Schumpeterian approach highlights five kinds of innovations: a new product (or a new quality of a product), a new production or commercialisation method, a new market, a new raw material source, a new business organisation (Schumpeter, 1959).

According to Schumpeter innovation is not only technical, though many neo Schumpeterian authors focused their analysis on technical innovation (Nelson and Winter, 1982 for example). According to Schumpeter, the origin of innovation is supply and not demand. Adaptation to the consumers' needs is normal production. Schumpeter highlights discontinuous innovation coming from production.

Nevertheless, in the same theoretical framework, Saviotti (1996) points out Lancaster's (1966) consumer theory to specify that any good has two kinds of characteristics, the technical ones [T_i] and the ones dedicated to services [S_i]:

$$\begin{pmatrix} T_1 \\ T_i \\ T_n \end{pmatrix} \Leftrightarrow \begin{pmatrix} S_1 \\ S_i \\ S_n \end{pmatrix}$$

Figure 1. Technical and service characteristics of a good (from Saviotti, 1996).

Studying innovation in services, Gallouj (2002) widens the analysis by stipulating that the service characteristics [S_i] of products depend on the mobilization of the technical characteristics [T_i] and the competences of the provider and its partners [C_i]:

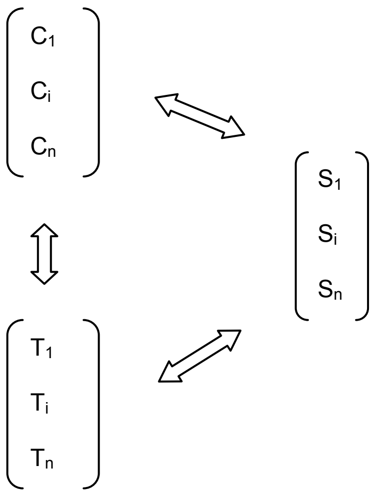

Figure 2. Service characteristics, technical characteristics of a product and competences of the provider and its partners (from Gallouj, 2002).

Gallouj specifies that a product can be a good or a service, as technical characteristics can be material or immaterial. Innovation is a significant improvement of the service characteristics [ΔS_i] of products. This improvement is created by a significant change of the technical characteristics [ΔT_i] and of the competences of the provider and its partners [ΔC_i]:

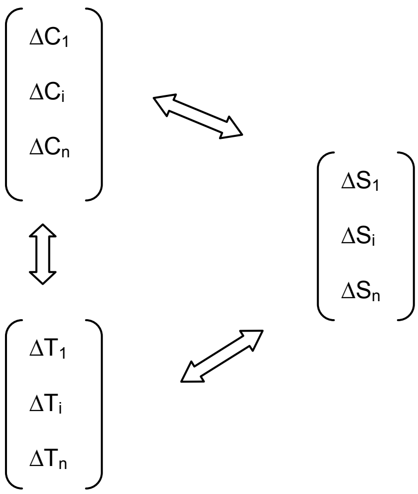

Figure 3. An innovative product (good or service): a significant change of the service characteristics from change of the technical (material and immaterial) characteristics and of the competences of the provider and its partners (from Gallouj, 2002).

As far as services are concerned, Gallouj highlights the role of the client's competences, the client being often a co-producer of the innovation.

In their analysis of innovation in services, Barcet and Tannery (1998) suggest a socio-eco-technical method in four analysis levels summed up in the following table.

Table 1. The four levels service innovation analysis method (from Barcet and Tannery, 1998).

Analysis level	Question	Topic	Meaning
1. The client system	What for? Whom for?	The functionalities	The service as an *aim*
2. The result of the performance	What?	The service product	The service as a *concept*
3. The supply system	How?	The performance	The service as a *process*
4. The means and resources	What with?	The tools, methods, information, technical means, skills, competences	To implement, or to obtain, *means* and *competences*

In the two first editions of the "Oslo manual" defining guidelines for collecting and interpreting innovation data, OECD describes a narrow definition of innovation limiting it to *technological product* and *technological process* innovation.

For the first time in 2005, OECD points out a socio-eco-technical approach of innovation by specifying that "innovation is the implementation of a new or significantly improved *product* (*good or service*), or *process*, a new *marketing method*, or a new *organisational method* in business practices, workplace organisation or external relations".

OECD specifies that "innovation activities are all *scientific, technological, organisational, financial and commercial* steps which actually, or are intended to, lead to the implementation of innovation".

Four types of innovation are distinguished: *product innovations, process innovations, marketing innovations and organisational innovations.* Innovations can concern a novelty for the firm, for the market or for the world.

The OECD definition of a *radical innovation* is interesting to be noticed: "an innovation with a significant impact on a market and the economic activity of firms in that market". The concept is focused on the impact of innovations as opposed to their novelty. The impact can, for example, "change the structure of the market, create new markets or render existing products obsolete".

3. THE BUILT ENVIRONMENT CLUSTER: AN INNOVATIVE SYSTEM FOCUSED ON LOCAL MARKETS WITHOUT ANY DOMINANT ACTOR

In the major part of literature, the construction industry is limited to the construction firms sector. Using the narrow definition of innovation, limited to technological product and process innovation of manufacturing industries, literature concludes that the construction industry is a low tech and not innovative sector.

The major part of literature forgets that the construction industry, defined as the construction firms sector, is not a manufacturing industry. The construction firms does not belong to the two types of manufacturing industries, the repetitive industries (cars, computers…) and the process industries (steel, cement…). It is a *site process industry*. It is not understandable that a non manufacturing industry does not implement manufacturing industry innovations.

We haved suggested a different definition of the construction industry, analysed as a "built environment cluster". This new approach has been tested in one country (Carassus, 2002), and then in eight other countries (Carassus, 2004).

Based on the buildings and infrastructures life cycle, the built environment cluster approach includes not only the site process industry (construction firms), but also manufacturing segments (construction material and equipment firms), services segments (developers, designers, material distributors, asset, property and facilities managers…) and regulatory actors (public continental, national and local authorities, private industry and professional organisations) see figure 4 and table 2 from Carassus et alii, 2006.

Two characteristics of the built environment cluster are the lack of a dominant actor in the cluster and the importance of local markets (demand and supply), at least for the building part of the built environment cluster which also includes the civil engineering infrastructures.

With this definition of the construction industry and with the socio-eco-technical definition of innovation, innovations are various and numerous in the built environment cluster:

- technological product and process innovations in the material and equipment providers (cement, glass, steel, wood, site machines…),
- site organisation and marketing innovations in the construction firms,
- service, marketing and organisational innovations in the service segments (developers, designers, material distributors, asset, property and facilities managers),
- with an important role of the public and private regulatory bodies defining rules which can promote or limit innovations.

Many punctual innovations improve aspects of the production and management of the buildings and the buildings themselves, a lot of those innovations being not well known, as most of the surveys are focused on technological product and process innovations.

Figure 4. Built environment cluster: functions and regulations (from Carassus *et al.*2006)

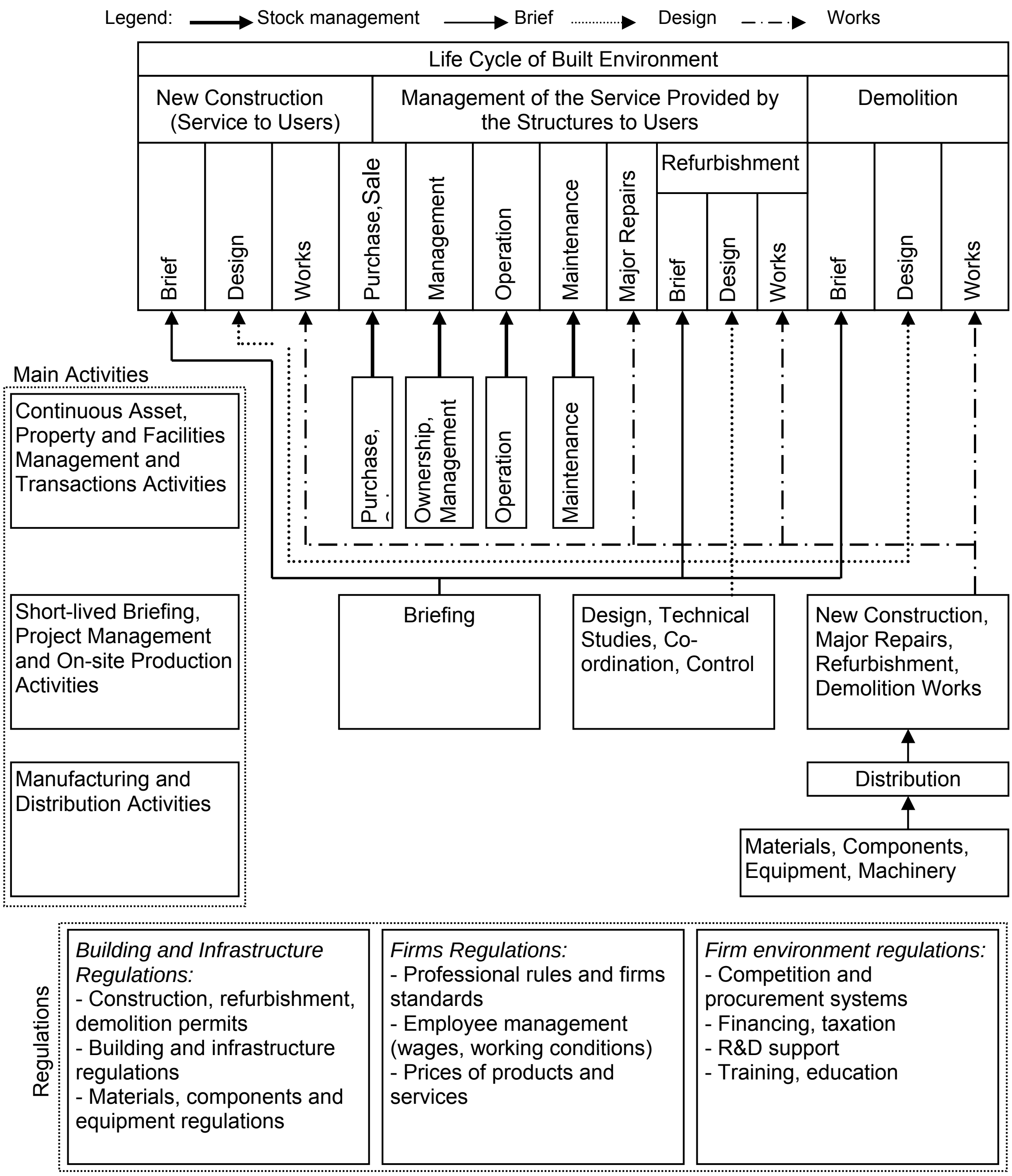

Table 2. Ouline of the built environement cluster

	Construction life cycle			
Economic activities	Built environment cluster			
		Services firms	Site process firms	Manufacturing firms
	Asset, property, facilities, transaction management	X		
	Project management and on site production*	X	X	
	Manufacturing and distribution	X		X
	Institutional environment			

*developers, designers, construction firms, trades (From Carassus *et al.,* 2006)

We will rather focused on innovations dealing with the building as a whole for the end user. The socio-eco-technical innovation analysis and the built environment cluster approach will be mobilized.

Two green innovations will be studied: the French solar houses programme in the 80' and the Swiss Minergie© label in the 90'.

4. TWO GREEN INNOVATIONS: THE FRENCH SOLAR HOUSES PROGRAMME IN THE 80' AND THE SWISS MINERGIE® LABEL IN THE 90'

After the 1973 oil shock, the French government elaborated the first thermal rules for new buildings and launches the first research programme dealing with thermal aspects of the buildings (the HOT programme "Habitat Original par la Thermique"). Meanwhile, the first pioneers have experimented solar houses. Most of them belonged to middle or upper middle class (technicians, teachers, executives…).

Government has decided to accelerate the process by setting up the "5000 solar houses" competition. 285 projects have been submitted, 62 selected, 19 houses have been built as demonstrators in a village in the Parisian area. Incentives have been given to public housing companies which implement the projects. They did so especially in the social rental sector.

The solar house was presented as a technical object using solar techniques ("active solar" approach) and architectural innovations ("passive solar" approach) (Dard, 1985). Most of the tenants of the experimental projects belonged to popular classes (workers, employees). It was a captive demand which had no choice on the housing market. They did not choose to live in a solar house. The solar houses are often seen as technical and architectural innovations lacking comfort (Laumonier et alii, 1983, 1985).

The social housing companies experimented solar houses as punctual innovations which were not integrated in their strategy. A solar label was created and used by some of them. 3000 solar houses were built but very few private developers have experimented them. The demonstration village did not convince many households. In the second half of the 80', the solar houses programme stopped.

In Switzerland, after the 1973 oil shock, thermal rules were specified at the cantonal level for new construction, the constitutional article dealing with energy being voted not before 1990. At the beginning of the 1990', the first low energy buildings were tested, inspired by the experimentations implemented in Germany, Austria and Scandinavian countries. The pioneers belonged to middle and upper middle class.

In the middle of the 1990', the Minergie® concept was elaborated by the energy office of the Zurich canton. It was focused on energy performance and comfort. The technical means to meet those aims were high thermal insulation, air tight envelope, mechanical ventilation, controlled electrical consumption and use of renewable energy.

At the early beginning, a partnership between the Zurich canton and a marketing company allowed a dissemination of the concept in the canton among the construction actors (architects, technicians, construction firms, trades) and the population. The communication has highlighted didactical technical information for the construction players, comfort and increase in value of the buildings for the owners. The first Minergie® commercial fair brought together households and almost all the local construction actors in 1997.

In 1998, the Minergie® association was created by the Zurich and Bern cantons, which were the owners of the trade mark. The Minergie® label stipulates energy performances (42 KWh/year m² of primary energy for heating, hot water and ventilation for new housing, 80 KWh/year m² for renovated housing), comfort level and maximum cost (not more than 10% over usual cost). The Minergie® residential and non residential buildings energy consumption was roughly the half of usual Swiss buildings.

Training sessions were set up for the construction players. Most of them had to innovate with new design and new types of materials and equipments (windows, ventilation systems…). The technical innovations were supported by specific Minergie® material labels for components and equipments contributing to energy performance and comfort.

The Minergie® internet website played a central role to inform and educate professionals and population. The Minergie® label was backed by financial incentives by almost all cantons and several banks. Some incentives were also legal like the allowance of 10% more floor area for Minergie® buildings in the Genève canton. The label was also backed by the federal government through its SwissEnergy programme.

The first labels were given in 1998, and as early as in 2001, Minergie® buildings represented 24 % of new production in the Zurich canton. In 2005, they corresponded to 17% of new construction in the country. At the end of 2006, 6300 buildings, including 500 renovated ones, had obtained the Minergie® label (Haefeli et alii, 2006).

The evolutionary framework and our built environment cluster analysis will help us to compare the failure of the French solar houses programme and the success of the Swiss Minergie® label.

Firstly, in the Swiss case, the service characteristics (energy performance, comfort, price) were the departure point, the technical characteristics (high thermal insulation, air tight envelope, mechanical ventilation, controlled electrical consumption and renewable energy) were means employed to meet the service characteristics.

Referring to the Saviotti framework (figure 1), the service characteristics [S_i] were first, defined by a label considering the building as a whole, the technical characteristics [T_i] were second and dedicated to [S_i] through technical labels.

The existence of a label compensated the lack of a dominant actor in the built environment cluster. Different kinds of demand segments (households, local authorities, private firms…) used the label as the same reference to specify the service characteristics they choose. Using Barcet and Tannery method (table 1), the service characteristics were the aim, the Minergie® label was the concept.

In the French case, the technical characteristics (solar techniques and architectural innovations) were emphasized to the detriment of comfort. The technical characteristics [T_i] were first, the service characteristics [S_i] were second.

Secondly, the origin of the Swiss innovation was local, close to the local supply and demand. Local market was an important characteristic of the built environment cluster. On that market like many others, middle and upper middle class households were the leaders of innovation. Minergie® information and incentives reinforced their leadership.

The French solar houses programme was a central programme, set up by national government, far from local dynamics. It was focused on social housing companies. The major part of their popular class tenants were not motivated by innovation. Solar techniques were imposed to them.

Thirdly, the Swiss experience developed practical information (website, commercial fair, guides…) and put emphasis on the mobilisation of the construction actors' competences to be bettered through training.

Referring to the Gallouj analysis (figure 3), the link was quickly made between the improved service characteristics [ΔS_i], the innovative technical characteristics [ΔT_i] and new competences of the construction players (designers, construction firms, trades, material producers…) [ΔC_i]. Innovations were not only technical but also organisational, commercial and financial.

To use the Barcet and Tannery approach, innovation was considered as a new service which was the result of a process where means and competences were mobilized.

In France, the accent was put on demonstration especially through a solar houses pilot village in the Parisian area, with the hope that construction actors and households would duplicate the visited models.

Fourthly, the Swiss cantons and federal government backed the innovation through different incentives, especially financial incentives broadly used by private actors. In France, the innovation was essentially based on the social housing companies, without any incentive for the private sector.

Fifthly, the result was very different. The Swiss innovation represented 17 % of the new construction market in the country after seven years. This was clearly a success. According to the OECD approach, Minergie® is a radical innovation because it “has a significant impact on the market”, at least on the new buildings market. The challenge is now the existing stock which is distinctly the main energy consumer in the built environment. Only 10 % of Minergie® labels concern renovated buildings.

3000 solar houses were built through the French solar houses programme, mainly social rental houses, and then the programme stopped. The explanations of the failure are complex; the study has to be deepened. Let us just sum up the main points of our analysis in table 3.

Table 3. Comparison of the French solar houses programme and the Swiss Minergie® label innovation processes

Innovation process	*French solar houses programme*	*Swiss Minergie® label*
1/ Innovation characteristics	Technical characteristics [T_i] were first, service characteristics [S_i] are second.	Service characteristics [S_i] were first and specified in a label, technical characteristics [T_i] were means to meet the service ones.
2/ Innovation initiative	Central government	Local authority
3/ Dissemination	Exemplarity of a pilot village	Practical information for population and professionals, training of local construction players to improve their competences [C_i].
4/ Incentives	Financial incentives for social housing companies, with solar techniques imposed to popular class tenants.	Financial incentives by public authorities and banks for all actors, especially private, reinforcing the middle and upper middle class groups leadership in innovation.

5/ Results	3000 houses (mainly social rental houses) built, for a 5000 houses programme, then the programme stopped.	A “radical innovation” having a “significant impact on the market”: 17 % of the new construction market, after 7 years. The challenge: the existing stock.

A clear opposition appears between a centralised technical innovation process mobilizing essentially scientific and technical activities and a decentralised socio-eco-technical innovation process activating scientific, technical, organisational, financial and commercial know how.

5. CONCLUSION

Two kinds of construction innovations may be distinguished: partial innovations (as a new material, a new site organization, a new management system) and comprehensive innovations (as low energy buildings).

The first ones are backed by one construction actor or a small group of actors. The partial innovations may be technical, organisational, financial and commercial. But how to initiate comprehensive innovations, such as low energy buildings, in an industry focused on local markets without any dominant actor?

The French solar houses programme was a central initiative backed by government and highlighting the technical aspects of the innovation. The Swiss Minergie® innovation process showed another solution: local initiative with common rules specified by consensus.

The local initiative may be public as for Minergie® or private. Common rules defined the service and technical characteristics of the innovative buildings. The comprehensive innovation was promoted by consensus by local construction actors with organisational, financial and commercial initiatives. Such an innovation process seems to be much more efficient than the first one.

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