The self-sustainable enterprise

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1. Introduction

It appears that a useful and operational definition of "sustainability" remains quite elusive, even in most serious and pragmatic of researches. Our understanding of the meaning of what is or is not sustainable is still intuitive and experiential and even if correct, it can only rarely be directly applied. We are increasingly being convinced that a sustainable system is better than a non-sustainable one - a self-evident conclusion that could have been surmised all along.

In this paper we discuss some aspects of sustainability which demand more serious and sustained attention by the research community.

The questions of sustainability of systems are too often limited to public institutions, goods and resources. Yet, it is the private systems, families, businesses and corporations, which often manifest not only sustainability, but the more essential *self-sustainability* in a given milieu. Even though we talk about sustainable systems, it is the self-sustainability of systems which interests us most. The question is not How can *we* sustain a given system, but How can a system sustain *itself* in a given milieu?

Another dimension of sustainability must be its *organizational mode*. It is important to realize that sustainability (and self-sustainability) is directly related to system organization and its self-production (autopoiesis). How are systems organized is much more important than how its individual agents think or what values they uphold. There can be a lot of sustainability thought floating within a fundamentally unsustainable human system. Properly organized self-sustainable systems survive and flourish even if their agents do not know or say anything about sustainability.

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Self-sustainable systems are autopoietic and must therefore be organized for *autopoiesis*. Sustainable systems are heteropoietic, i. e., their sustainability does not come from within (from its own organization) but from without, from planned, system-sustaining activities of external agents. Non-sustainable systems are allopoietic, i. e., they are organized to produce things other than themselves. Allopoietic systems necessarily deplete their environment.

Heteropoietic systems can be sustainable as long as external agents sustain their system-sustaining efforts. Only autopoietic systems replenish their own environment and thus can become self-sustaining.

Another dimension of sustainability is a *common resource portfolio* which ties collaboratively together all relevant system agents and stakeholders. System sustainability is related to optimal management of such common resources. Competition and competing uses assure proper valuation and pricing of resources, elimination of waste and induce necessary rates of renewal. Collaborative arrangements emerge to secure long-term usage of the common resource.

Collaboration and competition are not mutually exclusive but complementary dimensions of self-sustainability.

Self-sustainable systems must maintain their ability to coordinate their own actions. Purposeful coordination of action - or *knowledge* - has to be continually produced and maintained: self-sustaining systems must be knowledge-producing, not just labor or capital consuming entities. Knowledge-degrading or knowledge-neglecting system cannot be self-sustainable, but only temporarily sustainable.

In summary, the presented view of sustainability can be characterized as follows: *both sustainability and self-sustainability are time and context dependent system properties emerging from system organization. System organization must be continually produced or renewed via operating a common, shared resource system, optimally managed through competition and collaboration of agents. Continued functioning of the organization thus requires continued coordination of action, i. e., continued production of knowledge.*

Self-sustaining systems continually produce their own organization and the requisite knowledge in its evolving milieu.

2. Self-sustainability

Traditional hierarchical enterprises can often be sustained - and therefore are sustainable - but they are not *self-sustaining*. It seems that sustainability is a different issue: most systems can be sustained over long periods of time through an external supporting agent disbursing effort, money or resources. Once this external agent withdraws his support, system's sustainability can be directly challenged. *Externally sustainable systems do not have to be internally self-sustainable.*

A concentration camp can be externally sustainable while it lacks any indigenous attributes of self-sustainability. Any resources-depleting system can be sustainable as long as the external agent maintains the ability to "support" the system through inputs and imports of resources, efforts, funds and values. A resource-depleting system can be sustained through rationalization, savings and self-restraint of external agents, but that does not make it any more self-sustainable.

A self-sustainable system is independent of external agents' sustaining activities. The economic development of towns and landscapes should not be just sustainable but fundamentally self-sustainable.

Free-market system is essentially self-sustainable because the value of resources, goods and services can be assessed via transactions between suppliers and purchasers. Non-market systems can only be more or less sustainable - through external-agent (such as State) supportive intervention.

Environmental resources are provided "free of charge" - and thus are being dangerously depleted - because they are part of a fundamentally non-market system and thus sustainable only through enhanced dependency on external agent support. They can hardly be self-sustaining.

Any relationship (External agent ---> Sustainable system) can be transformed into a *self-sustainable metasystem* (External agent <---> System). While an external agent can in principle make any system sustainable, only a meta agent-system can become self-sustainable: through making the external agent an internal part of the system.

An infant is sustainable through his mother's care, but it is not self-sustainable as a separate, autonomous system. A mother-infant metasystem is not only sustainable by others, but also self-sustainable in its social or even physical milieu.

Free-market ordering principle is effective mostly in *private use of private goods*. It is much less effective is public use of public goods, ineffective in private use of public goods and potentially devastating in public use of private goods. The reformulation of a sustainable (or non-sustainable) target system into a potentially self-sustainable metasystem is the necessary condition for exploiting free-market ordering functions effectively.

3. Autopoiesis

Autopoiesis or self-production can take place when there are distinct and autonomous individuals or agents interacting and communicating in a specific environment and according to specific behavioral *rules of conduct and interaction.*

Autopoietic organization can be defined as a network of interactions and processes, involving at least:

1) *Production (poiesis)*: the rules and regulations governing the entry of new components, such as emergence, input, birth, membership, acceptance.

2) *Bonding (linkage)*: the rules governing associations, arrangements, manufactures, functions and positions of components during their tenure within the organization.

3) *Degradation (replenishment)*: the rules and processes associated with the termination of membership, like death, separation, consumption, output and expulsion.

In Figure 1, the above three poietic processes are connected into a *cycle of self-production.* Observe that all such circularly concatenated processes represent productions of components necessary for the subsequent processes, not only the one labeled as "production." Although in reality hundreds of processes could be so interconnected, the above three-process model represents the minimum conditions necessary for any autopoiesis to emerge.

An autopoietic system can thus be defined as a system that is generated through a closed (circular) organization of production processes such that the same organization of processes is regenerated through the interactions of its own products (components), and its boundary or distinction emerges as a result of the same constitutive processes.

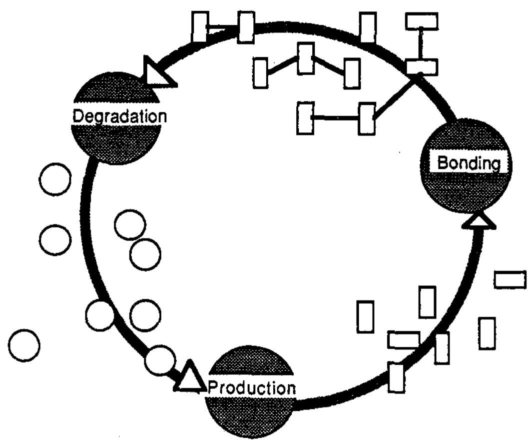

Figure 1. Circular organization of interdependent processes and their "productions"

Autopoietic *organization* is an autonomous unity of a network of productions of components, which participate recursively in the same network of productions of components, which produced these components, and which realize such a network of productions as a unity in the space in which the components exist.

Such organization of components and component-producing processes remains temporarily invariant through the interaction and turnover of components. What changes is the system structure (its particular manifestation in a given environment) and its parts. The nature of the components and their spatio-temporal relations are only secondary to their organization and thus refer only to the *structure* of the system.

An organization becomes autopoietic if *all three* types of constitutive processes are *balanced* or *in harmony*. If one of the three types is either missing or if one or two types predominate (out-of-balance system), then the organization can only be allopoietic, i. e., capable of producing only "the other" but not itself.

For example, production and bonding without degradation quickly depletes the environmental substrate and comes to a halt, like crystals and crystallization. Production and degradation without bonding leads to ephemeral oscillatory systems, and so on.

Any self-sustaining system will have production, bonding and degradation concatenated in a balanced and harmonious way, so that production rate does not exceed replenishment rate and vice versa. *Self-sustaining systems will be autopoietic in an environment of shared or common resources.*

In autopoietic social systems, dynamic networks of productions are being continually renewed without changing their organization, while their components are being replaced; perishing or exiting individuals are substituted by the birth or entry of new members. Individual experiences are also renewed; ideas, concepts and their labels evolve, and these, in turn, serve as the most important organizing factor in human societies.

4. Coordination of action

Autopoietic social systems, in spite of all their rich metaphoric and anthropomorphic meanings and intuitions, are networks characterized by *inner coordination (or harmony) of individual action achieved through communication among temporary agents.* The key words are coordination, communication, and limited individual lifespan.

Coordinated behavior includes *both cooperation and competition,* in all their shadings and degrees. Actions of predation, altruism, and self-interest are simple examples of different and interdependent modes of coordination. Communication could be physically, chemically, visually, linguistically, or symbolically induced deformation (or in-formation) of the environment and consequently of individual action taking place in that same environment.

So I, as an individual, can coordinate my own actions in the environment only if I coordinate it with the actions of other participants in the network. In order to achieve this, I have to in-form (change) the environment so that the actions of others are suitably modified; *I have to communicate.* As all other individuals are attempting to do the same, a *social network of coordination* emerges, and, if successful, it is being "selected" and persists. Such a network improves my ability to coordinate my own actions within the environment effectively. Cooperation, competition, altruism, and self-interest are therefore inseparable.

Any self-sustainable system must secure, enhance and preserve communication among its components or agents as well as their coordination and self-coordination capabilities.

Systems with limited or curtailed communication can be sustained and coordinated through external commands, but they are not self-sustaining. Hierarchies of command are sustainable but not self-sustaining.

Consensual (unforced) and purposeful (goal-directed) coordination of action is nothing less than knowledge. Knowledge, in contrast to data and information, cannot be separated from action and its coordination. Production of knowledge is production of the capability to coordinate action. Self-sustaining systems must be organized so as to continually "produce themselves": their own capability of their own action coordination.

5. Self-sustainable enterprise

F. A. Hayek, in his book *The Fatal Conceit* [1], explains why to the naive mind, that can conceive of order only as the product of deliberate action, it may seem absurd that order, and its adaptation to the unknown, can be achieved more effectively by decentralizing decisions, and that such division of authority will actually extend the possibility of an overall order.

Hayek was the first to recognize the non-sustainability of traditional hierarchies of command and the inevitability of agents' empowerment, self-management and self-coordination.

The self-sustaining organization has recently found its organizational embodiment in the "amoeba system" of Kyocera Corporation [6]. This system is quite reminiscent of the famous Bata-system of management in the 1920s and 1930s in Moravia [5].

The "amoebas" are independent, profit sharing and self-responsible units of three to fifty employees. Each amoeba carries out its own statistical control, profit system, cost accounting and personnel management. They compete, subcontract, and cooperate among themselves on the basis of the intracompany market of market-derived transfer prices.

Depending on the demand and amount of work, amoebas can divide into smaller units, move their members from one section of the factory to another, or integrate with other amoebas or departments. All amoebas are continually on the lookout for a better buyer for their intermediate products. Many amoebas even produce the same or similar products. They are authorized, as in the Bata-system, to trade intermediate products with outside companies; if the internal supplier is unreasonable, the buyer amoeba will search for a satisfactory supplier outside the company.

A most remarkable feature in the autonomy is the member trading. Heads of amoebas lend and borrow members and so eliminate losses caused by surplus labor. Kyocera's amoebas multiply, disband, and form new units according to the autopoiesis (self-production) of the enterprise. Amoeba division and breakup are everyday occurrences and are decided upon the criteria of output and a worker's added value per hour.

This concept of ultimate flexibility is best summed up by Kyocera's President Inamori: "Development is the continued repetition of construction and destruction" [6], as if coming directly from the systems theories of autopoietic self-organization.

Neither age nor training are essential to become the head of an amoeba - only the faculty for the job under the immediate circumstances. If unsuitable, amoeba heads are being replaced immediately.

This system represents quite a revolutionary step beyond the traditional Toyota "just-in-time" system. At Kyocera, orders received by the sales department are passed directly to the amoeba of the final process. The rest of the amoebas in the preceding processes are then given free rein in entering into mutual contracts: the intracompany market takes over. Kyocera Corporation is one of the most profitable companies in Japan.

6. Self-sustainable networks

Australian TCG (Technical Computer Graphics) provides a good example of a self-producing network in a business-firm environment. There are no coordinating divisions, "leading firms", or management superstructures guiding TCG's 24 companies; the coherence, growth and maintenance of the network is produced, according to J. Mathews [3], by a set of network-producing rules:

1. Mutual independence, binding firms through bilateral commercial contracts. This excludes the formation of an internal hierarchy.
2. Mutual preference to member firms in the tendering and letting of contracts.

3. Mutual non-competition among members, to establish self-denial and trust.
4. Mutual non-exploitation among members, based on "cost-plus" contracting, not profit maximization.
5. Flexibility and business autonomy; no need for group approval of any transactions, if no rules are broken.
6. Network democracy without a holding company, "central committee", owner, controller or formal governance structure.
7. Non-observance of rules leads to expulsion.
8. All members have equal access to the open market.
9. Entry: new members welcome, but financed by debt, not through drawing on group resources.
10. Exit: no impediments to departing firms.

The above ten rules constitute the autopoietic organization of a network TCG. They insure that the networks continually produces itself and maintains its coherence over time. There has never been a bankruptcy within the TCG network.

In a changing environment, TCG network grows outwards and adapts to a global market place through a "triangulation process" of collaborative alliances and through spinning-off new companies. A triangle is a strategic alliance of <TCG + external company + customer> and their bonding and concatenation expands the network.

7. Evolution and adaptation

Self-sustaining systems persist. They can persist as ecosocieties of agents only if the individual members are born, communicate, and die in harmony with themselves and their environment. Because of the turnover of components, self-sustaining networks not only persist and are renewed, but they also *evolve*.

The unit of evolution (at any level) must be a network capable of variety of self-organizing configurations. These evolving networks are interwoven and co-evolving with their environment; they do not only adapt to the environment, but also adapt the environment to themselves - through a reciprocal *structural coupling*.

For example, a bird must undoubtedly adapt to a mountain. However, a society (network) of birds can make the mountain adapt to them. By overconsuming particular berries, the new bush growth is arrested, the mountain's erosion enhanced, and the production of both berries and birds reduced until a temporary balance or harmony is restored.

The environment is tehrefore not a structure imposed on living beings from the outside but is, in many ways, a creation of those beings. The environment is not an autonomous process, but a reflection of the biology of the species. Just as there is no organism without an environment, so there is no environment without an organism.

Especially in social domains, the environment is created, maintained and degraded by networks of human beings. Self-sustaining networks, economic, social and cultural, are structurally coupled with their environment and co-evolve with it.

8. Optimization of common resources

Any self-sustaining organization, network or enterprise of autonomous (non-coerced) agents is bound together through drawing on *common* resource system (portfolio of resources). If there is no such intersection, no commonality of resources, we face only individually and separately self-sustainable (or sustainable) entities.

Common resources are always limited and must compete for different uses, projects and productions. Continued assessment of *trade-offs* between competing criteria and alternatives is therefore at the core of relevant decision making processes. When deploying resources towards a particular purpose A, how much of a purpose B (and C, D, etc.) has to be sacrificed or given up?

It is the trade-offs and their assessment where the individual and group interests clash: Better quality or lower cost? Economic growth or environmental preservation? Employment or inflation? Guns or butter?

The above is typical of the traditional zero-sum economics, the "every benefit has a cost" way of thinking. This economics is so logical and pervasive that its precepts have settled down even within the assorted ecology, sustainability and quality of life sciences.

It ignores the dynamics of the win-win, positive-sum, wealth-creating nature of modern, knowledge-based capitalism.

Yet, at least in the business world, the right questions are being asked: *"Are trade-offs really necessary?"* [4]. The answer is no, *trade-offs are* *not really necessary*. Pursuing and achieving lower cost, higher quality (and improved flexibility), all at the same time, is not only possible but clearly desirable and quite necessary. For example, lean manufacturing has apparently eliminated the trade-offs among productivity, investment, and variety.

Quality and low cost and customization and low cost were assumed to be trade-offs, but companies can overcome the traditional trade-offs [5]. In other words, companies can "have it all" - if they embrace trade-offs-free thinking and trade-offs-free methodology of expanding and optimizing (restructuring) their resource system.

How can traditional trade-offs be "eliminated" or "overcome"? Are not trade-offs generic to multiple-criteria conflicts? Can we have it both ways? Can one decrease cost and increase quality at the same time - and continue doing so? The answer is yes: trade-offs are properties of badly designed systems and thus can be eliminated by designing better, preferably optimal, systems.

Obviously, different compositions and structures of resources will produce different levels of trade-offs: optimal design of a resource portfolio is therefore desirable and also a prerequisite to effective self-sustainability. It does matter how the levels of individual resources are determined with respect to each other, as a totality of a system.

8.1. Multiple objectives and trade-offs

There are no conflicting objectives per se. No human objectives are in conflict by definition, that is, inherently conflicting. Everything depends on the given situation, the historical state of affairs, the reigning paradigm, or the lack of imagination.

We often hear that one cannot minimize unemployment and inflation at the same time. We are used to the notion that maximizing quality precludes minimizing costs, that safety conflicts with profits, Arabs with Jews, and industry with the environment. Although these generalizations may be true, they are only conditionally true. Usually inadequate means or technology, insufficient exploration of new alternatives, lack of innovation - not the objectives or criteria themselves - are the causes of apparent conflict[1].

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1) These two paragraphs are reprinted from the conclusion of author's text on *Multiple Criteria Decision Making*, McGraw-Hill, New York, 1982, p. 402.

Trade-offs among multiple objectives (there can be no trade-offs when only a single objective is considered) are *not* properties of the objectives themselves, but of the set of alternatives or options they are engaged to measure.

For example, trade-offs between cost and quality have little if anything to do with criteria of cost and quality themselves: rather, they are implied by the limits and constraints on the characteristics of available automobiles they measure. Measuring sticks are neutral and any apparent relations (like trade-offs) are only induced by the measured [8].

8.2. Graphical example

Suppose that objectives f_1 = Profit and f_2 = Quality. Both of these objectives are to be maximized with respect to given resource constraints (feasible options).

In Figure 2, the polyhedron of system-feasible options is well defined System I. Maximizing *functions* f_1 and f_2 separately, leads to two different optimal solutions and levels of criteria performance (designated as *max*). If System I remains fixed, observe that the maximal, separately attainable levels of both objectives lead to an *infeasible* "ideal" option. The trade-offs between quality and profits are explicit and must be dealt with (selecting from the heavy boundary, i. e., nondominated solutions, of System I.

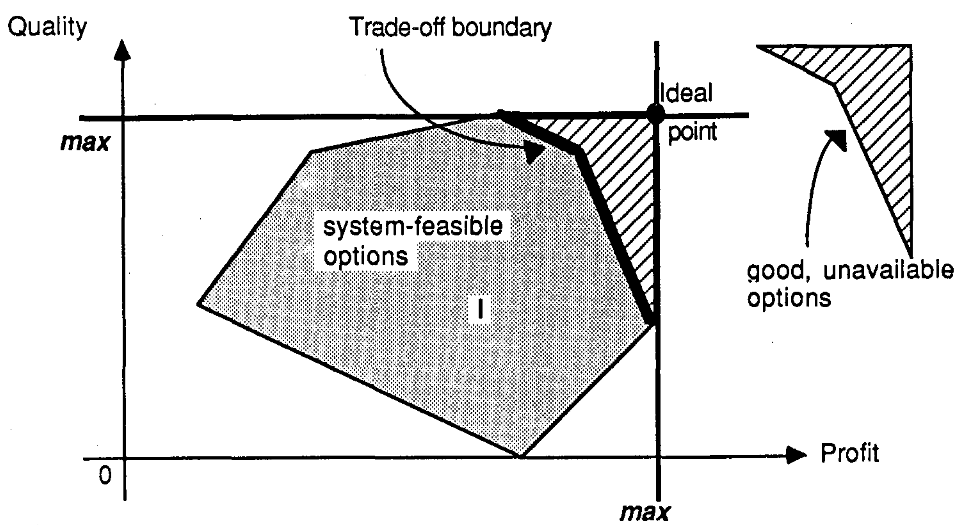

Figure 2. System I: given design with natural quality-profit trade-offs.

In Figure 2, observe that the system I is poorly designed because there exists a set of good, currently unavailable options which would make the "ideal" point feasible and thus allow the maxima of f_1 and f_2 (Profits and Quality) be attained both at the same time.

Any manager's lifetime of work in System I shall unfailingly lead to the following wisdom: There is always a trade-off between profits (or costs) and quality, one cannot have both ways, one has to pay for quality. As more and more managers derive (from their own experience) the same wisdom, textbook writers and instructors accept the wisdom as conventional, embed it in their own educational efforts and teach it to multitudes who had no such prior experience. Trade-off-based systems and culture are thus perpetuated.

In other words, reshaping the feasible set (reconfiguring resource constraints) in order to include the "missing" alternatives, if realizable at the same or comparable costs, would lead to a superior system design with higher levels of criteria performance.

Such desirable "reshaping" of the feasible set is represented in Figure 3, where System II of system-feasible options is sketched. Given System II, both objectives are maximized at the same point (or option): System II is superior in design to System I.

From all such possible "reshapings" of system configurations, given some cost or effort constraint, the best possible *optimal design* or configuration of resources can be chosen.

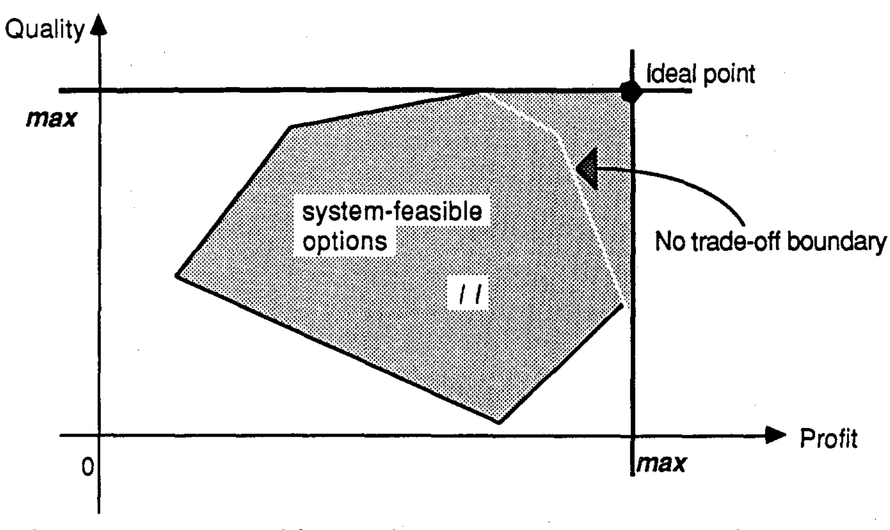

Figure 3. System II: optimal design with no apparent quality-profit trade-offs.

Such system (like System II below) will be superior with respect to both profit and quality and no trade-offs between them are possible. Trade-offs have been eliminated through optimal system design.

In Figure 3, system with no quality-profit trade-offs is presented. Observe that the maximal separately attainable levels of both criteria now form feasible ideal option. Consequently, the trade-offs between quality and profit ceased to exist (heavy trade-off boundary of System I has disappeared in System II).

Any manager's lifetime of work in System II shall unfailingly lead to the following wisdom: There is never a trade-off between profits (or costs) and quality, one cannot have one without the other, quality pays for itself. As more and more managers derive (from their own experience) the same wisdom, textbook writers and instructors accept the wisdom as conventional, embed it in their own educational efforts and teach it to multitudes who had no such prior experience. Trade-off-free systems and culture are thus perpetuated.

8.3. *Numerical Example*

Let us consider a simple production problem [9] involving two different products, say suits and dresses, in quantities x and y, each of them consuming five different resources (nylon through golden thread) according to technologically determined requirements (technological coefficients). Unit market prices of resources are also given, as are the levels (n. of units) of resources currently available (portfolio of resources). The data are summarized in Table 1.

Unit price $	Resource (Raw material)	Technological coefficients (Resource requirements)		No. of units (Resource portfolio)
		x = 1	y = 1	
30	Nylon	4	0	20
40	Velvet	2	6	24
9,5	Silver thread	12	4	60
20	Silk	0	3	10,5
10	Golden thread	4	4	26

Table 1. Original data for production example

In the above example, observe that producing one unit of each product x and y (x = 1 and y = 1) requires 4 units of nylon (4x1 + 0x1), 8 units of velvet (2x1 + 6x1), etc. Total number of available units of each material (given resource portfolio) is given in the last column of Table 1.

Current market prices of resources (first column) allow us to calculate the costs of the given resource portfolio:

(30x20) + (40x24) + (9.5x60) + (20x10.5) + (10x26) = $2600

The same prices can be used to compute unit costs of producing one unit of each of the two products:

x = 1: (30x4) + (40x2) + (9.5x12) + (20x0) + (10x4) = $354
y = 1: (30x0) + (40x6) + (9.5 x 4) + (20x3) + (10x4) = $378

In other words, it costs $354 to produce one suit and $378 to produce one dress. Suppose that we can sell all we produce at current market prices of $754/unit of x and $678/unit of y.

Expected profit margins (price-cost) are:

x: 754-354 = $400/unit y: 678-378 = $300/unit

As profit maximizers, we are interested in maximizing total value of function $f_1 = 400x + 300y$.

As a second criterion let us consider some quality index: say 6 points per x and 8 points per y (scale from 0 to 10), so that we can maximize total quality index or function $f_2 = 6x + 8y$.

We are now in a position to analyze the above outlined production system with respect to profits and quality. Maximizing levels of x and y (best product mix) can be easily calculated by techniques of mathematical programming (here we need only the results).

1) Function f_1 is maximized at x = 4.25 and y = 2.25, thus achieving maximum of

(400x4.25) + (300x2.25) = $2375 in profits.

2) Function f_2 is maximized at x = 3.75 and y = 2.75, achieving maximum of

(6x3.75) + (8x2.75) = 44.5 in total quality index.

This situation corresponds to situation in Fig. 1. The two maximizing points are the endpoints of trade-off boundary. One can trade-off quality for profits by moving from x = 3.75, y = 2.75 to x = 4.25, y = 2.25 and back again, trading profits for quality. Because we can produce only one product mix at a time, we can choose to either maximize profits (x = 4.25, y = 2.25) or maximize quality (x = 3.75, y = 2.75), but *not both*. The choice is difficult because of the trade-offs between profits and quality. Their importance is difficult to evaluate.

Let us heed productivity consultant's advice and purchase a portfolio of resources different from that in Table 1, other things being equal. We keep this new production system comparable and compatible in all respects, except the last column of Table 1. The new portfolio of resources in Table 2 has been proposed by the consultant.

Unit price $	Resource (Raw material)	Technological coefficients (Resource requirements)		No. of units (Resource portfolio)
		x = 1	y = 1	
30	Nylon	4	0	16,12
40	Velvet	2	6	23,3
9,5	Silver thread	12	4	58,52
20	Silk	0	3	7,62
10	Golden thread	4	4	26,28

Table 2. New data for production example

We are now in a position to analyze the newly proposed production system under the same conditions.

1) Function f_1 is now maximized at x = 4.03 and y = 2.54, achieving maximum of (400x4.03) + (300x2.54) = $2375 in profits.

2) Function f_2 is maximized at x = 4.03 and y = 2.54, achieving maximum of (6x4.03) + (8x2.54) = 44.5 in total quality index.

Both previously achieved maximum values of f_1 and f_2 have been matched. More importantly, *both* maximum profits ($2375) and maximum quality index (44.5) are achieved through a single product mix: x= 4.03 and y = 2.54. This particular product mix, or ideal point in Figures 1 and 2, was infeasible in the previous system. By allowing its feasibility now, we have eliminated all and any trade-offs between the criteria of profits and quality.

The previous trade-offs-based system (Table 1) was operated at the cost of $2600. The newly designed trade-offs-free system (Table 2) is realizable at the following cost:

(30x16.12)+(40x23.3)+(9.5x58.52)+(20x7.62)+(10x26.28) = $2386.74

The superior performance of the newly designed system comes at \$213.26 cheaper than the suboptimal performance of the original system.

8.4. Optimal portfolio of resources

The above example demonstrates that the chosen portfolio of resources is crucial for assessing maximum achievable levels of profits, costs, quality, flexibility, etc., at which corresponding production system can be operated, other things being equal.

In our example, should any company choose to operate *any other* resource portfolio (at cost ^{2} \$2600) than that of Table 2, other things being equal, then its performance with respect to f_1 and f_2 would be necessarily inferior. Simple rearrangement of resource levels (Comparing Table 1 with Table 2) "reshapes" the management system (of feasible opportunities) From Fig. 2 to Fig. 3 and provides superior performance at the same or even lower costs.

The explanation is simple. Productive resources should not be engaged individually and separately because they do not contribute one by one according to their marginal productivities. Productive resources perform best as a whole system: they should be determined and engaged jointly as a portfolio and in an optimal fashion [9].

8.5. Profit Maximization

Free market systems are rooted in the assumption of profit maximization by individuals and their corporations.

This time-honored premise is usually not further specified or elaborated, as if there was only a single form of profit maximization.

Yet, rational economic agents can maximize profits in *at least two* fundamentally different - often mutually exclusive - ways:

1. Manage (operate) a *given* system so that a profit function is maximized.
2. *Design* a system so that its management (operation) would result in maximal profits.

These two forms of profit maximization are not the same.

In the first case, one is doing his managing best and squeezing maximum profits from a *given* system. This is known as profit maximization.

In the second case, one designs (re-engineers) a profit-maximizing system: doing one's managing best leads to maximum profits. This is, undoubtedly, also profit maximization.

The two modes are mutually exclusive because one cannot follow the second without first dismantling the first. It is not sufficient to (continually) improve the given system: because there is *only one* optimally designed system, then all*other* systems must be suboptimal by definition.

9. Customer integration

Traditionally, customers (or consumers) have been viewed as being distinct and separate from the production process. Such separation has become unwise, ineffective and non-competitive in the 90s.

In the era of mass customization, the product in the hands of the customer is *still* a part of the production process cycle. In other words, the product remains essentially incomplete or unfinished until the customer completes it or issues instructions for completing it. This system is referred to as *Integrated Process Management* (IPM) [10].

Traditionally, we have perceived production process as simply a transformation of inputs into outputs. Such linear and one-directional scheme, where customer remains an object, separated "out there" in the environment, is is now replaced by the circular integrated process, as portrayed in Fig. 4. The customer is both the purpose and the driving force of an enterprise.

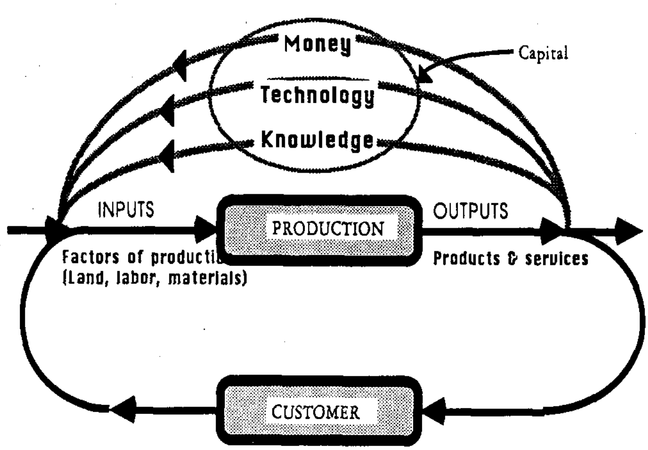

Figure 4. Customer integration into the production process

Observe also the "capital loop", the continuous self-renewal of the portfolio of *money, technology and knowledge* which "produces", over and over again, the enterprise itself.

Increasingly, each modern enterprise is engaged in *two types of production*: **1.** *allopoiesis*, producing "the other" than itself (i. e., goods and services) and **2.** *autopoiesis*, producing itself, i. e., its own production process, its own ability to produce.

Self-sustainability of systems is crucially dependent on the reliability of the second type of production, autopoiesis. Only a system that could continually "produce itself" under changing environmental conditions can be deemed self-sustainable.

10. Self-service and self-sustainability

Self-sustainability in socioeconomic systems is necessarily related to the levels of self-service and do-it-yourself activities of their independent economic agents. No central government, no matter how benevolent or competent, will be able to match the power and influence of modern, technology and knowledge based self-service activities. Self-service implies self-sustainability virtually by definition [2].

A self-service society has already started emerging in the U. S.A., fueled by the continuous decline in job-generating capacity of the so-called service sector.

Services are no different from any other economic sector, like agriculture or manufacturing, which went into their irreversible losses of employment capability some decades ago. The accelerating productivity growth rates in those sectors have caused the steady decline in their job-generating capacity. The service sector is simply following the same pattern: increasing automation, increasing productivity, global competitive pressures, high relative costs and overgrown hierarchies are annihilating its own employment opportunities.

In Fig. 5 is a sketch of the general sectoral dynamics from which there is no escape and which all economies, slowly or rapidly, sooner or later, are bound to follow. Each sector has to emerge, grow, persist, decline and dissipate in terms of its employment generating capacity [11, 12]. It has never happened otherwise and it never will.

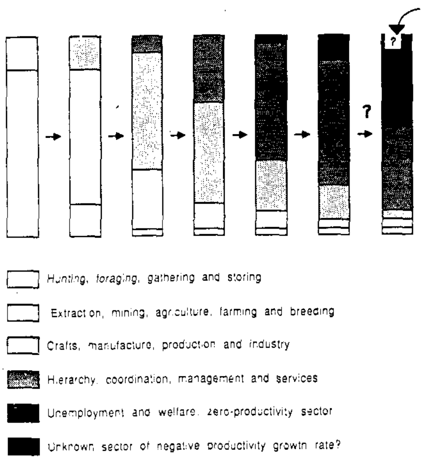

Figure 5. *Sectoral evolution and differentiation* (in a rapidly maturing economy): Each sector, including services, emerges, persists and declines.

The high-productivity growth sectors emerge and dissipate first, the low-productivity growth sectors (like services) are completing their cycle only in the nineties. No new sectors can emerge because we have already exhausted the potential of low-productivity growth sectors. Zero- or negative-productivity growth "sectors" (unemployment, welfare, etc.) cannot sustain any economy for too long. The last bar of Fig. 5 suggests the an *unsustainable* employment structure of the U. S. economy could settle in about the year 2000.

The *differential* productivity growth rates in different sectors are accompanied by virtually *uniform* growth rates in wages and salaries across sectors. This simple empirical fact, often ignored and rarely explained, implies that the costs and prices grow relatively faster in low-productivity sectors and relatively slower in high-productivity sectors. Therefore, in mature economies, the prices of food and manufactured goods are getting relatively cheaper and the prices of services are becoming relatively more expensive. In slow-developing economies of the Third World, it is still the other way around: food and manufactured goods are most expensive while services and human labor remain relatively the cheapest.

This fundamental systemic disharmony (Between differential productivity growth rates and the uniform wage/salary growth rates across sectors) points to a self-organizing, spontaneous mode of resolving the conflict. Rational economic agents will exhibit and support the tendency towards substituting relatively

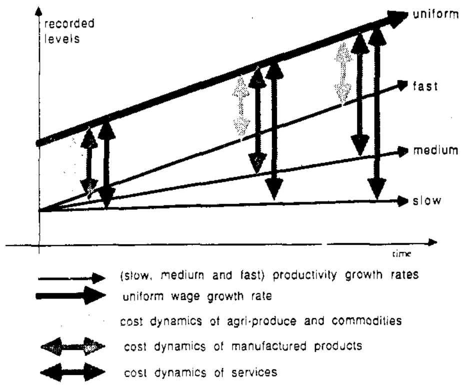

Figure 6. *Price gap:* Differential sectoral productivity growth rates, combined with the uniform wage growth in the whole economy, causes the prices to grow faster in the "lagging" sectors.

cheaper capital-intensive manufactured goods for relatively dearer labor-intensive services.

Consumers will start using goods instead of services wherever economical and possible, while the producers will respond by supplying them with goods instead of services, also wherever economical and possible. The economy of free markets searches out its own self-sustainable regime.

Consequently, self-service and do-it-yourself activities are replacing the traditional, other-person-delivered services at an increasingly accelerating rate, in spite of the uninformed legal, business and governmental/political counter-strategies. *Mature economies have entered the era of self-service and do-it-yourself societies.*

Self-service activities are very effective: they can be delivered when, where and at what quality the user desires, at lower costs and at a shorter time. They do require user-friendly support products with easy-to-use, reliable instructions and backup, as well as sufficient time and higher costs of alternative services. All these conditions are now present in mature economies. Do-it-yourself industries are the fastest growing parts of the U. S. economy, virtually impervious to recession or depression.

The self-service society is self-sustainable: characterized by increasing autonomy of workers and consumers, accelerating growth in work-at-home, telecommuting, self-employment, community self-help, home office, part-time and seasonal work, early retirement, barter and exchange networking, home shopping and banking, flexible workhours, self-management, decline of supervisory "services", and fortified decentralized *self-reliance.*

Households are once again becoming primary investment/ production units and producers and consumers are merging into "prosumers". Integration is replacing specialization and vertical hierarchies are being flattened into self-managing, horizontal heterarchies. Knowledge has become the most important form of capital. Democracy and autonomy are penetrating beyond the factory gates, into the companies and inside the enterprises.

Only the governments are failing: instead of creating the right milieu for self-sustainability, self-reliance and self-service, instead of acknowledging and amplifying these powerful spontaneous trends, many politicians are still selling the Big State. The new generation of politicians, businessmen and managers will have to replace those who are obviously tired in their thinking, overwhelmed by these changes, elderly in their habits and too predictable in their conservative action.

The U.S., Japanese and European persistent economic "recessions" are nothing less than fundamental structural realignments of the socioeconomic forces pulling away from specialization and division of labor and pushing towards reintegration of task, labor and knowledge, towards the autonomy of producers/consumers and towards the renewed self-service, self-help and self-reliance of increasingly self-empowered citizenry.

Although many social systems can be temporarily *sustained* externally and from above, the same systems become *self-sustainable* only internally and from below: they can only be sustained through involving and empowering their most active components, the people.

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Abstract

As human labor is increasingly replaced by human *knowledge*, the major productive resource and the most potent form of capital, a newly emerging *organizational mode* shifts from the traditional vertical hierarchy of command to horizontal patterns of internal markets of autonomous agents. The organizational mode is characterized by *self-management*, *autonomy* and *self-sustainability*, the trio of prerequisites for a successful, self-sustainable enterprise of the 21st century.

Employees, managers and community stakeholders are striving to create the *self-sustaining* organizational milieu by pursuing decisional autonomy, self-management and shared "insider" ownership: they are all tied together through operating a *common resource portfolio.*

This common resource system should be optimally designed and optimally managed: for teams, for enterprises, groups of enterprises as well as for institutions. In order to do that, ideally, teams of employees and managers should become autonomous, flexible, self-managed and participatory in ownership. Like biological "amoebas", they should adapt to the ever changing circumstances in terms of size, shape, function and interaction.

The role of government is similar to that of top corporate management: it should abandon the central-planning approach of traditional hierarchical command, flatten the pyramids of power, support re-engineering of corporate structures and position itself as a market milieu-producing and market milieu-sustaining agent of considerable importance: assuring fair play, providing infrastructure of communication and optimization services, setting the "rules of the game". It also sets productivity and added-value measures, accounting and evaluations for all participants.

Market forces have been proven to induce great ordering and organizing powers *if* the rules of conduct and fair play are adhered to and enforced and their violations punished. Under such conditions, market forces (and self-rule of democracy) can be extended from the macro-organization of the society to the micro-organization of a company, beyond the company gates.

There aren't abstracts in italian language and in french language because they aren't furnished by the Author; so we are sorry.

Il n'y a pas les résumés en englais et française pas evoyés par l'A.; nous Vous prions de nous excuser.

Mancano i sommari in lingua italiana e in lingua francese non forniti dall'autore; ci scusiamo vivamente di ciò.