Chapter 4

THE PRODUCT-LIFE FACTOR

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ABSTRACT

This paper attempts to show that the extension of the use-life of goods is, first, a sensible point at which to start a gradual transition towards a sustainable society in which progress is made consistent with the world's finite resource base and, second, a strategy consistent with an active and independent role for the private sector.

Product-life, or the period over which products and goods are used, governs their replacement speed and thus the consumption of natural resources required for their manufacture and the amount of waste they create. Shortening product-life increases demand for replacement goods where these can be afforded. Extending product-life optimizes the total life-span of goods and reduces depletion of natural resources and consequently waste; it builds on and increases wealth. Longer use of products will thus contribute to the transition towards a sustainable society. Compared to fast-replacement, product-life extension is a substitution of service activities for extractive and manufacturing industries, and a replacement of large-scale capital-intensive companies by smaller, labour-intensive, locally integrated work units.

The private sector, whether R&D, manufacturing or finance, will find innumerable business opportunities in product-life extension activities - REUSE, REPAIR, RECONDITIONING and RECYCLING. Indeed, while increasing the number of skilled jobs available and reducing our dependence on strategic materials, such activities will provide the private sector with fresh impetus to make cheaper goods available as part of a self-replenishing economy built on a spiral-loop pattern which allows a substitution of manpower

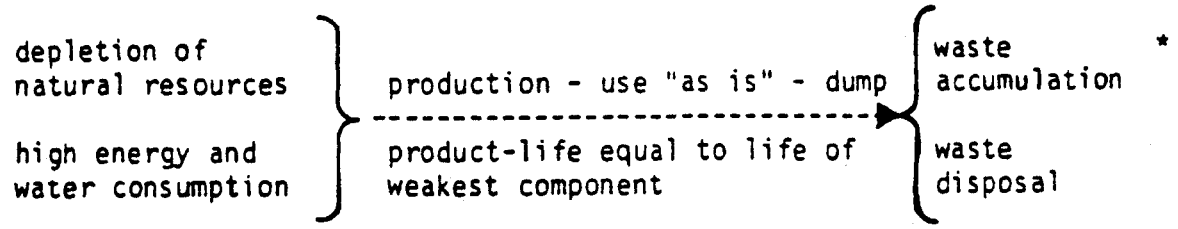
for energy. In this way, unemployment and poverty which certainly aggravate the fundamental instability of the world economy might be substantially reduced. The private sector has, moreover, resources and skills that uniquely qualify it to initiate this transition towards a sustainable society where a balanced use of resources and other societal goals are achieved. Potential disincentives and obstacles can, we believe, be overcome with appropriate education and fiscal and policy measures.

CHAPTER ONE: PRODUCT-LIFE ALTERNATIVES

Three Basic Approaches

Today, industrial activity involves a linear production-consumption system with inbuilt environmental deterioration at both ends:

FIGURE A: THE FAST-REPLACEMENT SYSTEM



(* Appendix 1)

Fast replacement has been a persistent trend in economic history, and has gained momentum in our fashion-based consumer society ("bigger-better-faster exciting new products") as economists have become preoccupied with production optimization, economy of scale and fast depreciation and replacement. The result has been short-life, incompatible goods and products characterized by lack of repairability. It has also meant that an ever-increasing part of our income has been devoted to the replacement of products, maintaining, not adding to, wealth.

Growth, i.e., higher production volume in stagnant domestic and export markets, can only be achieved by shortening the design life of products, thus speeding up replacement.

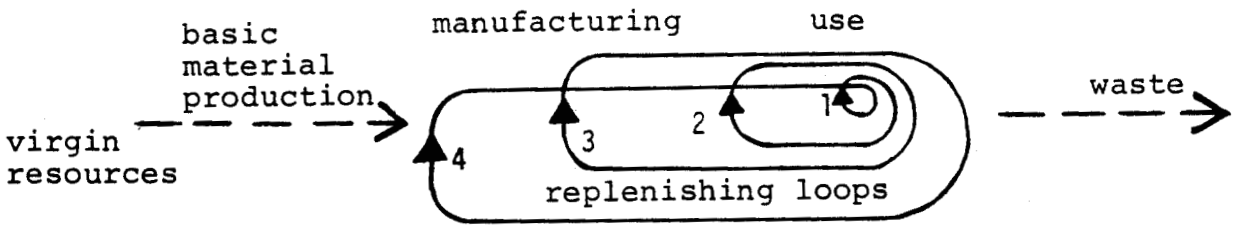
However, there are alternatives to this fast-replacement system that would half the use of raw materials and resources and the amount of waste produced.

FIGURE B: THE SLOW-REPLACEMENT SYSTEM (LONG-LIFE PRODUCTS)

depletion of resources halved } production - doubled period of use "as is" - dump { amount of waste halved

Doubles the design life of products in manufacturing, (e.g., cars that are designed to last 20 instead of 10 years by using corrosion-resistant materials, appropriate assembly methods, and periodic maintenance).

FIGURE C: THE SELF-REPLENISHING SYSTEM (PRODUCT-LIFE EXTENSION)



independence of the life-times of inter-compatible systems, products and components

Creates an economy based on a spiral-loop system that minimizes matter, energy-flow and environmental deterioration without restricting economic growth or social and technical progress:

REUSE (loop 1), REPAIR (loop 2) and RECONDITIONING (loop 3) utilize used products or components as a source for new ones, and RECYCLING (loop 4) uses scrap as locally-available raw material.* A society relying on this self-replenishing economy is building on existing wealth and applying economics to optimize the total life-span of goods and products. Financial and resource management is now aimed at reducing total long-term utilization costs.[1,2] The effectiveness of this spiral-loop system is greatly enhanced by a built-in inertia which keeps the loops as small as possible: do not recondition something that can be repaired, do not recycle a product that can be reconditioned economically.

This inertia can in turn be applied to components, products and

* John Davis [3] calls this the "Four R's of Appropriate Technology".

systems themselves, i.e., replace or treat the smallest possible unit only.

However, this paper concentrates mainly on alternative C, product-life extension, because:

- Alternative C is available to any entrepreneur or company able to seize the opportunity, the necessary capital investment being modest and emissions minimal, whereas alternative B depends on a change in established economic and business thinking that is unlikely to happen fast, as it will further reduce the utilization of production capacity of the companies best qualified to implement it.

- The price of a reconditioned product will be considerably below the price of a brand-new one (up to 40%) thus facilitating market entry, while the initial cost of a long-life product will be slightly higher than that of current short-life products; but long-term leasing instead of selling could reverse this. (Appendix 3)

- Reconditioning, with the option to up-grade technologically, leaves room for innovation, whereas long-life products may give rise to concern about hampering technical progress.

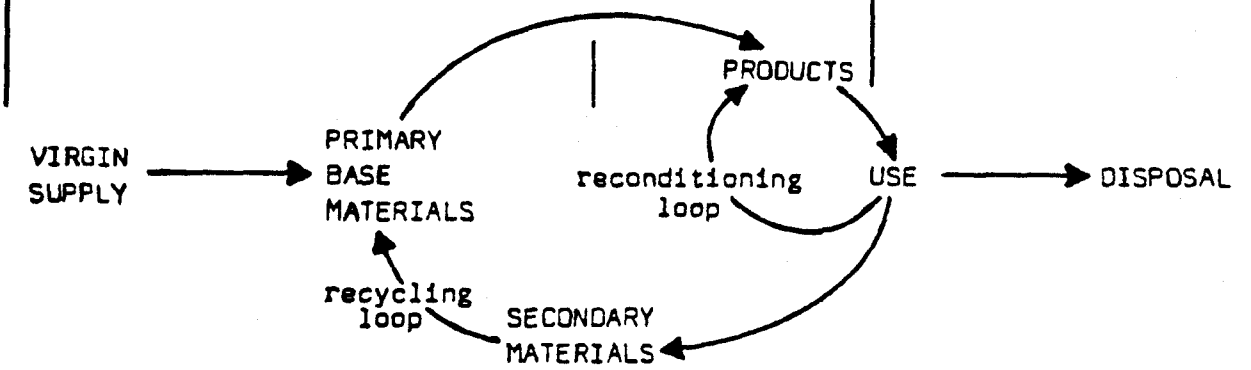
- Compared to the fast-replacement system (A), alternative C is a substitution of transformation and service activities for extractive industries and base material production and thus a replacement of large-scale capital-intensive companies by smaller-scale labour-intensive, independent, locally integrated work units, i.e., a shift from the secondary to the tertiary sector.

Does Product-Life Extension Sound Too Good to be True?

Let us glance at some basic figures: roughly three quarters of all industrial energy consumption is associated with the extraction or production of basic materials like steel and cement, while only about one quarter is used in the transformation of materials into finished goods such as machines or buildings. The converse is true of labour, about three times as much being used in the conversion of materials to finished products as is required in the production of materials.

FIGURE D: ALTERNATIVE LIFE-CYCLES OF AN INDUSTRIAL PRODUCT AND INTENSITIES OF LABOUR AND ENERGY INPUTS IN THE PRODUCTION PHASES

	BASE MATERIAL PHASE	MANUFACTURING PHASE	TOTAL INPUT INCORPORATED IN PRODUCT
LABOUR	25%	75%	100%
ENERGY	75%	25%	100%



Source (1)

An increase in transformation-type industries, such as reconditioning, thus corresponds to a substitution of labour for energy. Skilled and experienced craftsmen are needed in repair and reconditioning activities which can be undertaken in comparatively small workshops scattered widely throughout the country wherever there are items in need of renovation and customers for them, as is still the case with car-repair workshops. These enterprises can be located in any rural or urban area with high unemployment, making reconditioning a doubly attractive proposition for job creation.[1,2]

A further energy saving (and reduction in pollution) is brought about by the decentralized structure with its reduced transport requirement.

"Is It Not Cheaper to Produce New Goods?"

Some examples may help to answer this question:

- "Patten Industries Inc., a Caterpillar dealer in Chicago's

Elmhurst suburb, has a production line to rebuild Caterpillar engines and other tractor parts. Its customers can buy rebuilt parts that last 80% as long as new ones yet cost only half the price. Caterpillar encourages the practice because its equipment becomes more economical in the long run for the customer.[4]

- The cost of an average modernization of a residential building is about 42% of new building costs.[5]

- The Dutch company Fokker has developed for the European rocket Ariane a parachute system to recover for reuse the first module which weighs 16'000g. This will result in savings of several million US dollars per take-off.[6]

But What of Technological Progress?

The NASA space-shuttle program has finally put to rest the erroneous notion that reconditioning activities and reusable goods are associated with second-class technology or less-than-best solutions. It has, on the contrary, shown that such procedures can provide fresh technological and R&D impetus.

Use-life extension will be enhanced and made cheaper by standardization and componentized product design (function modules), such as the new WE motorbike that allows an owner to "trade-up" by changing not the whole motorcycle but the engine only. The frame is made in five replaceable parts, influenced by aerospace technology.[9]

Moreover, product-life extension will greatly encourage creative thinking for new technologies and processes, such as dust-free cleaning of metal surfaces, material bonding (adding material to worn surfaces) and hardening, as well as basic research on, for example, component destruction by wear versus material fatigue.[10]

"Fashionable Products At All Costs!"

This is a stock excuse for ignoring the "cheap and less stylish" alternative. The dumpy but hardy Lada automobile, built in USSR and based on the 10-year-old Fiat 124, is selling some 40% below its cheapest rival, GM's Opel Kadett. It can thus be compared image-and-price-wise to a reconditioned car. Lada sold 141,000 units in Western Europe in 1981, 34% more than the previous year. In Belgium, a gateway for reexports to other European Countries, Lada is now outselling Honda and Mitsubishi.[11]

A successful example of what may be termed "selective reconditioning", --"price before beauty"-- is the US "Rent-A-Wreck". "Rent-A-Wreck

hires out cars that are up to ten years old and look it. They are mechanically sound and clean, though they may sport a dent or two. Daily charges in 1981 are $12 to $15 while Avis' shiny, new models can cost up to $65. Rent-A-Wreck has 150 franchised outlets nationwide and is growing."[12]

Recent examples for technological up-grading include a $1 m conversion to turboprop power as well as other retrofit services for DC-3 aircraft of which about 2,500 are still flying![13]

What About Safety?

What could be safer than a periodically-maintained and upgraded system, the performance of which is regularly monitored? "Delta and United Airlines have converted and modernized their fleet of DC-8 jets with new quiet and fuel-economic engines. The dollar-per-seat price for the modified DC-8 ranges between $45,000 to $60,000, compared to $100,000 to $150,000 for a new aircraft."[14]

The US Navy uses SLEP (a Service Life Extension Program), a complete overhaul and upgrading procedure lasting 2 years, to prolong the life of its major vessels, including nuclear-powered aircraft carriers, by 10 to 15 years.[15]

Selection Criteria for Product-Life Extension

In the past, many activities were started by insiders, such as original equipment manufacturers (industrial diesel engines), or salesmen who were familiar with prices, clients and trade-in offers for used products. C.L. Schalenbrand was one of these. In 1975, he started to sell reconditioned IBM word processors at about 50% of the new price. He bought initially in the cities and sold in smaller communities.[16]

Even if the life of almost any product can be extended, the following points should be borne in mind:

- Technical maturity: mature components such as electric engines or railroad rails, will not be made superfluous in the short-term by innovations (electronics), and will be obvious targets for product-life extension. Complex products and systems incorporating technically-superseded components, such as electro-mechanical telephone exchanges, however, may be ideal for technological upgrading in an electronic age.

  Figure E shows technology jumps and resulting potential product-life

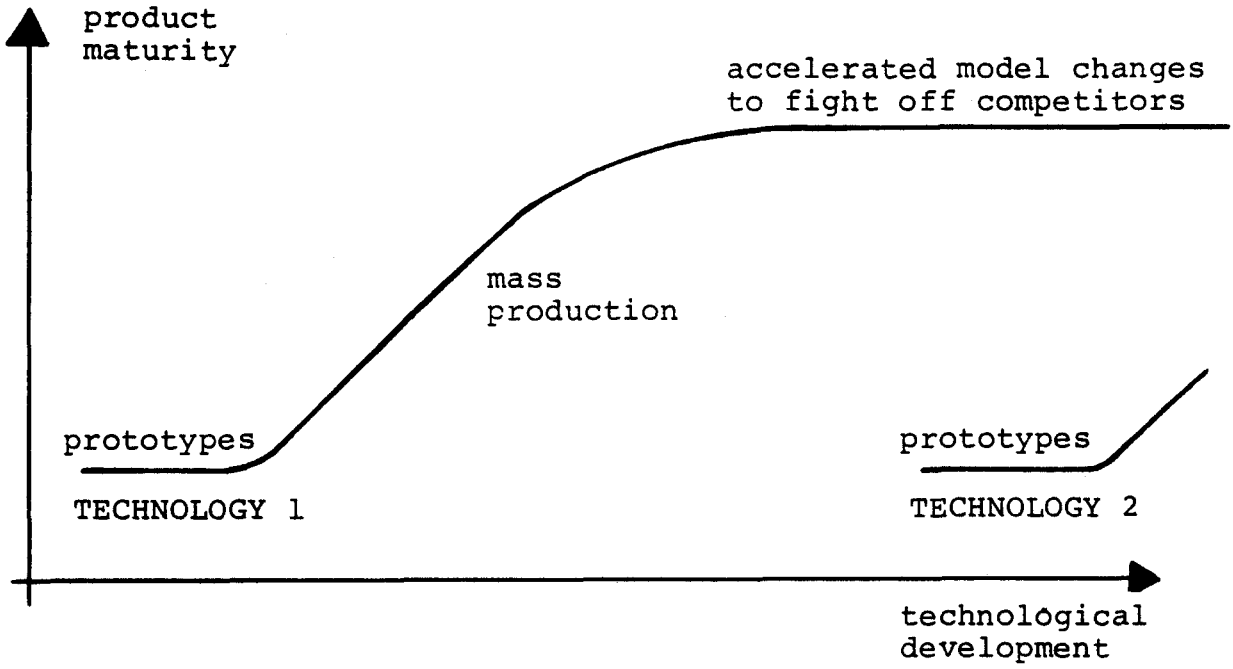
extension. A differentiation between substituting and parallel technologies is essential to product-life extension, as a substantial market for used products continues to exist for a long time in the case of parallel technologies.

- Production maturity: mistakes are often made in times of radical change or economic boom. Early prefabricated buildings, for example, may be structurally less safe than earlier traditional construction and technically less sophisticated than later buildings.

- Life-extension procedures may, in this instance, be more comprehensive and costly, but owners may prefer redevelopment to reconditioning.

- Assembly follies: increases in manufacturing productivity are often to the detriment of use-life quality, such as the substitution of spot for seam welding in car manufacturing, which creates ideal corrosion conditions difficult to repair.

FIGURE E: TECHNICAL MATURITY VERSUS PRODUCT-LIFE EXTENSION



	EXAMPLES	POSSIBLE PRODUCT-LIFE EXTENSION PROCEDURES
Technological maturity	cable-based telecom	
TECHNOLOGY JUMP	to telecom via satellite	reuse or recycling of components
Product maturity	manual typewriters	
TECHNOLOGY JUMP	to word processors via electric typewriters	away-grading of old product, recycling of components
Component maturity	telecom copper cables	
TECHNOLOGY JUMP	to glassfiber cables	upgrading of system, re-use of components, recycling of components

what if we forced typewriters recycle

SUBSTITUTING TECHNOLOGIES (for similar needs and prices): word processors will replace electric typewriters in the office of the future

PARALLEL TECHNOLOGIES (for different needs and prices): manual typewriters will continue to be used in small offices, at home, in areas with no electricity

SPECIAL CASES

Hybrid Materials

Programmed cascading from harvesting or extraction to final consumption can considerably increase the use-value of hybrid materials, for example oil or timber that can be used for different applications (structural, pharmachemical or combustion). These properties are hardly ever fully exploited: the same tree could consecutively be used as structural timber, planks, chip- or fiberboard, and fuel. Alternatively, it could be transformed into paper, recycled paper, cardboard, home insulation panels, and fuel. These options are normally wasted, however, in order to facilitate transport (wood chips), for lack of care (burning of old timber in house demolition), or because of the need for survival. (Appendix 4)

Uncontrolled consumption of timber, based on the widespread misconception regarding the economic feasibility of the single use, has resulted in disastrous soil erosion and desertification.

THE ROLE OF THE PRIVATE SECTOR*

What's In It for the Private Sector?

Most product-life extension activities require a low capital-investment cost per worker, are normally free of excessive noise or pollution, and are best undertaken in small units close to wherever there are items in need of renovation and customers for them. These new activities are thus accessible to many new or existing small enterprises, with inherent long-term stability as business depends on existing stocks rather than "replacement" sales, which vary between 2% (for buildings) and 10% (for cars) of stock. We may add to these advantages the attraction of developing new markets with low entry costs and few competitors (and thus a low risk of failure), where business can develop freely consistent with the long-term goals of a sustainable society. In time, new commercial and technical ideas will emerge, providing improved product/service mixes for exploiting the market potential, which in turn will make reconditioned goods even more attractive.

In countries with a skilled labour force, the private sector, through reconditioning, can:

- Gain access to higher technology levels: Israeli Aircraft Industries, founded by an American in 1950, started off with overhauls and repairs of military aircraft, moved up to building components and today is a manufacturer of airplanes, radar systems and rockets. IAI has become Israel's biggest exporter![17]

- Develop high-technology diversification: Swissair has become a world leader in overhauling DC 9 engines and DC 10 aircraft.[18]

- Open up new export markets for process know-how and secondhand products: used trucks for reconditioning locally accounted in 1979 for 25% of Chinese truck imports from Japan.[19]

The private sector might even be able to develop a new market for used products by catering to a large segment of customers who

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* This chapter concentrates on the situation in industrialized countries. Its findings can be translated to the context of LDC** mutatis mutandis the differences in markets, needs, and priorities. Examples of product-life extension in LDCs can be found in various publications.[23]

** LDC: Less Developed Country

cannot afford to buy new ones: up to 20% of the population of developed countries live below the poverty line; about 20% of the population are people in retirement; today, except for the bare essentials, both groups are largely excluded from participating in the consumer society for lack of money. (Appendix 5)

And, last but not least, the private sector can, with product-life extension, become a constructive partner of government by increasing the number of skilled jobs and reducing the country's dependence on imports of strategic materials.

What is to be The Role of The Private Sector in The Transition to A Sustainable Society?

Manufacturing has traditionally been located near raw-material extraction and production, typically coal and iron deposits. Electronic industries have preferred areas such as Silicon Valley where other electronics firms were already established. In both cases, mobility was the worker's problem.

Today's unemployed are often poor, unskilled and not mobile. Product-life extension activities are labour-intensive and highly mobile; and are best undertaken where cheap labour is available, i.e., where the people who were replaced by machines are to be found, or, alternatively, near the user and the goods he uses.

For an enterprising private sector, the situation constitutes a large untapped sector of customers for low-priced goods, once jobs in product-life extension activities have created additional income.

But job creation is the government's responsibility, one may well object. The 1982 annual report of BIS in Basle describes "rising unemployment in the industrial countries (for which it sees no early improvement) and the alarming worsening of the position of the developing countries as contributing to a state of fundamentally unstable equilibrium in the world economy."[22]

This is a real threat to our liberties, to free trade and enterprise. The private sector has resources and skills that uniquely qualify it to start the transition to a sustainable society, where a balanced use of all resources and other societal goals are achieved!

The following pages attempt to identify some of the many facets of product-life extension activities which offer innumerable business opportunities to the private sector, and lead to sustainable societies.

Business Opportunities in Product-Life Extension

Almost any product or component can be made to last longer than it was originally intended to. However, in view of the many possible alternatives, a selection from among different options will have to be made. This selection will depend on local factors such as the availability of cheap resources, socio-economic priorities, and regulations which vary from one state or country to the next.

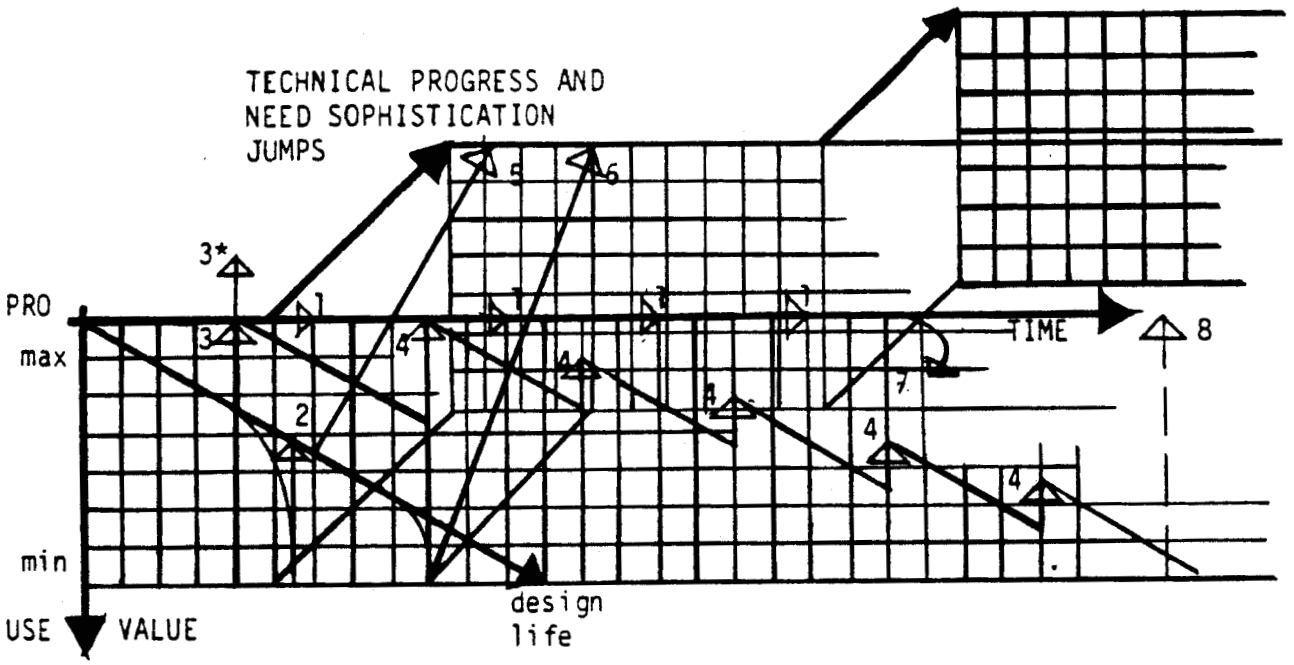
The following is, therefore, a broad description of business opportunities known to us:

- life extension activities for products and systems

- life extension activities for components

- current industrial and commercial activities

FIGURE F: LIFE EXTENSION ACTIVITIES FOR PRODUCTS AND SYSTEMS



	ACTIVITIES	PRODUCT-LIFE EXTENSION AIM	EXAMPLE
PRO	production		
1	reuse	check quality, clean	glass bottles, tools
2	repair & preventive maintenance	eliminate secondary damage	worn components, dents
3	reconditioning	put back in prime condition	overhauls of machines, dampproofing of walls
3*	overgrading	recondition a product to a quality superior to the original	rail grinding
4	cascading or periodic reconditioning	maintain original performance long-term	railway engine from express to goods train to shunting
5	technological upgrading	adapt product to newest technology	turbocharger for engines, home insulation
6	reconversion	adapt product to new user/market need	VLCC tanker to life stock carrier, "jumboizing"
7	rebuilding	extensive repairs	engine that blew up
8	away-grading	transfer used goods to environment of corresponding sophistication	high-quality instruments, tools to LDCs
9	restoration	recreate original state	antique artworks, machinery

TABLE 2: LIFE EXTENSION ACTIVITIES FOR COMPONENTS

ACTIVITIES	EXAMPLES of product-life extension
reconstituting	retread tires, add material to worn surfaces
rebuilding	bond new edges to turbine airfoils, heal defects in castings
upbuilding	preventive reconstituting, metal powder additives in engine oil to reduce wear

ACTIVITIES	EXAMPLES of product-life extension
upgrading	plastic resin injections into wood or concrete components to improve original performance (strength, impermeability)
reconditioning	milling of brake-disks or drums to eliminate uneven wear
in-situ	renewal of road surfaces by milling the top layer and mixing the resulting aggregate with hot bitumen to provide the new top layer
recycling	
regrading	cut sandals or rope from used tires, cut tires into small cubes to be added to aggregate for road surfacing, cut decommissioned railroad ties into wood panelling
reactivate	clean charcoal used in filter systems for reuse

We might also add:

re-envelopping	building a glass dome over Athen's Acropolis to protect it against decay due to air pollution
centralized recycling	melting of steel scrap in high furnaces

Centralized recycling helps to reduce waste disposal and the depletion of raw materials but with little savings in energy and no substitution of manpower for energy.

Current Industrial and Commercial Activities in Product-Life Extension

Most private sector services and activities from R&D through manufacturing to banks and insurance companies can contribute to and profit from product-life extension activities.

Many companies are already actively reconditioning capital goods, such as railroads, buildings and engines, but seldom consumer durables such as cars, refrigerators and those other products which we all expect to purchase from time to time. For many years, a leading French car manufacturer has applied reconditioning with technological updating to his machine-tools but refuses to consider product-life extension for his products, automobiles!

This may be an indication of the non-technical barriers to be anticipated where consumption-oriented business is involved.

But to return to the extension activities themselves, a basic distinction can be made in terms of the mobility of goods. Fixed or immobile systems such as railroad tracks or sewers, with components that cannot easily be exchanged without a disruption of the everyday functions are ideal candidates for mobile reconditioning units that can perform in situ. Highly mobile goods such as ships, cars and aircraft with easily exchangeable components are ideally suited to small workshops, which can be located according to prevailing needs, conditions, and demand. Buildings and other immobile systems with exchangeable components require both on-site intervention and workshop activities.

Table 3 shows a typical range of activities needed in product-life extension that goes beyond treating the products themselves. Once systems or standardized components designed for long life are available, additional supporting products will be needed, such as active devices which protect goods against misuse (e.g., rpm governors on car engines) and self-monitoring components which protect against premature deterioration (overheating, lack of oil).

With the transition to a sustainable society based on slow-replacement and self-replenishment, a change will come in distribution structures and usage patterns especially for consumer durables. In the case of finance and insurance, serious consideration will have to be given to replacing the now all-too-accepted fast-depreciation system with a use-value concept (2), such as the "rebuilding" value which is already commonly used in insurance of capital goods in industry. Long-term floating-rate leasing contracts linked to performance-ratings rather than a specific product could still leave room for the fashion-conscious customer. Financial institutions and leasing companies, as well as owners of "fleets" (e.g., rental companies) are well placed to contribute to the transition to longer product-lives and the creation of high-quality used-goods markets with prices well below those of new products. Used-goods and components Exchanges similar to the waste exchange service offered by some European Chambers of Commerce would increase opportunities for all interested parties and facilitate away-grading, the purchase of used low-priced intermediate-technology goods in working order, or in need of reconditioning, across frontiers.

Innovation and Repairs and Reconditioning

There can be no doubt that product-life extension will foster innovation and a new approach to traditional assumptions.

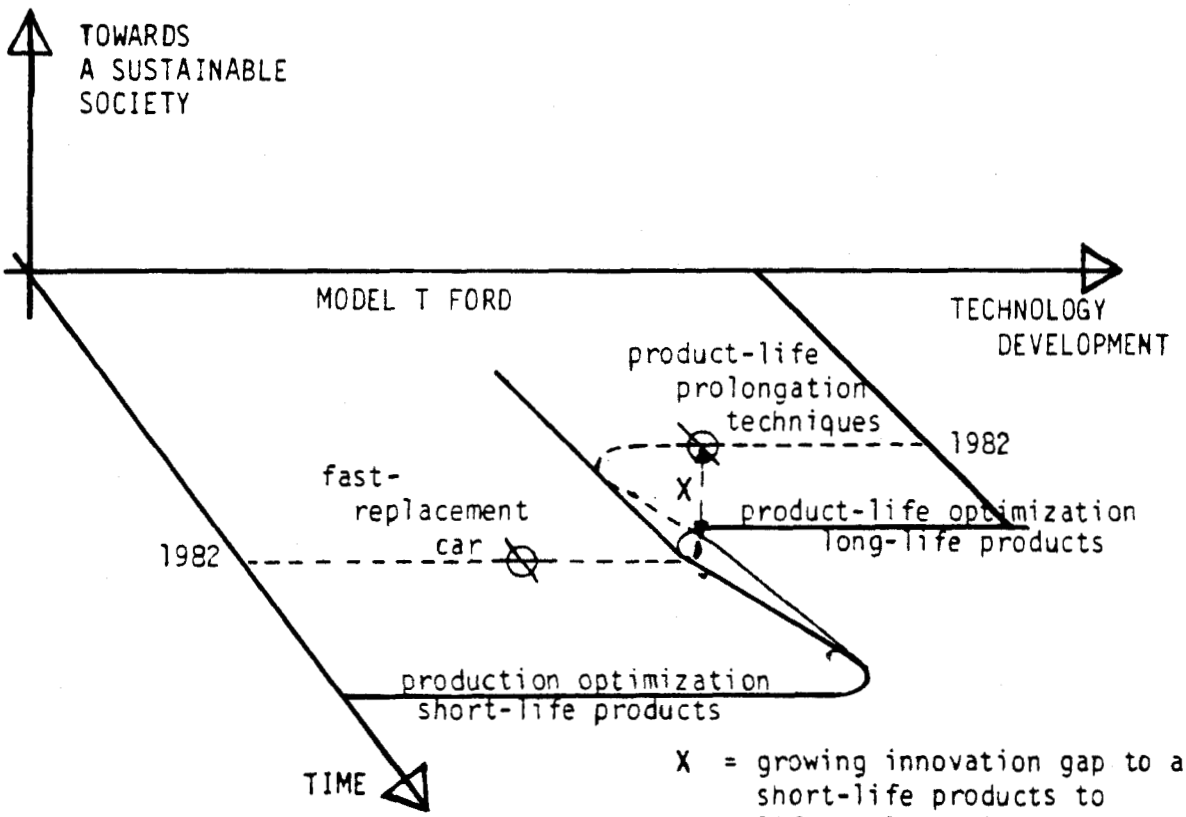
EXAMPLES OF RECONDITIONING AND RELATED ACTIVITIES

CONSUMER GOODS BUSINESS	RE-CHARGING OF BATTERIES RE-USE OF BOTTLES RECONDITIONING OF ENGINES, TYPEWRITERS, RETREADING OF TIRES				
CAPITAL GOODS BUSINESS	REFURBISHING OF BUILDINGS RENOVATION OF BUILDINGS PREVENTIVE MAINTENANCE OF CAPITAL GOODS PARTIAL RECONSTRUCTION OF SYSTEMS (RADIO STUDIOS, FIRE ENGINES) TECHNOLOGICAL UPGRADING OF SYSTEMS (MACHINE TOOLS, TELECOMMUNICATION EQUIP.) APPLICATIONAL " " " (for more autonomy, flexibility, mobility)				
PRIMARY ACTIVITIES (task execution)	COLLECTION/ INTERMEDIATE STORAGE of goods, systems. DISASSEMBLING PRODUCTS FROM SYSTEMS	DISMANTLING/ CLEANING OF PRODUCTS.	QUALITY CONTROL. EXCHANGE OF WEAR MODULES. REPAIR AND SURFACE COATING OF ENVELOPE MODULES. REPLACEMENT MODULES FOR TECHNOLOGICAL UPDATING (e.g. electronics).	REASSEMBLY OF RECONDITIONED PRODUCTS/ SYSTEMS.	SALE / DISTRIBUTION OF RECONDITIONED PRODUCTS/SYSTEMS. INTEGRATION OF PRODUCTS INTO SYSTEMS.
SECONDARY ACTIVITIES (auxiliary equipment/ services)	PRODUCTION / SUPPLY OF				
	SORTING EQUIPMENT. REPAIR SPARES.	CLEANING EQUIPMENT. DISASSEMBLY LINES. QUALITY TESTING.	NON DESTRUCTIVE TEST. ANALYTICAL CONTROL E. WEAR MODULES. HIGH TECH REPLACE-MENT MODULES.	RE-ASSEMBLY LINES. " " MANAGEMENT. " " EQUIPMENT. e.g. recoiling of electrical engines	
	MOBILE UNITS / SPECIAL MACHINERY / EQUIPMENT FOR IN-SITU ACTIONS PROCESS TECHNOLOGIES / R & D / CONSULTING EQUIPMENT RENTAL FOR DIY / TOOLS / MOBILE REPAIR UNITS FINANCING / LEASING / INSURANCE LONG-TERM				
GENERAL SERVICES	COLLECTION SERVICE	RECYCLING OF MATERIALS	BROKERING FOR 2nd HAND SPARES	TESTING EQUIPMENT	DISTRIBUTION LEASING

Researchers and investors will have to look at familiar problems in a new, abstract way, and a considerable amount of innovation will come from the comparative assessment of alternative solutions.

Figure G shows the innovation gap that will have to be bridged to make product-life extension of modern cars, and similar goods, even more attractive. The modern "world car", with a high production volume of short-life clones produced by robots in different countries, where optimization of the manufacturing process is all important, and Henry Ford's Model T, "Everyman's car", whose main components had to be repairable by any local blacksmith, are worlds apart:

FIGURE G: INNOVATION GAP CREATED BY PRODUCT-LIFE EXTENSION



X = growing innovation gap to adapt short-life products to life prolongation potential,

e.g. skin replacement panel technique

The pioneers of research into product-life extension, such as the Motor Insurance Repair Center in Thatcham, UK, have been motivated by financial savings in car repairs, not life extension. They have come up with highly innovative techniques, such as "skin replacement panels", that greatly reduce waste in component exchange and repair costs compared to traditional techniques! Whereas hitherto production components have been used in repairs, the UK car industry has now started to produce repair components.

As with components, the processes used in manufacturing may not be appropriate to reconditioning. Take the retreading of tires: The standard hot process requires high pressures (12 atu) and temperatures (160° C) and cannot be repeated. A novel process uses vacuum and lower temperatures (90° C), which allows repeated retreading and big savings: a new truck tire that costs $500 can be retreaded with the new method for $175, and will give another 65,000 miles![25]

The US aircraft industry has developed the activated diffusion bonding technique, which can bond new edges to the worn-out surfaces of turbine airfoils and eliminate the need for new spares.

The second generation of researchers will also have to take a closer look at preventive maintenance for reducing the cost of product-life extension. In order to make selective reconditioning of components such as rails, we need to measure and record defects, deformation and hidden deteriorations accurately before the rail is worn beyond repair, and thereby avoid reconditioning of unsafe components (cracks, material fatigue). The instruments required for this purpose need to be very sophisticated and yet more ingenious still for monitoring the condition of a complex system such as an aircraft turbine, or a car engine.

Existing processes in reconditioning, such as sand-blasting, can be improved to eliminate unwanted side-effects. Lockheed has developed an advanced system that uses frozen pellets of carbon dioxide -- dry ice -- to blast and clean metal surfaces. After striking the target surface, the volatile pellets quickly vaporize, and the vapor harmlessly dissipates. The process is low-cost, can clean complex machinery without the disassembly needed for sandblasting, and can be used on anything from ships to electronic assemblies.

Inventors should thus receive fresh impetus to find new solutions to clearly-defined problems fostering the transition towards sustainable societies.

Innovation and Recycling

Most production technologies can process economically only virgin, not recycled, materials.

Important discoveries are, therefore, possible in new recycling procedures that are no longer inspired by the initial production process:

- Compound goods such as car tires have been disposed of by pyrolysis, which produces heat, oil, steel scrap and ash. A new process, "debonding", uses liquid nitrogen to cool car tires to low temperatures (-80°C) before they pass through a shredder and separation plant. The result is a pure rubber powder and steel scrap. Debonding is also successfully used for material separation of cables, computers and similar complex goods.[29]

The Impact of Socio-Economic Priorities

In the long-term, the future of the private sector could be strongly influenced by current socio-economic priorities.

Some repairs and even the reconditioning of certain products can be done most cheaply by the owner/user if he has access to the required tools, machines and skills. Do-it-yourself of, for example, housing and vehicles may be the only reconditioning many people can afford!

Within the wide range of possible commercial activities from the recycling of materials to the restoration of works of art, business can emphasize any one of three factors:

- labour

- energy

- (scarce) materials

The following figure shows the interrelation of these factors. By shifting from left to right, we reduce energy consumption in life-extension actions and increase the amount of skilled labour involved, with a constant saving in materials.

FIGURE H: ENERGY - LABOUR - MATERIAL TRADE-OFFS

cumulative factors	USE OF SKILLED LABOUR / ENERGY CONSUMPTION
	(SCARCE) MATERIAL SAVINGS
actions	recycling reconditioning repair reuse restoration

Labour is not a Commodity[30]

If these three factors are expressed in monetary terms, we find substantial fluctuations in material and energy prices in recent years, while the cost of labour has hardly altered.

This situation could mislead us into thinking that the depletion of resources is no longer a problem and that emphasis should be placed on the use of cheap materials and machines rather than on expensive labour in making best overall use of resources.

However, whereas most resources such as oil and ores do not deteriorate when left another fifty years in their natural state, we cannot waste labour and deprive people (including women, handicapped and old people who want to contribute) of meaningful work for such long periods. Or we might find we can no longer train them when we need them, and be faced with an increasing "Fourth world", i.e., retired (up to 30% of total population in 2020) and younger unemployable people living at subsistence level. (Appendix 5) Manpower is the most perishable of all resources, as unused skills are easily lost or outdated by new techniques, and the mental motivation needed for work, once lost, may never be fully recovered.

Why Change to a Sustainable Society Now?

The 1980s might well prove to be the right moment for a progressive transition from a highly automated, production-oriented economy to a more labour-intensive, quality economy[31] leading to a sustainable society.

- A sustainable society should allow for social and economic progress consistent with the world's finite resource base. Today, however, social stability and private sector freedom may be threatened by an underuse of manpower.

- The product-life extension of consumer durables such as modern cars initially requires a substantial volume of skilled labour. Today, most industrial and all less-developed countries have large numbers of unskilled young, and a growing number of skilled adults, out of work, who could be retrained and employed in product-life extension activities, as engineers, mechanics, electricians, plumbers and so on.

- Furthermore, changes in environmental conditions may influence consumer attitudes towards longer product use:

  . General speed limits of 55 mph in the US, and 100 to 130 km/h in Europe have taken some of the "sport" out of cars.

  . Some observers suspect that two oil-price shocks have permanently changed the behavior of car buyers. Indeed, the sharp rise in the age of cars on US roads from 5.7 years in 1971 to an average of 6.9 years today and the rising share of smaller cars (now 37% of the total) were caused not by the recession but by a lasting shift in consumer preference for utility rather than glamour.[32]

The private sector, through its capacity for innovation and its freedom of movement, is probably the power-center best placed to start the transition towards a sustainable society.

It has also a vested interest in maintaining a balanced use of resources. Alternatives, such as a fully robotized economy where each individual receives a state pension, will lead to alienation between the individual and business, the creation of a significant hidden economy, and either to increased control of key industries by the state, or to control of the state by industry.

None of these is compatible with the ideal of individual liberty and free enterprise within a democratic framework. A transition to sustainable societies in which macro-economic aims (good husbandry and a balanced use of all resources) are achieved through coordinated growth of those contributing to the private sector (microeconomics) in a state of socio-economic and technico-ecological equilibrium would thus benefit all partners in society. Such a society, however, will need to remain adaptable to evolving human needs and social priorities and to new applications of technical discoveries.

HOW TO OVERCOME OBSTACLES AND BARRIERS TO PRODUCT-LIFE EXTENSION

We may suggest three reasons as to why product-life limitation and short-life products are still so widespread:

- technical and economic disincentives

- psychological obstacles within ourselves

- self perpetuating vicious circles

Many technical and economic disincentives can be overcome by changes in product design, taxation and improved selection of materials. But overcoming the psychological obstacles will call for changes in our perception of the individual's role in society, and for an increased understanding of the accumulative impact of individual behavior on the social environment. The only way to combat vicious circles is to destroy them at the roots and these are often embedded in the consumption patterns of society itself.

Let us first look at some of the technical and economic disincentives to product-life extension:

- In-built obstacles

At the design stage, many free options for ease of maintenance, such as functional modular distinction and out-of-sequence dismantling, are ignored. This leads to the "Pars-pro-toto" syndrome, where sealed-unit products such as hairdryers have to be destroyed for a minor component change. This can be overcome by standardization and componentized design as with Motorola and JI Case products. When this is done to a used product, we have overgrading (added value).

- Economic confiscation

Replacement-part prices of mass produced goods are prohibitive compared to the price of the overall product, and secondhand spares can be difficult to obtain. A car with a sticker price of $6,000 may be worth over $26,000 if the prices of its component parts are totted up separately.[34] This, combined with fast depreciation, means that, when an old car is involved in an accident, the insurance company can seize the vehicle against payment of a fractional sum (residual value) which is often far below the repair costs, and which has no relation to the use-value of the car. The result is a criminal black market for spares

supplied by wasteful thieves, the most valuable parts, engines and transmission units, being frequently dumped in the nearest lake, because they are numbered, and hence traceable![35]

Again, standardization and plug-in-compatible components can greatly reduce the number of products to be stocked! "During the paper shortages of 1973/74, a paper products company cut the number of its products from 2,000 to 340 with no loss of sales."[36]

- Profit and overhead structures

Profit and overhead structures in many companies are designed to promote sales of new products rather than product-life extension. A US car dealer, for example, gets a mark-up of 22% on a new car sale (36% to the assembly plant, 42% to Corporate headquarters). It would be difficult for him to get the same "return-on-effort" for repairs or reconditioning![37]

- Taxation on depreciation

Reduced depreciation periods are a popular method of increasing consumption, and result in a use-life far below the design-life! Since depreciation is a state subsidy to business, prolonged use of goods becomes an economic penalty for any profit-oriented company. Bottom line pressures will, therefore, push consumption. "The main thing is to break forever the connection between the time you use equipment and the time you write it off," says James Lyon of the Capital Cost Recovery Act.[38]

But should not a company's strategy be social in design? To provide a service to a group of clients, create jobs, help with the solution of social problems? These do not exclude profits or competitiveness!

- Choice of raw materials

We frequently know little of the long-term behavior of new materials, especially when used in new ways. Materials selection is often influenced by commodity prices or ease of transformation in manufacturing. Basic research into subjects such as relative failure modes of wear versus fatigue for rails will in many cases make it possible to optimize the application of product-life extension. (10)

These disincentives can be discussed and researched at a scientific level. Converting them into factors for fostering the transition to sustainable societies could well be a political or management decision in the short-term.

Psychological Obstacles Within Ourselves

The basic problem here is the "new is bigger-better-faster" syndrome. Whereas an old New England maxim said: use it up
wear it out
make it do
or do without,
many people today believe they can always buy a new one, so why take care of what we already possess? Caring seems to be limited to goods with an artistic or emotional value.

Economic progress may have turned many away from the ideas of such as Erich Fromm[40] or Abraham Mazlow[41]: we do not want to be, but to have more, and we look for personal satisfaction and self-fulfillment in our spare time because work does not provide them.

But let us take a closer look at some of these obstacles:

- Used or repaired goods are no longer a sign of good husbandry, but of poverty and even second-class status: "I won't have you mending stockings in this house! Now throw them out!" says Willy in Death of a Salesman.[42] No distinction is made between "old" and "properly maintained" products. Many professionals react in the same way. "It is worrying that, of the new work being commissioned, over a third is for rehabilitation of existing buildings. Rehab may be popular with the public (in the UK), but most architects regard it as frustrating."[43]

- Product-life extension activities require skilled manual work. But manual work and shopfloor have become dirty words, and there is a stigma on the young person who "has to take a manual job". Even in times of high unemployment engineers are hard to find.

  "The most highly industrialized nation on earth is in danger of becoming a nation of industrial illiterates who do not know how to stop a running toilet, or identify anything on a car more complicated than the gas-tank cap," observed Machinists' Union President W.W. Winpisinger.[45]

  The satisfaction of skilled work has become a non-subject. Yet repair and reconditioning depend on trained, skilled labour and the private sector is best qualified to train and motivate it. We need to be reminded of the dignity and importance of skilled blue-collar work![46]

- Marketing has become a tool for creating needs which are substitutes for, not additions to, wealth; fashion has long reached consumer durables. Wealth is expressed in consumption!

How can we convey the message of "old is resourceful" to people? It will need a great deal of patience and education to demonetarize beauty and distinction, and to persuade people that a sustainable nation that exercises consumption restraints is not a poor nation. Playful self-help training for the young could create "industrial boy-scouts", and fashion could be redefined in terms of components. This would mean keeping your class symbols technologically up to date, installing turbo-blowers, May fireball cylinder heads and electronic ignition systems on your used car, rather than buying a new car equipped with one of these devices!

The restoration of old industrial equipment, technical museums with old machinery in working order, and the teaching of practical industrial archeology are excellent ways of reestablishing a relationship between young people and the anonymous technology that surrounds them. "Vintage-goods Clubs" do not have to be restricted to expensive makes of cars.

Vicious Circles that Limit Product Life

Some of the biggest threats to long-life products and product-life extension are to be found in our basic assumptions about progress in a consumer society.

Centralized mass production and universalized use-patterns have led to a generalized pollution of air and water, which, combined with growing sophistication in material applications, has led to ever-shorter product lives, and thus to a speeding up of fast replacement:

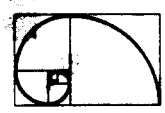
- impurities in recycled material accumulate through periodic recycling
- economics of mass-production demand light-weight construction, i.e., thin steel sheets and micro-coatings
- vagabond currents in electric systems cause corrosion of steel structures
- all-year traffic security requires deicing of roads and runways, for vehicles and aircraft, using potentially corrosive agents
- the economics of production demand minimal anti-pollution measures thus increasing generalized air and water pollution that reduces the "eternal" product life of galvanized or stainless steel components and produces acid rain that attacks any material.

In places where these factors coincide, the design life of products can be drastically curtailed.

Few today would contest the assertion that concern about return-on-investment must be married up with commitment to the community at large. Product-life extension, we hope we have shown, does bring this long-desired "ménage" within the reach of the Private Sector. It may prove a valuable object-lesson for the future.

An Inquiry Into the Nature of Sustainable Societies: The Role of the Private Sector

Edited by
Susan Grinton Orr



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