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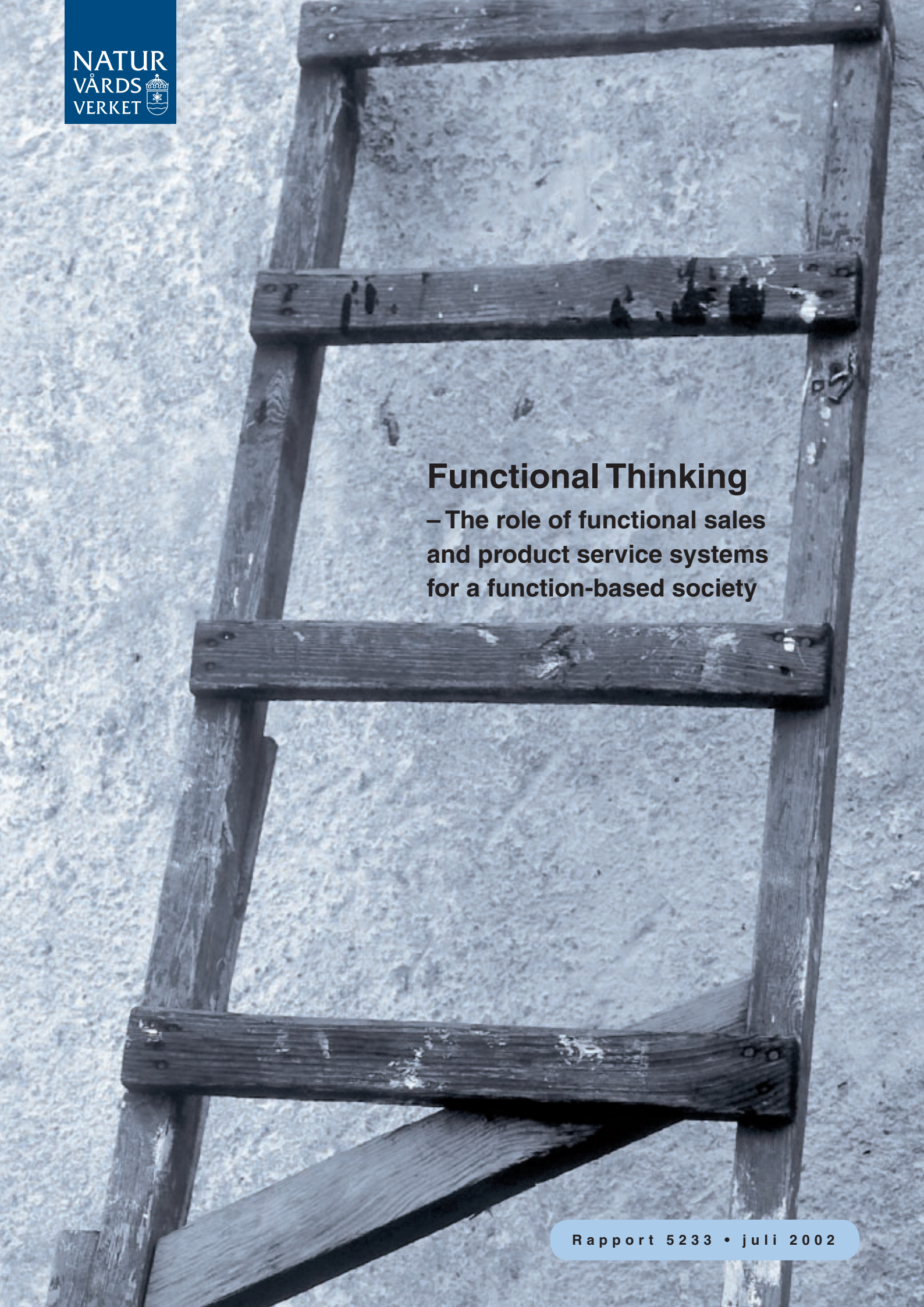

Functional Thinking

– The role of functional sales and product service systems for a function-based society

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Functional Thinking

- The role of functional sales and product service systems for a function-based society

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Preface

In order to develop products and services with lower environmental impact along the entire life cycle, an integrated system approach is needed. Integrated Product Policy (IPP) is based on such integrated system thinking. In 2001, the Swedish Environmental Protection Agency received in 2001 an assignment from the Government to analyse how an environmentally oriented product policy can be developed. This study was commissioned by the Swedish Environmental Protection Agency and conducted as a part of a research initiative into the contribution of functional sales and product service systems (PSS) to the development of an Integrated Product Policy.

In order to develop a function-based society, there was a need to investigate the contribution of functional sales and product service systems to functional thinking and the role of IPP in stimulating the incorporation of functional thinking, in future policy developments. The report provides a vision of a society, based on functional arrangements, and advises on policies and actions to support the shift towards a more sustainable society. The report also sets out the rationale for considering functional thinking and presents arguments for incorporation of such an orientation into Swedish policies and actions. The study comprises an analysis of existing literature on the topic and was enhanced by contributions from 20 experts in the area of product service systems.

This report was made by Oksana Mont at the International Institute for Industrial Environmental Economics (IIIEE) at Lund University in Sweden. Associate Prof. Thomas Lindhqvist and Andrius Plepys, Naoko Tojo, Mårten Karlsson, Carl Dalhammar and Nicholas Jackobsson at the IIIEE have also contributed to the report. The authors are fully responsible for the content of the report, which does not necessarily reflect the position of the Swedish Environmental Protection Agency.

This report is a background study to the report "På väg mot miljöanpassade produkter" (in Swedish) ["Towards greener products"], the Swedish EPA Report No. 5225.

Stockholm, July 2002

The Swedish Environmental Protection Agency

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Executive summary

Reaching more sustainable production and consumption patterns goes beyond more efficient production processes and products, and requires solutions that could optimise life cycle environmental impacts. This study describes the concept of function-oriented society that has been envisioned as a step toward reduced environmental impacts throughout the entire life cycle. The idea of functional thinking rests on the premise that to reduce material throughput in the economy, functions should be provided, not material products sold.

The main goal of this study is to investigate the contribution of functional sales and PSS to functional thinking and to the development of a function-based society, and the role of IPP in stimulating the incorporation of functional thinking in future policy developments. This study provides the Swedish EPA with a vision of a society, based on functional arrangements, and advises on policies and actions to support the shift towards a more sustainable society. The report sets out the rationale for considering functional thinking and presents arguments for incorporation of such an orientation into Swedish policies and actions.

A vision of a function-oriented society is outlined in this study. The function-oriented society recognises the value of utilisation, with the consumer paying for utilisation of the product. Producers retain ownership of products and treat them as capital assets. They become more concerned about the durability and maintenance costs of products, and thus, product design is affected to reflect these concerns. The feasibility of shifting toward a more function-oriented society needs to be further investigated. Some shortcomings of the function-oriented society were identified, such as acceptance of functional arrangements by private consumers and lack of data about possibilities to translate successful business-to-business examples to a societal level. The study shows that functional thinking will not allow us to reach sustainability on its own. It may, however, help producers to close the loops, in order to reduce life cycle environmental impacts, or it may help to make consumers aware about impacts associated with consumption. The transition towards a society envisioned in this study will require migration from a culture based on material throughput to a closed loop function-oriented society. In order to fully utilise benefits of a function-oriented society, producers will become function providers. They will find new profit centres based on value added to customers, provide dematerialised solutions, establish long-term relations with customers and take responsibility for life cycle impacts of their offers.

This study argues that a function-oriented society will have to be built on a more integrated approach to sustainable production and consumption. Existing range of policies, instruments, and tools may be considered sufficient in order to develop a more function-oriented society. However, the scope of the strategies and instruments should be formulated so that to stimulate the most effective and efficient solutions in each specific case, and closed loop function-oriented solutions should be envisioned as possible outcomes. In this respect, IPP has a potential to become a policy that could stimulate optimisation of life cycle environmental impacts. However, its current formulation has a too narrow focus on products, does not systematically address consumption levels, and

the range of included tools do not stimulate development of alternatives. Both functional thinking and consumption patterns should be strategically discussed within IPP.

Sammanfattning

Att uppnå långsiktigt hållbara produktions- och konsumtionsmönster kommer att kräva mer än enbart en effektivisering av produktionsprocesserna och produkterna. Det som behövs är en optimering av produktens hela livscykel. Den här rapporten beskriver det funktionsorienterade samhället, som ofta har ansetts vara ett sådant steg mot en total minimering av miljöpåverkan från hela livscykeln. Centralt för de funktionsbaserade lösningarna är att de utgår från att det krävs en minskning av materialflödet i ekonomin och denna uppnås genom att marknaden erbjuder funktioner istället för att sälja materiella produkter.

Huvudsyftet med den här studien är att undersöka det bidrag som funktionsförsäljning och produkt-servicesystem kan ge till utvecklingen av ett funktionsbaserat samhälle samt den roll den integrerade produktpolitiken (IPP) kan ha för att integrera funktionstänkande i den framtida miljöpolitiken. Rapporten diskuterar hur ett funktionsbaserat samhälle är uppbyggt och vilken miljöpolitik och konkreta åtgärder Naturvårdsverket kan använda sig av för att styra samhället mot en sådan vision av ett hållbart samhälle. Detta görs genom en analys av motiven för en inriktning av miljöarbetet baserad på funktionstänkande samt en genomgång av de argument som talar för att detta skall bli en aktiv del av den svenska miljöpolitiken.

Det funktionsorienterade samhället, som det framställs i rapporten, fokuserar den nytta som uppkommer från användandet av varor, vilket leder till att konsumenten bör betala för brukandet av varan, i motsats till för varan i sig. I ett sådant scenario behåller producenten ägandet av varorna och de blir en del av producentens egna tillgångar. Som producent har man då mer anledning att ta hänsyn till varans hållbarhet och underhållskostnader, vilket betyder att nya varors utformning kommer att anpassas också till dessa parametrar.

Förutsättningarna för att skapa denna förändring mot ett mer funktionsorienterat samhälle behöver analyseras mer. En del argument som talar mot det funktionsorienterade samhället identifierades, såsom möjligheterna för att få privata konsumenter att acceptera dessa nya alternativ. Dessutom saknas erfarenheter av att överföra de existerande exemplena på framgångsrika affärsidéer, som bygger på funktionsbaserade arrangemang mellan företag, till samhället i stort.

Rapporten argumenterar att enbart funktionstänkande inte kommer att vara tillräckligt för att samhället ska nå långsiktig hållbarhet. Det kan dock bidra genom att producenterna får motiv att sluta materialflödena på ett sätt som minskar miljöpåverkan från hela livscykeln och genom att det skapas ett förbättrat konsumentmedvetande avseende sambanden mellan konsumtion och miljöpåverkan.

Övergången till det funktionsbaserade samhället kommer att kräva en förändring av samhällskulturen från ett konsumtionssamhälle baserat på ökande materialflöden till ett kretsloppsbaserat samhälle. För att utnyttja affärsmöjligheterna i det funktionsorienterade samhället kommer tillverkarna att alltmer betrakta sig som förmedlare av funktioner. De kommer att basera sina inkomster på den nytta användning av varorna ger och ha möjligheten att erbjuda dematerialiserade lösningar och aktivt ansvar för varans livscykel, vilket leder till långsiktiga relationer mellan kund och tillverkare.

Rapporten visar att det funktionsorienterade samhället måste bygga på ett mer integrerat synsätt avseende hållbar produktion och konsumtion. Den existerande miljöpolitiken, och dess styrmedel och verktyg, förefaller innehålla de element som behövs för att utveckla det mer funktionsorienterade samhället. Däremot behöver de enskilda strategierna och styrmedlena utformas så att de stimulerar de mest effektiva lösningarna i de enskilda fallen, där kretsloppsbaserade funktionsorienterade lösningar ses som ett möjligt resultat. Härigenom får IPP en potential att bli en miljöpolitik som leder till en optimering av miljöpåverkan i ett livscykelperspektiv. I dagsläget är åtgärderna ofta produktorienterade utan att ta hänsyn till konsumtionsnivåerna och de använda styrmedlena stimulerar inte nya former av alternativ. Lösningen ligger i en strategisk diskussion av funktions-tänkandet och konsumtionsmönstrena inom IPP-arbetet.

Abbreviation list

FS	Functional sales
GATT	General Agreement on Tariffs and Trade
OEM	Original Equipment Manufacturer
PSS	Product service systems
WTO	World Trade Organisation
ISO	International Standard Organisation
OPI	OEM Product-Services Institute
IPP	Integrated Product Policy
GDP	Gross Domestic Product
MIPS	Material Intensity Per Service unit
EEE	Electrical and Electronic Equipment
CMS	Chemical Management Services
EPR	Extended Producer Responsibility
TQM	Total Quality Management
EPD	Environmental Product Declaration
DSD	Duales System Deutschland
GNP	Gross National Product
SMEs	Small and Medium size Enterprise

1. Problematique

There is plenty of evidence that the modern industrial economy, with its main emphasis on throughput manufacturing is not sustainable. It is based on the optimisation of the production process in order to reduce unit costs. Its emphasis on ever more efficient process technologies has led to an enormous increase in labour productivity - on average a factor of 20 in 150 years (Lehner, Bierter et al. 1999). This was only possible because energy, natural resources, and other materials were very cheap in relation to the other production factors. The consequence of this is poor performance with respect to resource productivity. Studies of the US Academy of National Engineering show that in the USA, 93% of exploited resources are never transformed into final products, 80% of all products are one-way products, and 99% of the material content of goods become waste within 6 weeks (Allenby and Richards 1994).

On the other hand, many companies are improving their processes and products. For example, numbers from the USA show that the country is on its way to improving material productivity through material substitution initiatives; material weight/GDP is 30 % less than it was in 1976 (Giuntini 2001).

Despite efforts by many enterprises to improve their competitiveness and reduce their negative impacts through new approaches to environmental management, and notwithstanding, the general level of public consciousness for these issues, current production processes can hardly be called sustainable. Current trends in the modernisation of production and dissemination of environmental management practices have the potential to improve competitiveness and to reduce environmental impacts, but are unlikely to bring production, and the use of products, within the framework of sustainability. So how is it possible that we have done so poorly by doing so well? Obviously, while the production side has been addressed to some extent in environmental policies and company activities, leading to some improvements in the resource productivity, the consumption side and impacts of increasing consumption of products has been largely neglected. Several strategies are suggested to address the aforementioned problems associated with consumption of goods. One of the recent developments at the policy level to stimulate development of more environmentally apt products and to affect consumption patterns is the effort to develop an Integrated Product Policy (IPP) as a framework for existing environmental product policies that intends to utilise their potential to greatly improve environmental features of products and services throughout their life cycle (European Commission 2001). It aims at “a new growth paradigm and a higher quality of life through wealth creation and competitiveness on the basis of greener products”. It looks at how product design could be improved and how markets for green products can be stimulated. IPP consists of a mix of instruments and tools, and it tries to optimise their synergistic effect. The Green Paper on IPP provides a list of such tools (European Commission 2001), which however, do not include a very important concept – functional thinking, the role of which is discussed in this paper.

The idea of functional thinking rests on the premise that to reduce material throughput in the economy, products should not be sold to consumers, but the functions (Stahel 1994), through leasing, sharing and other functional arrangements. For example, leasing

is a large business area in the US, where approximately 226 billion USD worth of equipment was leased in the US in 1999, which means that around 80% of all US companies lease some or all of their equipment (The Association for Equipment Leasing and Finance 2002). Shifting the profit centre based on volume and number of products sold to profits based on satisfying customers with the provided function without them owning the product might help to decouple economic growth[1] from environmental impact. This is partly due to the retained ownership by the producer and the fact that closing material loops may become a matter of competitiveness under these conditions.

There are statistical data available that support the notion that economies are already shifting from a manufacturing-based economy to a service economy and that closed loop systems are becoming an integral part of contributions to GDP. In 1997, manufacturing accounted for 17% of USA GDP and 20% in the EU, for 15% of total USA employment and 26% of corporate profits. Besides, the EU market for "products sold as services" in 1998 is estimated at 758 billion Euro, or 10% of GDP. Within this segment, selling the function of products (through e.g. fleet management) accounts for 60% (equal to 6% of GDP), while remanufacturing services account for 40% (4% of GDP) (Stahel 2000). In the European remanufacturing sector, revenue today comes predominantly from the building and construction industry. In contrast, the US has a well-developed market for the remanufacturing of components, estimated at 50 billion USD per year, 50% of which are in the field of remanufacturing of components for road vehicles (Stahel 2000).

Breakthrough innovations required for reaching more sustainable production and consumption patterns go beyond more efficient production processes and products and require solutions for making both the demand and supply side more sustainable. This study describes the concept of functional thinking that has been proposed as an important component for societal development in order to facilitate the transformation to more sustainable patterns of consumption and production that constitute a sustainable society.

[1] Economic growth expressed in financial indicators does not necessarily have negative environmental impacts. It becomes environmentally problematic when it is linked to the quantity and the quality of material inputs in economic production and consumption that endangers the stability of ecosphere. Lehner et.al. call such growth "problem solving growth" and define it as a growth "which derives its dynamics from two sources, namely development of innovative solutions to social and environmental problems, and the valorization of diversified needs, and of social and cultural diversity" Lehner, F., et al. (1993). New markets, new structures and new strategies. The future of industry in Europe. Occasional Papers/European Community/Forecasting and assessment in Science and Technology.. The authors try to suggest the alternatives to modern ideas that often advance enterprise competitiveness at the expense of welfare and environmental quality and to indicate that the environmental limits to growth may be overcome with strategies of dematerialisation based on innovation.

2. Methodology

2.1 Goals of the study

The main goal of this study is to investigate the contribution of functional sales and PSS to functional thinking and to the development of a function-based society, and the role of IPP in stimulating the incorporation of functional thinking in future policy developments. The goal of this study has been divided into three sub-tasks:

- To collect existing knowledge, perceptions, and expert opinion about functional thinking in the international arena and in Sweden in order to map out projected and documented influences at the societal level.
- To analyse the results and conclusions of collected research projects and case studies in order to investigate how a function-based society can affect traditional business models and stimulate the development of competitive and innovative enterprises.
- To map out existing tools and approaches of environmental management and policy in order to preliminary evaluate which of these may potentially facilitate the shift toward function-based society.

This study should provide the Swedish EPA with a vision of a society, based on functional arrangements, and advise on policies and actions to support the shift towards a more sustainable society. The report sets out the rationale for considering functional thinking and presents arguments for incorporation of such an orientation into Swedish policies and actions.

2.2 Design of the study

In order to answer the question of “How does functional thinking and PSS contribute to a function-based society?” a literature review was conducted. Special focus was put on recent EU and national projects and the findings that could help with mapping out projected and documented influences of functional sales (FS) and product service systems (PSS) at the societal level. Particular attention was paid to implications of functional sales and PSS on infrastructure, actor networks, etc. This study is built on existing expertise at the IIIEE in this area. A survey of 17 experts in the area of functional thinking was conducted.

The second step of this study focused on investigating how a function-oriented society can stimulate development of competitive and viable enterprises. To fulfil this task analysis of results and conclusions of collected research documents and case studies was conducted. As a starting point for this part of the study, existing competence at the IIIEE and reports written by the author. Moreover, experts from PREPARE and UNEP external consultant groups were contacted and asked to provide opinions and input about a vision

of a function-oriented society. Based on their input a more comprehensive picture of drivers and barriers for enterprises to move toward a function-based society was drawn.

The preliminary mapping out of tools and approaches of environmental management and policy, which have a potential or are currently contributing to the shift towards a function-oriented society, was conducted with the use of the results from previously conducted studies at the IIIEE (Mont 2001). A deeper literature survey was conducted in order to fill identified gaps in tools, which were integrated into the scope in previous studies. Special attention was given to IPP. The evaluation of the role of these tools in promoting a function-oriented society included the results of other international studies. The result helps identify instruments that could be used in facilitating the shift and the role of IPP in incorporating functional thinking into product-related environmental policies.

2.3 Limitations

The main limitation of this study is the scope, which embraced mainly the business side of a function-based society. Therefore, in this study, the term function-based or function-oriented society will be used interchangeably with the term functional economy, due to the limited scope. The social side of the function-oriented society was mentioned in the study, but at a very superficial level. The role of private customers and the implications of the function-oriented society for them were largely left outside the scope of this study, due to the sociological and psychological nature of the issues arising when investigating the role of households in relation to functional arrangements.

2.4 Report structure

This report is divided into eight chapters.
Chapter 1 outlines critical trends and problems that characterise current global production.
Chapter 2 provides an overview of the study goals, methodology, limitations, and disposition of the study.
The concept of functional thinking is explored in Chapter 3, which also tries to give definition to a function-based society, describe a vision of a function-based society based on the survey conducted among experts from three networks in the environmental area, two of them from the product service system area. In this chapter, an answer to the question of whether the shift towards a function-based society is feasible is discussed and provided. Finally, the role of functional sales and product service systems in the development of a society based on functional arrangements is presented.
Chapter 4 provides a scenario for how a function-oriented society can stimulate the development of competitive enterprises, focusing on questions such as what is a competitive enterprise and what features it would have in a society based on functional arrangements.

Chapter 5 presents an overview of product policy principles, strategies, instruments, and tools that have or potentially can have influence on development of a society based on functional arrangements. First the logic for classifying different approaches into tiers is presented, followed by the suggested logic for developing approaches of environmental policy with the starting point from environmental impacts associated with particular activities and products.
Chapter 6 investigates the particular role and place of functional thinking in IPP and provides an analysis of IPP from a functional point of view.
Chapter 7 provides recommendations to the Swedish Environmental Protection Agency regarding possibilities of facilitating the shift towards a closed loop society based on functional arrangements and about the role of IPP in aiding the process.
Conclusions are presented in chapter 8.

3. How does functional thinking and PSS contribute to a function-based society?

The vision of a function-based society in this study is drawn on the experts' opinions, extrapolated from state-of-the-art research in this area, and is based on the existing examples of functional sales, eco-efficient services, and product service systems with projections of societal and technical changes these might lead to. Besides these examples, the vision is grounded on a number of trends in manufacturing that indirectly stimulate elaboration of functional ideas. These trends include the following examples:

- Production is becoming progressively more resource efficient.
- There are increasing numbers of examples of closed-loop production.
- Manufacturers are more and more often addressing consumers' needs for product function.
- There are also some achievements in working towards environmental and social sustainability at the company level.
- Latest strategy schools include learning organisations and multi-actor learning networks. These emphasise collaborative processes for developing visions based on systems thinking in response to finding the root of environmental problems.

The point of departure for this study is the strong belief that society based on functional thinking can only be built on the grounds of integration and system thinking, that comprise the recognition that production is closely linked to consumption, that technologies are integrated into socio-technical systems, and these in turn are based on networks of actors.

3.1 How is a function-based society defined?

A number of perceptions exist about what a function-based society is.[2] To start with, the literature review and expert survey revealed that there is no single definition of a function-based society. People working in this area in academia and at the policy level use different terms for expressing overlapping concepts. This section provides an

[2] The original intention was to define a "functional society". There was, however, a problem with the name functional society from a terminology point of view. As Philip Sutton explained, the term functional society is misleading for native English speakers, at least in Australia, because it has connotation of a society that operates well socially – few dysfunctional families. For this reason a function-based society or function-oriented society are chosen to be used in this study.

overview of existing opinions about the subject, and lists different definitions of related concepts.

Walter Stahel, Director of the Product-Life Institute, Switzerland, defines a functional economy, as an economy that "optimises the use (or function) of goods and services and thus the management of existing wealth (goods, knowledge, and nature). The economic objective of the functional economy is to create the highest possible use value for the longest possible time while consuming as few material resources and energy as possible. The functional economy is therefore more sustainable, or dematerialised, than the present economy, which is focused on production as its principal means to create wealth and material flow"(Stahel 1997).

For Philip Sutton, Director for Policy and Strategy at Green Innovations Inc., Australia, function-based society, is "a society where the sale of service dominates rather than the sale of the physical goods/materials. This idea also relates to dematerialisation".

Garsett Larosse, CEO of the Ecotopia, Belgium, defines a function-based society as "a society that is more based on the processing of enriching experiences and intelligence, and less on the processing of raw materials. It is also a society that promotes participation and enables everyone to contribute in a meaningful way."

During the PREPARE meeting in Cologne 2000 the following definition was discussed: "The service or functional economy – selling services instead of products, decoupling economic and private welfare from consumption of materials, energy and land". This definition is also shared and depicted by econcept's Director Ursula Tischner, Germany in Figure 1.

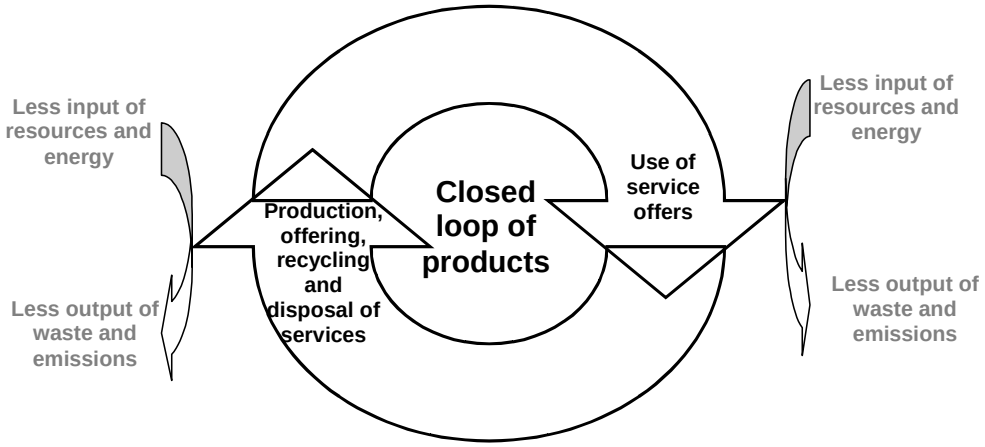

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Figure 1 The access to utility based economy (econcept 2000)

Ron Giuntini, Executive Director of the OEM Product-Services Institute (OPI), USA, associates a functional economy with a remanufacturing economy, in which leasing arrangements and multi-actor networks play a vital role.

For Friedrich Schmidt-Bleek, President of the Factor 10 Institute, France, eco-intelligent economies are market systems within political boundaries, providing a maximum of wealth to all their people by providing them with eco-intelligent goods that were produced with eco-intelligent production systems. In their turn, eco-intelligent production systems are competitively priced technical and organizational procedures,

conducted with the help of eco-intelligent goods while minimizing the consumption of natural material, energy, surface coverage, the generation of wastes, and the dispersion of toxic or eco-toxic materials. And eco-intelligent consumption is the use of eco-intelligent goods within the confines of the overall sustainable availability of natural resources.

For Chris Sherwin, EcoDesign consultant at the Philips Centre for Industrial Technology, Netherlands, the main concern with function-based society is the reference to consuming "function". He argues that perhaps in the field of ecodesign the focus was more on the technical, engineering and supply-side dimensions of an issue because they are "hard" and easier to design and control, and not enough attention was given to the "softer" demand side issues that had to do with consumption and behaviour. For him, a function-based society inevitably means demand side changes with all the complex and uncontrollable things that were mentioned above. Sherwin is however concerned with that the approach to developing a "functional" society will merely take such a rational, technology-led view of the demand side.

Indeed, the definition of functional economy is based on a very functional view on products. This concept assumes that products only provide functional outputs (Meijkamp 2000). Adding to the functionalistic view is the fact that the term "user" is often used in this context instead of "consumer", which indeed focuses on the use phase rather than on consumption *per se*. The latest standard on incorporation of environmental considerations into product design uses the term "user", along with consumer (ISO 2002). In this functional output, product use is certainly essential, but the emotional values associated with product use should not be neglected in most domains of consumption.

To Niels Peter Flint, Design Producer, Experience Design Lab, Denmark, "it sounds VERY old-fashioned to talk about the function-oriented society... We are on our way away from the purely function-oriented society and on our way into a new much more emotional society - blended with advanced technology which will become even more emotional when it really develops since it is going to satisfy our deepest dreams…".

For John Ehrenfeld "we are already a functional society and have always been". He uses a model of human behavior based on intentionality, that shows that humans act out of intention to create a present based on some vision of the future that is unsatisfied either due to some problems and barriers or due to new unexplored visions. "It is arguable that all human societies … were functional societies where the artifacts and relationships evolved to satisfy the members. The nature of these 'functional' elements has, of course, changed as we have progressed into the modern, industrial, technological age, and will continue to change in the future as different visions and problems demands the design of 'new functions'. The question is not one, then, of moving into a 'functional' or service' economy, but one seeking new means of satisfaction that are appropriate for the times. As we seem to be running out of materials or at least are stressing the global system, the types of satisfaction-producing systems we must design 'should' be less material and energy consumptive". John Ehrenfeld warns "the somewhat blind and misconstrued focus on 'service' and 'function' is a bit dangerous as it overlooks the negative size of commodifying all forms of satisfaction (serving up a MacDonald's hamburger) erodes the human competence with an addictive consequence and possibly a new form of rebound through even more consumption."

The shift in focus on function as opposed to focus on material product is undoubtedly the major intention of the functional economy. The warnings of the last two experts should be taken into consideration as they stress the need to focus on consumer satisfaction rather than function. The problem is however, how to incorporate satisfaction delivery systems into the policy agenda, as introducing functional thinking into IPP at the EU level and ISO product development standards proved to be a difficult task. Obviously this direction needs to be further explored.

3.2 How is a function-based society envisioned?

When it comes to envisioning a functional economy, experts are more united in their perceptions. This section is based on the conducted e-mail survey and literature analysis. A vision of a functional economy is created by extrapolating from existing examples and research in the area, which make projections of societal and technical changes that a function-oriented society might lead to.

3.2.1 Functional economy…

The functional economy recognises the value of utilisation, a performance driven orientation where the consumer pays for utilisation of the product. Thus, products and technologies are considered to be mere modes of providing function. In a functional economy consumers are buying mobility instead of cars, cleaning services instead of washing powders, and movies instead of videocassettes (Popov and DeSimone 1997), (Friend 1994), (Pantzar, Raijas et al. 1994), (Ayres 1998).

If needs are met through the performance provided by products then it is possible for manufacturers to retain ownership of the material locked in their products and to sell performance to the consumer. When manufacturers retain ownership of the material content of products, they become more concerned about the durability and maintenance costs of products, and about managing the asset value of materials in products. Product design and production are more adapted to handling of mixture of newly produced components and reused or recycled modules and materials. Goods are developed to be durable, consume as little as possible resources and energy during the use phase, and designed to be suitable for remanufacturing, which includes ease of dismantling, renovation, and upgrading or at least to be used as a raw material in a new production. Considerable savings in raw material and waste disposal can offset higher costs of the more time-consuming design process and compensate for the loss of economy of scale through a remanufacturing process. IT development with new methods of monitoring function and quality is a driving force that provides opportunity to develop such business concepts (TekniskFramsyn 2000). Quality and security will be of higher importance in future systems with high service content, alternative use schemes, and upgrading.

3.2.2 Products - capital assets…

In the functional economy, material products are treated as capital assets rather than as consumables. This shift in the perception might stimulate the appreciation of material products not for their price per unit, but rather for the units of function, they might deliver over their lifetime. Thus, an incentive may be created for producers to improve the efficiency of this value generating system. This also leads to that the distinction between manufacturing/production equipment and products disappears, as both become capital assets and ownership of equipment and product stays in the hands of producers / providers. So, in this case there is a supply-side shift from equipment to products. The factors governing this shift and experiences with maintaining equipment might help in understanding the incentives in shortening or lengthening the service life of goods. From an environmental point of view, this shift facilitates adding and expanding services for prolonging the product's life and minimising loss of resources. An extension of the life span and service life of products leads to a longer circulation of products in the economic process and thus to a deceleration of material throughput in the economy. A further reduction in the volume of material flows can be achieved with a more intensive and shared use of products (Lehner, Bierter et al. 1999).

In the functional economy, the highest priority for generating prosperity will be in:

- improving the productivity, performance-capacity and quality of service functions, and
- maximising the use of systems as an integral unit of products and services during their total life-span, while considering total costs "from the cradle to the next cradle" (Lehner, Bierter et al. 1999).

3.2.3 Profit centre …

In contrast to the manufacturing economy, economic success in the functional economy does not arise from mass production, but from life cycle stewardship for products. "Economic rewards come from maximising tasks needed to transfer a product from one user to the next one" (Stahel 1997). The profit centre in the functional economy is shifted from a unit of product to a unit of function, producers' focus on delivering functions. This leads to the situation in which the "traditional demarcation line between manufactured goods and services is becoming obsolete" (Schmidt-Bleek 1999). In manufacturing, the service content of goods is rising and in many cases outweighs in terms of value-added the material content.

3.2.4 Manufacturer – provider …

In a functional economy, the role of the manufacturer is shifted towards provision of services (Stahel 1997). Stahel notes that a functional economy "optimises the use (or function) of goods and services and thus the management of existing wealth (goods, knowledge, and nature). Possibility to upgrade and renovate products leads to a situation in which customers rarely buy new products. Companies develop long-lived products because they are utilised throughout their entire technical life. An obvious consequence is

that production of products is reduced considerably, while maintenance and care for products is increasing. In the same way, remanufacturing and reuse of products and materials for secondary use is growing (TekniskFramsyn 2000). Thus, producers become function providers and their core businesses include besides product design, development of supporting services, actors' networks, etc.

In a function-oriented economy, functional arrangements offer the possibility to develop new products and technologies and at the same time, also result in changed consumer involvement. This ultimately leads to changed behaviour due to feedback information and education. The function-oriented society can only be built on profound transformations, which lead to new ways of satisfying human needs and generating market opportunities. In the functional economy, individual customers' utility will be the primary benchmark for the design of offers - whether this is a "service" or a "manufactured good" in the traditional sense. Moreover, most offers will represent a complex combination of "manufactured goods" and "services". Providers of such offers, for example, will make available to their customers not only products, but also accompanying services, such as training, operation, maintenance, recycling, financing, development, and disposal. They will increasingly offer services by renting and leasing their products to customers. With such developments, customers will be more and more involved in design and customisation of offers and in that sense, become integrated into the company's network. They will play a role of co-producers of value, as they extract the product function in the use phase and considerably shape the environmental profile of the entire system. By establishing long-term relations with customers, PSS providers secure the market share. The direct feedback from customers to producers ensures continuous improvement of the product-service system.

3.2.5 Closed loop …

The combination of changed consumer behaviour and products that are more eco-efficient has the potential to close loops of materials and components (reverse logistics, recycling) and/or to optimise and intensify the use and re-use of products (maintenance, repair, renting, sharing). Due to the important role the functional arrangements can play, facilitating new arrangements, which create new forms of added value and reduce environmental impact, a functional economy may be a means to de-link economic growth and environmental degradation.

3.2.6 Networks of actors …

As was mentioned above, the integration of customers into customised solutions, closed loops of materials, maintenance of products at the customers' sites and schemes of reverse logistics will require that new, "beyond the sector" networks of actors will need to be established.

3.2.7 Decentralised markets …

Besides, there will be the rise of entirely new decentralised markets for used goods, components, and valuable materials – an entire second-hand market that is now left outside of producers' interests and reach. While, closed loop economies most probably will lead towards losses of jobs in the area of direct manufacturing, new jobs opportunities will open up. This will also reduce the transportation level, as refurbishing, repairs, and renovation will be done close to utilisation. The new system will require qualified and skilled workers, who would be able to process and manufacture small quantities of discarded products and materials at the local level more quickly and more flexibly.

3.2.8 Environmental side of functional economy …

Positive environmental effects are created in a functional economy because of shared use of products, remanufacturing processes (estimations of environmental potential were presented in section 1) and slower product cycles, which ultimately lead to less products being produced from virgin raw materials, and with shorter transportation distances. For example, a study of car sharing schemes reported a 44% reduction in the number of cars leading to a reduced need for parking space (Meijkamp 2000). Besides, it was shown that members of these schemes use cars 33% less than the use by an average household. Another study on ski rentals shows that equipment rental consumes approximately half the resources than when it is privately owned (Hirschl, Konrad et al. 2001). IT services based on thin client technology prolong equipment lifetime by 3 years (Mont 2001). Paul Hawken estimates that replacing only worn out carpet modules produced by Interface and provided through the Evergreen programme reduces consumption of virgin materials by factor 5 (Hawken, Lovins et al. 1999).

Still the environmental expectations from a function-oriented society may also be reversed, leading to unwanted rebound effects and more environmental impact, therefore, the view that the functional economy is inherently clean is incorrect. It could be better characterised as a value-added layer resting upon a material-intensive industrial economy. The question that should be posed is how to halt expansion of this material basis and yet continuously satisfy human needs and provide improved quality of life for people.

3.2.9 Political basis and economics …

If the rising of disposal, material and energy costs will be witnessed, it will not only accelerate the process of the dematerialisation of products and processes, it will also lead towards higher transportation costs, making long-term shipments of new and discarded products a less feasible option. Consequently, more and more products and materials will circulate, and be refurbished and re-used regionally (Bierter 1998), (Bierter and Brödner 1998). Rationalization of remanufacturing schemes may help reduce the need for packaging and transport necessary between two service periods. Some authors, e.g. (Stahel 1994), predict that centralised manufacturing industry could be replaced by decentralised remanufacturing activities. This will create jobs at the local scale, because

refurbishments and remanufacturing[3] involve processes that are less automated than processes of primary production and therefore more labour force is needed. The labour costs constitute of course a considerable part of company costs especially in developed countries, but it can be compensated by reuse of components from remanufacturing processes. For example, at Xerox the labour costs of remanufacturing are approximately double the labour costs of primary production, but remanufacturing reduces the amount and cost of materials used resulting in estimated savings of $200 million in 1999 through product remanufacturing. Besides, remanufacturing diverted approximately 24 million kilograms of waste from landfills (Xerox Corporation 2001).

Fiscal reform would greatly support this by breaking down ecologically damaging subsidies, by making the consumption of energy, natural resources, and other materials more expensive and by reducing the tax burdens on labour through cutting income taxes. The market thus will become more service oriented, energy, and material intensive; productions based on virgin materials become more expensive and less price competitive, and labour-intensive repairs and re-manufacturing become cheaper.

A shift from a manufacturing industry to a functional economy can greatly increase the shareholder value of a corporation (Stahel 2000). This is based on the fact that investors at the stock market systematically rate companies selling services higher than they do those selling products. This is due to the considerably higher rates of return on equity in services, compared to production, in the modern economy.

3.2.10 Equity …

The shift towards functional, utilization-oriented service economy means that new possibilities for part-time work will open up, including extended opportunities for older and physically-challenged people to work from home or nearby, who earlier were left out of the working society. Self-employment could also play a growing role as well (Lehner, Bierter et al. 1999).

3.3 Is the shift towards a function-based society feasible?

There are still open questions with regards to the feasibility of the shift towards a function-based society as well as pertaining to the environmental preference of such society. The feasibility of the shift concerns such issues as to what extent it is possible to

[3] It is important to remind the reader that fundamental principles of cleaner production (CP) strategies could be employed by companies to make sure that remanufacturing activities apply currently best available techniques and technologies for reducing environmental impact. Authorities may promote use of these CP approaches, widely used in the linear economy. Companies are already familiar with these strategies, so it is a matter of ensuring that they are also widely applied in the processes of reverse logistics. The good intention of remanufacturing activities does not take away the need to conduct them in the least environmentally harmful way

extrapolate several successful examples of functional arrangements in companies to the industry level and even further to the societal level.

There is little doubt that many companies, independent from their environmental aspirations, are positioning themselves as service providers (see examples in (Mont 2000), (Fishbein, McGarry et al. 2000), and (Zaring, Bartolomeo et al. 2001)). On the other hand, there is also evidence that business customers also often prefer services to product ownership (Alexander 1997).

The following cases show that functional sales and remanufacturing makes environmental and economic sense in some companies. For example, Collins & Aikman was the first company to develop a closed-loop recycling process for commercial carpet backing made of 100 % reclaimed carpet. It now holds a USA patent for this environmental technology. This carpet is recognized by the interior design industry as the first carpet meeting the full quality, design, and performance standards of virgin material (Collins & Aikman 2002). In the last five years, Collins & Aikman has reduced waste by 78 percent, reduced energy usage by 43 % (while manufacturing has grown), and reduced water usage by 43 % (through a unique recycling system).

Another example is of Xerox's strategy of operational leasing, which "sells" customer satisfaction, the only payment is a fee per copy made (i.e. per function the copy machine provides). No distinction is drawn between new and remanufactured equipment and parts; preventive engineering is the key to profit for companies operating in this way (Azar, Berko-Boateng et al. 1995). This system allowed the company in 1995 to avoid 93 million USD of raw material and component purchases.

Functional sales and remanufacturing have seen more successful examples in business to business (B2B), in so-called rational markets that have little complexity at the demand side, than in the business to customer (B2C) markets, recognised as less rational. There is little evidence that consumers are willing to adopt "ownerless consumption". Some studies, however, show that young urban consumers are less interested in necessarily owning rather than using products (Hirschl, Konrad et al. 2001), (Schrader 1999), (Littig, Steiner et al. 1998).

Some authors note that many of the often-presented examples of business-to-business functional sales are being developed independently from environmental concerns (Heiskanen, Halme et al. 2001). Only Electrolux, so far, claims that functional thinking was elaborated into a business idea due to environmental concerns. On the other hand, there are many traditional companies, those who do not claim providing function or service to customers, but who are involved in traditional operational leasing practices. The problem is that they do not see added value in evaluating environmental parameters of these operations and in using this gained knowledge in order to strengthen their green image through their marketing strategies. Besides a few examples of functional sales, some authors point out that there are still too few companies who develop closed loop systems based on functional sales idea (Charter and Polonsky 1999). At the same time some authors believe that if companies recognise where the economy is heading, they will progressively shift towards provision on functional offers due to such drivers as real and potential financial returns, technological development, and competitiveness (Stahel 2001).

The feasibility of the shift towards a more function-oriented society can be considered from the two different points of view. The first issue is whether the functional arrangements are beneficial from an environmental point of view to clarify the reason for shifting. The second is how this function-oriented society could be arranged, so that it was possible to translate successful business examples into private consumers realm and to the societal level.

In order to address the first point, more research is needed, which would evaluate environmental profiles of functional arrangements and compare them with traditional business models. So far, the functional arrangements have not lead to drastic improvements from a dematerialisation point of view on a large scale. However, they can be utilised in the future in the search for a more sustainable society. Other effects of functional sales, such as trade implications should also be explored in further studies. Concerns are raised based on the Articles I, III, IX of the General Agreement on Tariffs and Trade (GATT). Specifically, Articles I and III are designed to restrict policy measures that aim to differentiate between the upstream processes in the product life cycle and production methods of similar products. These rules consider it discriminatory to differentiate products based on their life cycle, because of a narrow definition of “like” products, defined only by their physical characteristics as they enter the market rather than by their life cycle. Article IX limits countries from using product-related measures that impede the quantity of products entering the country. This rule is of particular relevance to the functionality thinking and goals of reducing material flows in the economy. Under current rules, countries cannot even use market access as a gatekeeper to coerce other countries to adopt a stricter health and safety or environmental standards in upstream phases of the product life cycle.

As to the point of transferring functional arrangements into the private customer area, some experts urge to utilise knowledge of social science, psychology, and consumption theory to prevent the bigotry to rationalism and functionalism. “Consumption can be both rational and irrational, products can be “tools and toys”, services can also be status symbols, people can “make meaning” from a cabbage as much as from a Ferrari” (Sherwin 2002). There is a clear need to combine expertise in such areas of science as environmental sciences, sociology, economics and psychology.

The prospects of utilising remanufacturing potential at the company level are somewhat more optimistic: change will not be easy, but it can be achieved! (Giuntini 2000) “It takes some serious strategic planning, a rethinking of product design, experimentation with new organisational structures, reengineering or creation of new business processes, reconfiguration of rewards and compensation systems to align with desired business outcomes, implementation of support infrastructures, and training or hiring of qualified people. Most importantly, it takes commitment, courage, and wilfulness of the executive management team to implement and sustain the type of environment needed to support a business model in which new-condition and remanufactured products are both incorporated into one enterprise business strategic focus”.

This standpoint is supported by scenarios made for the sector level, showing that by addressing the remanufacturing issues, the USA could experience a major material productivity surge. The OEM Product-Services Institute (OPI) has estimated that “automotive original equipment manufacturers (OEMs) would deliver 10 % of their

product output, and if all other non-defence capital goods OEMs would deliver 20 % of their product output in a remanufactured condition, in lieu of delivering a new-condition product, remanufacturing activity in the USA would increase by 200%”(Giuntini 2001). However, the authors of the study show that such an initiative, despite the same or greater product utility, would show in the short-term as a decline in GDP. Reductions of new product output expenditures would be greater than the increases in remanufacturing expenditures. Therefore authors argue that government officials and economists have not yet considered the impact of how large scale remanufacturing initiatives would negatively skew the GDP, and how its impact would send the wrong signals to governmental fiscal policymakers, nor how remanufacturing initiatives would be measured to reflect their favourable impact on the environment. The OPI has estimated that the above scenario would decrease waste and energy consumption throughout the entire USA manufacturing supply chain by 5 to 10 percent (Giuntini 2001).

This scenario shows that if the shift towards a more function-based society is to occur, new indicators and accounting techniques will be needed to reflect the entire picture of the shift and facilitate the progress by continuous monitoring. Besides, in order to address limitations of social parameters of the functional thinking and to take the holistic perspective on development for the entire society, it would probably be more feasible to strive for a sustainable society with the triple-bottom line addressed, considering a functional economy as a way of trying to address problems stemming from ownership-based consumption and considering a closed loop economy as an integral part, prerequisite, and a feature of a sustainable society.

3.4 FS and PSS contribution to a function-based society

3.4.1 Functional sales

In functional sales, a very strong focus is placed on fulfilling customer needs and creating value through a function delivered to the customer. Thus, focus is shifted from the traditional goods to the function that the customer wants to achieve (Lindahl and Ölundh 2001). A typical business-to-business example is given by (Abrahamsson and Eriksson 1997). A company that produces office equipment shifts from selling goods to supplying a good office environment. The company owns products that can be used as building blocks of the office environment. However, the company can also use products of other companies in order to provide the office environment to customers. Thus, the function this company delivers is not locked into the products the company manufacturers, but is extended to products, which can satisfy the need to good working environment. As a result, a more diversified offers and customised solutions can be provided to individual customers.

There is also a detainment of the ownership by producer/provider. The structure of the relations with customers is more formal than in the traditional case of purchasing products and therefore, contracts are needed that would regulate the content of the offer.

This concept is not new; it has been employed in businesses for a long time now. The same arrangements are traditionally called operational leasing. The main drivers are business opportunity, based on new grounds for profit maximisation, and for competition, increased value creation by offering more services, and establishment of longer-term relationships with customers. Rapid technical development especially in the IT-sector is also a driver for functional sales. It is difficult for consumers to continuously keep up to date with and afford the best and latest technology. The producers of IT technologies can deliver new solutions, and the consumers can avoid large initial investments under functional arrangements.

The development of functional sales comes with the idea that operational leasing can be an interesting concept to explore also from an environmental point of view. However, as operational leasing is an established concept in companies, and environmental considerations came later, it is sometimes difficult to show the environmental profile of leasing, as these arrangements were never measured from an environmental point of view. However, there are other problems associated with functional sales. First of all, not all products are returned to the producer who leases them. Large portions of such products are sold at the end of the lease period. Secondly, some producers are reluctant to wait for the payment coming from leasing contracts because it is spread over time and the producer is the one who essentially finances the leasing arrangement. Some big companies, though, state that this is not a real problem as soon as they can with some precision predict the cash flow. There are also risks involved for producers if customers go bankrupt during the time of the leasing contract. It is usually the case that a company both sells and provides functional sales of the same products. This might lead to problems at the design stage where durability requirements from functional sales may contradict requirements in the case products are sold.

Despite the abovementioned problematic areas with functional sales, these arrangements can greatly contribute to the functional economy. It is product ownership at end of life that impacts producer behaviour, and functional sales can be an important means of increasing the probability of ownership detainment by the producer. Functional sales may also increase the probability that a product will be used a second time and that it will be serviced or upgraded, thus its life will be prolonged. In addition, functional sales contribute to the longer relationships between producer and customer, which can be interesting for both sides. Detaining ownership can help close material loops and predict flow of end-of-life products. Functional sales can give producers greater control over the second-hand market, which becomes a source of profit and can also impact the volume of sales of new products and their price. For customers, functional sales open up possibility to upgrade some of the products, thus reducing their expenses for constantly buying new products and taking responsibility for managing end-of-life products from them.

3.4.2 Product Service Systems

The goal of the PSS concept is to provide a system of products and services that would be able to fulfil customer needs as efficiently as possible from both an economic and environmental point of view. In order to shift the focus from a particular product or service, the function comes into focus, and thus a function provider may generate profit

not from selling as many material products as possible, but from providing a function of the product or service. Any product or service can be equally important for the function fulfilment" (Goedkoop, van Halen et al. 1999). Usually it is a combination of both. But besides these two elements, there are others. Mont defines a product-service system as a system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs and have a lower environmental impact than traditional business models (Mont 2001).

In order to make the system function successfully, both economically and environmentally, a concerted effort from companies and society is required. This part of the system is referred to in the definition as the infrastructure and networks. The infrastructure represents existing structures and systems within society, such as, (recycling) technologies, waste collection points and incineration plants, the existence and suitability of which should be considered when a product and services are developed. In order to make use of these infrastructures or find new alternatives for efficiently utilising products, their components or materials, networks or alliances of companies need to be created in order to support products on the market and to ensure that they are effectively reused, refurbished and remanufactured or safely disposed of.

The PSS concept specifically highlights the necessity to develop feedback loops and product use alternatives, and provide information to customers about them and their economic and environmental profile. It is envisioned that these approaches could help confront rebound effects that appear in the consumption stage and undermine producers' effort to improve the environmental performance of their products and services. Customers are considered as partners in the common task of functional delivery.

Within the PSS concept, customers pay as long as they have a need for the function. In this case, companies have an incentive to optimise the function and to reduce associated costs of delivering the function, i.e. costs of consumables, labour, maintenance, and disposal/refurbishment. There is a need, however, to incorporate a continuous improvement element into current attempts to apply this functional thinking.

At the company level, the PSS concept tries to optimise existing resources for creating as much value to the customers as possible and to improve environmental profile of company products and activities. At a higher level, a systematic approach opens up new business opportunities through exploiting overall system innovation. New solutions and optimisation opportunities may be found when companies concentrate on their core activities and create partnerships with other businesses, delivering the function together. This strategy is named as one of the reasons for the growth of business services in recent years (Mogensen and Thumm 2000). It allows companies to reduce costs, increase quality and to specialise.

Services that are included into a PSS comprise all services of delivering the solution to the customer, i.e. transportation, marketing, sales, and existing or created remanufacturing schemes, which aim at extending product-service functional life (Mont 2001).

FS and PSS share a common element – in both schemes, ownership stays with producer for at least some part of the use phase of the product. The difference between FS and PSS is however in the fact that PSS is based on the strong belief that a sustainable society will be to a large extent a closed loop society, provided decisions about closing

loops are done based on economic rationale. There are few successful examples that support this idea from an economic feasibility point of view.

Xerox has an exemplary program for managing end-of-life equipment. The company traditionally leased copiers, got them back, and then had to pay to warehouse and ultimately, dispose of them. Economics drove the decision to develop the Asset Recycle Management program aimed at avoiding the costs of warehousing and disposal and recapturing the end-of-life value of products. Closing the material loop, through reusing, remanufacturing, and recycling copiers have been very profitable for Xerox. Besides, Xerox linked end-of-life management with product design to increase the residual value that could be recaptured. Revenues from equipment leasing account for approximately 50% of total Xerox revenues (Fishbein, McGarry et al. 2000).

IBM is another company for which leasing appears to be a driver of environmental initiatives. With a long history of leasing and getting products back, IBM has its own recycling programs, a worldwide network of recovery centres, and a well-designed program for asset recovery (Kirby 1999).

Another computer company Dell, with a strong focus on cutting costs, has also began to implement initiatives to redesign its products to enhance end-of-life value as the company is starting to get their products back through its leasing program (Fishbein, McGarry et al. 2000).

The PSS concept contributes to functional thinking in the following ways:

- It provides holistic view of the product-service system;
- It puts function at the focus of the PSS design and also recognises that function is delivered through both products and services that need to be designed simultaneously at the design stage and be adopted to each other;
- PSS is based on and supports the closed loop idea with the goal of reducing life cycle environmental impact, and recognises necessity to balance environmental goals with economic efficiency.

4. How can a function-based society stimulate development of competitive enterprises?

This question should probably rather be: what kind of companies can be competitive in the function-oriented society and what is a competitive company?

There are fundamental differences in the meaning of competitiveness in relation to companies and in relation to whole economies (Charles and Lehner 1998). Neglect of these fundamental differences leads to public policies which may support the competitiveness of companies in the short run, but do damage in the long run. Even more importantly, such policies are likely to damage employment, living standards, and social cohesion, and they frequently severely distort competition (Lehner, Bierter et al. 1999).

In a recent competitiveness report, the European Commission describes a competitiveness pyramid where the standard of living is the top concern and where productivity and employment are the goals on a level below (European Commission 1997). A competitive economy is described as an efficient economy, which creates jobs and raises the standard of living. In relation to individual firms, competitiveness can be defined as the capability of an enterprise to withstand competition and to secure profitability. Currently, many firms pursue strategies of competitiveness, which are merely based on cost factors. Cost-driven strategies are those where drastic reduction of production costs is the major means to secure and advance competitiveness. While cost-driven strategies of competitiveness are often necessary or at least reasonable for individual firms, they may create severe problems of employment and wealth for the whole economy. Data of the World Bank indicates severe structural problems of the many European economies, specifically slow structural change, delayed adjustment to global developments and deficits in innovation due largely to such strategies (World Bank 1998).

The report of the European Commission on Competitiveness of European Industry describes a successful strategy of competitiveness as one, which is based on innovation, product differentiation and productivity rather than cost reduction (European Commission 1997). In contrast, however, many European enterprises stick to the markets where they have been successful in the past and concentrate more on established core business rather than on developing new business. Introduction of functional thinking and closed loop requirements can potentially help identify new areas of innovation and suggest new ways of increasing productivity. The competitiveness of this system is greatly improved if circular thinking is introduced in the economic framework. In this condition, companies would need to develop circular business systems with a starting point from functional sales, life cycle thinking, development of a system for functional sales and life cycle thinking and for remanufacturing and reuse (TekniskFramsyn 2000). Competitive companies would produce durable products and sell their function.

For businesses, shifting towards function-oriented society can be quite a challenging task, especially if policies and legislative basis would lag behind the development in

companies. The biggest challenge will be in changing routines and finding new business opportunities and profit centres. Several reports consider the issue of how the shift towards providing functions can affect companies at the micro-level (White, Stoughton et al. 1999), (Zaring, Bartolomeo et al. 2001), and (Mont 2001). The changes required may strengthen companies, provided that internal capabilities match the challenge. One of the important changes at the micro-level will be a process of continuous organisational learning. The organisational learning would include the development of future scenarios, identification of visions, and ways of reaching them.

Competitiveness of companies in the function-oriented society will also be based on the changes in the time to market. For example, in the case of Xerox Life Cycle Design strategy, more time is needed for the conception and design phase as the entire system of remanufacturing needs to be developed, all products and components need to be designed for easy remanufacturing, and in accordance with commonality principle – functional standardisation of components across the total product range. However, as the company shows this time is regained each time the products come for the so-called “Asset Recycle” phase, by a gain of 16-22 month (Stahel 1994).

With take back legislation in place for some products (tyres, cars, EEEs), companies have to develop schemes for taking back their products and then reusing or recycling them. According to Robert T. Lund, reuse with remanufacturing is more economically beneficial for companies due to the possibility to recapture the value added to raw materials during the primary production processes by the producer (Lund 2000). Reuse and remanufacturing cleans and refurbishes entire equipment components instead of downgrading them to raw materials as in the case of recycling. A study conducted by the Massachusetts Institute of Technology found that remanufactured automobile components retain approximately 85% of the energy used in their original manufacture, saving the costs of producing new components.

Fast technological upgrading of existing products – products that are already provided/sold to consumers – might become a new area for companies to compete in, instead of selling products, developing new models, and finding consumers in highly saturated markets.

In the functional economy, it might be easier for companies to introduce innovative technologies and solutions if they are provided through leasing or renting contracts. The competitive companies will use these contracts as a strategy to commercialise innovations because they would help users get acquainted with new products and services without any initial cost for the users. In this way, customer uncertainty about offers and their promised features can be reduced.

At the macro level, competitiveness of a company in the function-based society would, to a large extent, depend on the company’s success in building partnerships along the product chains and beyond. The latter is especially important because technological convergence usually brings new types of commercial competitors (competition on car market will be among car companies, who consider cars as a mobility centre equipped with computer, or computer companies, who consider cars as a computer on wheels).

The competitiveness of companies selling functions will to a large degree depend on whether they would be able to utilise existing infrastructure or facilitate development of

new platforms that will enable their new product service systems to be designed and implemented through the active participation of the many key actors.

Successful companies will be those who would expand their involvement with the products they design and produce and extend responsibility for them to phases in the life cycle, which are usually outside the traditional buyer-seller relationship (White, Stoughton et al. 1999), such as take back, recovery, reuse, refurbishment, and remanufacturing. Information from the service provision and end-of-life stages in such companies will be easily transferred to the design stage and manufacturing, thus the entire system will become more responsive to changing market parameters and is probably, inherently more likely to stimulate innovation. There are already numerous examples of companies willing to accept even unlimited product liability, when it comes to product quality through money-back guarantee and exchange offers.

Functional thinking has implications for competitive advantage as it provides an opportunity for companies to compete on new grounds. The entire idea of competition based on selling more products is shifting towards establishing long term relationships with consumers and providing more function, comfort, satisfaction, and quality of life for a longer time.

Function providing companies will be in a better competitive position in conditions of acute disposal problems, as will they produce less waste. Such companies will obtain the greatest amount of service possible out of a product. The longer and more intensively a product will be used, the less new production and waste the same service will entail. While it is true that with sales of durable products, the turnover of companies in their role as producers will be reduced, their turnover in their role as function providers will increase (Lehner, Bierter et al. 1999).

5. Mapping out tools for shifting toward a function-based society

This section will describe and classify policy principles, strategies, instruments, and tools relevant to promotion of the functional thinking. Principles, strategies, instruments, and tools, which have been discussed in previous studies by the author, will be named and references will be made, but they will not be described here.

5.1 Classification logic

The classification of principles, strategies, instruments, and tools proposed in this study is based on the discussions about taxonomy held at the IIIEE recently. In this study, existing tools are described and classified in line with this discussion (Figure 2).

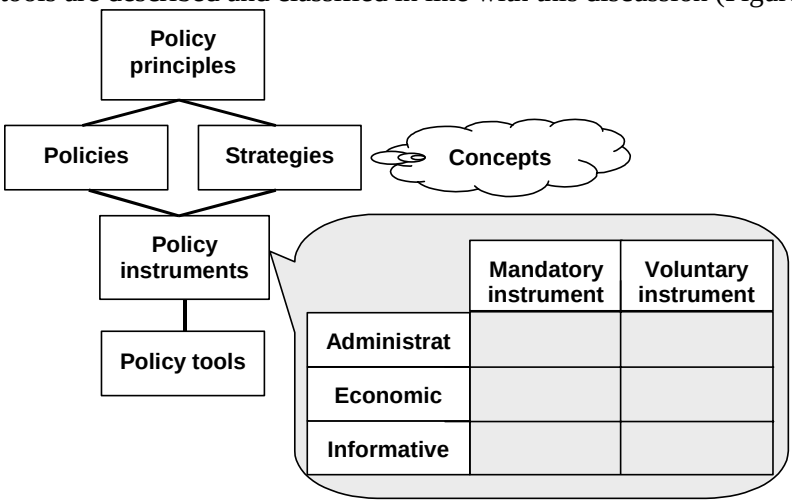

Figure 2 Categorisation of policy principles, strategies, instruments, and tools

The overall policy challenge is to establish a climate that fosters and supports functional strategies. The primary concern with policy making is the way the problem areas are identified. The areas to be governed by policy instruments were conventionally identified as technological problems; for example, as the need for new catalytic converters, rather than in terms of unmet societal needs, such as clean air. Identification of the problems and consequently search for their solutions should rather be done at the level of natural and human needs and not in terms of particular technical solutions. Therefore, it would probably be less economically efficient to develop policies and policy instruments for the level of functional sales, as this is a particular solution towards a problem of sub-optimised life-cycle impacts.

What the government should develop are policies for optimising and minimising environmental impacts associated with entire product life cycles. One possibility of doing this is to close the life cycle. This option proved to be optimal in many cases; therefore, it could be taken as a starting point. It should, of course, be noted that closing material loops is not always a justifiable option from an economic point of view. These cases are outside the current discussion. It might be reasonable to develop specific policies and strategies for somewhat higher levels, such as closed loop strategies, and not directly for functional arrangements.

The next section tries to apply a somewhat more functional approach to policy making, starting with the questions about environmental impacts concerned.

5.2 Background considerations for the choice of approaches

The starting point in the search for instruments and tools should be the question of what kind of problems do we want to solve by these tools? Thus, the question is what impacts product-service systems and functional arrangements have the potential to minimise? According to (White, Stoughton et al. 1999), there are two types of environmental impacts that can be addressed by functional arrangements – use and non-use impacts.

Use-related impacts come from inefficient products or from sub-optimal use of these products. Therefore, approaches to minimise environmental impacts should improve efficiency of the product use. This can be done through:

- product design for use phase, which can be facilitated if use related environmental costs are internalised, and these costs may be reduced by better design of product (for longer life, more rigid structure, customised solutions for multiple-use);
- optimal operation of existing product (maintenance, upgrading, use efficiency) if use-related environmental costs are internalised (service is provided on a mixed fee basis – cost of equipment and cost of consumables, such as energy, water, etc.), and consequently these costs may be reduced by more optimal operation of products, or in the case the product is a cost rather than a profit centre for the provider (e.g. volume of chemicals in CMS), more optimal operation can extend product life and reduce costs associated with the use of the product;
- increased turnover of products in use combined with progressive efficiency improvements and possibilities to upgrade or exchange products for newer models.

Non-use related impacts could be reduced via

- reductions in number or volume of product manufactured, e.g. increased durability, larger service capacity, and more efficient utilisation. In this case the product is a cost rather than a profit centre, providing incentives to create more durable products, or products of a larger service capacity, via the realisation of economies of scale, or via more efficient utilisation of products in use. For example, Electrolux produces commercial laundry equipment and in addition offers “laundering services” to large

customers, guaranteeing machine availability and providing the service capacity required by the customer. The manufacturer thus has an incentive to provide large-capacity, durable machines, which reduce maintenance costs.

- reductions in the volume of materials mobilised per unit, if the product has economic value at end-of-life, or where end-of-life costs are internalised — in either case stimulating reclamation activities.
- improved environmental performance of non-use processes, if the product has economic value at end-of-life, or where end-of-life costs are internalised — in either case stimulating reclamation activities. For example, a manufacturer and provider of desktop computing services guarantees a two-year upgrade cycle to its customers, taking back obsolete equipment and incurring responsibility for its disposal. The provider has an incentive to treat this equipment as an asset, minimising disposal costs, and maximising savings from recycling and reuse of viable components. This reduces virgin material employed in the manufacture of "new units". It also reduces disposal impacts of end-of-life units and may improve environmental performance of manufacturing.

The main conditions for reducing environmental impacts of functional arrangements are thus:

- use related environmental costs are internalised
- end-of-life costs are internalised
- product is a cost rather than a profit centre for the provider

The main prerequisite to the aforementioned conditions is that products should be capital assets rather than one-way low cost – low value items for producer/provider. Products can become capital assets if environmental costs related to use and end-of-life are internalised and if the product has economic value at the end of life. If these conditions were satisfied, then the provider or producer would be interested in increasing efficiency of products in the use phase and in trying to extend product life cycle.

From this evaluation the main directions for policies, instruments, and tools can be developed, that would

1. drive incorporation of use and end-of-life costs into product/service costs, and
2. facilitate the development of durable products.

The role of government is thus to set up a playing field for companies, and set new rules for competition, incorporating abovementioned environmental considerations into the parameters for competition. So far, very few companies are utilising these possibilities, because in the current framework it is difficult for them to find economic rationale to voluntarily internalise environmental costs of use and of end-of-life. While there are some frameworks and tools stimulating companies to internalise end-of-life costs, it is very seldom that use costs were internalised due to absence of external drivers and mechanisms for companies to do so. Therefore, there is a strong need, expressed by ever

increasing number of researchers, NGOs and other stakeholders, to internalise external environmental costs (see further discussion on this issue in section 5.5.3).

When it comes to policies, instruments, and tools that would facilitate the development of durable products, it should be noted that there are two major types of product obsolescence depending on what tools could be employed. There is an absolute obsolescence that is almost entirely determined by the wear and tear of the product and will be recognized by the user as faults in functional deployment (Dahl 1980). Manufacturers have always had a large influence on their manufactured goods resistance against wear and tear. Presently this influence is probably even greater than it has ever been, which depends on today's highly advanced quality control systems, such as TQM and ISO 9001. The crucial decisions are made in the early stages of design or when the desired quality is decided. The potential service-life of a product is just one among the many aspects of quality, but still one of the more important since this planned life-span of a product will set standards for almost all its features and physical components. The latest ISO standard 14062 addresses this issue. It maintains that a balance between the technical and useful lifetime of a product needs to be found in order to avoid environmental impacts (ISO 2002). It is clear that maintenance of products is a factor that affects absolute obsolescence. Therefore, easily available service-shops, spare parts at reasonable prices, well written service manuals, and a general ease of repair are the most important factors facilitating maintenance of products. An equally important, is that the owner of a good has an aspiration to pursue a necessary level of maintenance. Maintenance is affected by a number of influences, and both the producer and consumer exert power over it.

There is also a so-called relative obsolescence, which can be divided into obsolescence of functional value and of symbolic value depending on which criteria the owners use in their evaluation of an owned product. Obsolescence of functional value occurs if an objective criterion is used to determine the quality of the owned product. Obsolescence of symbolic value occurs if a subjective criteria is used by the users, as for example when the users thinks that the product is out of fashion or is tired of having the same product, or feels that his status has changed and so products should be changed. The ISO 14062 standard addresses this type of obsolescence as well. It ascertains that "designing a lasting aesthetic can help to improve the useful lifetime of the product. Some products are discarded before they are physically worn out or are technically superseded because their design is out of fashion or inappropriate to changed circumstances" (ISO 2002). There is obviously a grey zone between functional and symbolic obsolescence, because often decreasing symbolical value comes as a consequence of decreasing functional value (Dahl 1980).

So, what are the tools to be used to affect the symbolic value of obsolescence? Obviously tools that could slow product life cycles, providing opportunity to improve existing products through such approaches as modular design, which could help to renovate the products without greatly changing product function. This idea is illustrated by the example of Tibro Förenade Möbelfabriker AB, (Mont 2001). Other tools are reuse and schemes of reverse logistics, illustrated as a scenario case at Brio AB, described in (Jackobsson 2000). Another outcome of such slower product life cycles would be gaining

time for developing really innovative products and product service systems, which could be built with environmental considerations and with clear schemes of closing the loops.

Below a range of policies, instruments, and tools, which could facilitate aforementioned expected results will be presented and discussed.

5.3 Policy principles

5.3.1 Polluter pays principle

According to the article 174 (2) of the Amsterdam treaty "Community policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Community. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay" (1997).

Polluter pays principle can be considered as a powerful instrument to correct market failures by ensuring that the true environmental cost during the life cycle of products is integrated into the product price. By accomplishing this, it would be possible to make more environmentally apt products and services economically attractive to customers as well as to provide economic incentive to consumers to try alternative ways of satisfying their needs through functional arrangements, such as leasing, renting, sharing, pooling, etc.

5.3.2 Extended Producer Responsibility principle

Extended Producer Responsibility (EPR) is "a policy principle to promote total life cycle environmental improvements of product systems by extending the responsibilities of the manufacturer of the product to various parts of the entire life cycle of the product, and especially to the take-back, recycling and final disposal of the product (Lindhqvist 2000)."

This shift of responsibility would make manufacturers of products aware of the issues related to end-of-life management of their products, including the costs involved. Namely, it will provide manufacturers with incentives to incorporate the consideration of end-of-life management of their products into product design. The feedback loop between the downstream (waste management) and the upstream (design of products) is instrumental in improving the design of the product and product systems, so that the environmental impact of the entire lifecycle of a product is reduced (Mont 2001).

This principle is being applied to several product groups and the main elements of such programmes include a collection infrastructure for the end-of-life products; requirement of environmentally sound treatment of the end-of-life products; and provision of information to the users about the collection system such as the location of deposit stations. EPR programmes can be potentially extended to include larger number of product groups, to include informative responsibility to provide alternatives for product uses and deliver information about existence of functional arrangements to users. Thus,

EPR already provides a basis for the development of the closed loop systems and product-service systems, although functional thinking in not explicitly incorporated.

5.3.3 Closed loop principle and its application

Swedish authorities promote closed loop economies, and there was an extensive scoping exercise on developing ideas for closed loop society by the EcoCycle Commission in 1994-1998. Promotion of the presented work can be again made by several approaches, such as laws and economic frameworks. The Environmental Code of 1999 mentions in the first chapter that the Environmental Code should be used so that reuse and recycling as well as maintenance of materials, raw materials, and energy is promoted so that the life cycle loop is closed.

In April 1999 Parliament adopted 15 new national environmental quality objectives (Regeringskansliet 1999). In June 2000, a parliamentary committee, the Environmental Objectives Committee (M 1998:07), presented a comprehensive review of intermediate targets that must be achieved if the environmental quality goals are to be achieved within a generation (Dir. 1998:45). The Committee's report The Future Environment – Our Common Responsibility (SOU 2000:52) proposed intermediate goals, among them the area of "resource management and ecocycles" had the following target - The total quantity of materials and energy used by goods and services (functions) during their lifecycle will be lower in 2010 than in 2000 (Regeringskansliet 2000). Presumably, this reduction will be achieved partly through reuse of components and recycling.

5.4 Policies, strategies, and concepts

5.4.1 Integrated Product Policy

An integrated product policy is a policy which aims at, or is suitable for, continuous improvements in the environmental performance of products and services within a life cycle context (Abildgaard, Kærgaard et al. 1999). The European Commission has adopted a Green Paper on Integrated Product Policy (IPP) in order to stimulate a broader debate on "how to achieve a new growth paradigm based on greener products" (European Commission 2001). Its central objective is to improve the environmental performance of products throughout their life cycle. Based on the discussions both at national and international levels, IPP is based on the following four characteristics: life cycle thinking, involvement of various stakeholders, co-ordination and integration of existing instruments, and integration of environmental policy into other product related policies. Besides, the use of the price mechanism to take into account the external costs of products and in this way stimulate design and market for green products through, e.g. differentiated taxation is envisioned.

IPP as an integrative approach would be, ideally, a "best policy mix" to promote environmentally less burdensome products and product service systems, if the aforementioned elements are transformed into an actual IPP (Mont 2001).

The Green paper on IPP incorporated the closed loop principle. What is included in it is explicitly mentioned in the section, which gives guidelines on product design. This section lists a number of design strategies to pursue stated design goals, among the strategies are: design for durability, longevity and for extended function, along with design for reuse and recycling, comprising component recovery through closed loop re-manufacturing and secondary applications, design for simplicity, which also includes easier disassembly for maintenance or asset recovery. Thus, the closed loop principle is also recognised in IPP and the actual effect of it now depends on the practical application and implementation in real life.

When it comes to functional thinking, it is mentioned in the same section, which gives guidelines on product design and suggests to consider design for extended function with examples of multifunctionality, modularity, which is not the same concept as functional thinking. Once it is agreed that functional thinking should become a part of product policy, it would need to be incorporated into IPP to become an equal element. A more thorough discussion and suggestions on incorporation of functional thinking into IPP is presented in section 6.

5.4.2 Leasing concept

Leasing is a concept closely linked to functional sales. A recent study examines the practice of leasing products, as opposite to selling them, “as a strategy for increasing resource productivity, particularly by preventing generation of waste and moving towards closed-loop systems” (Fishbein, McGarry et al. 2000). The study shows linkages between leasing and closed-loop systems and explores possibilities of how they can affect product ownership structure, management of product life cycles. A particular attention in the study is being paid to end-of-life management, and to the prospects of closing the material loop by considering product design for a number of product groups and industry sectors.

In the report, the authors distinguish between capital and operating leases. Capital leases are financial arrangements, under which ownership of the product is transferred directly to the customer, while under operating leases ownership is usually retained by the lessor to the end of the lease term. Thus, the authors conclude that only operating leases enhance the probability that the producer will assume responsibility for managing the product at the end of life. Even in this case, the outcome further depends on what authors call “leakage in the ownership/responsibility loop”, meaning that many products, even if being initially leased, do not end up at the producers’ site. The main condition thus becomes that the product is continually leased throughout its life and never sold. Thus the research confirms the numerous studies, which show that manufacturer’s ownership and responsibility for end-of-life management create incentives to increased reuse, remanufacturing, and recycling (Kerr 1999), (Jackobsson 2000).

The results of the study also show that leasing, even for only the first use cycle, may increase the likelihood that a product will be reused and its life extended through later cycles, instead of being stored or discarded. That is, leasing generally keeps the equipment in a commercial channel in which its service life is more likely to be extended. The report further highlights the importance of design in closing materials loops, and

suggests that operating leases may encourage design for environment, but they are not sufficient to do so on their own, because the outcome greatly depends on organisational characteristics. Especially important becomes the link between product designers and managers of end-of-life products. These findings support previous studies in eco-design (EC 2001) and product-service systems (Ryan and Mont 2001).

Leasing is an old concept and has rarely been considered from the environmental point of view. Examples of eco-services show that there is some potential in these arrangements, which could be used in reaching both business and private customers. Facilitating leasing contracts at all levels (public procurement, businesses and households) could potentially reduce material throughput in the economy.

5.4.3 Dematerialisation

Dematerialisation is an important concept for more foresighted and precautionary ways to reduce the energy and resource flows, which are removed from nature. It is an integral feature of the factor 10 approaches. It includes a new consideration of “life-cycles” of products and product uses and includes the ways products are manufactured, packaged, transported, sold, used, re-used, re-manufactured, again re-used, cascaded and eventually disposed of. On a larger scale, entirely new products and services must be developed (Bierter, Stahel et al. 1996).

The principle, which guides service-oriented strategies of dematerialisation, is the MIPS concept - material intensity per service unit, where service unit refers to individual customer’s utility. The concept is sometimes criticised for not taking into consideration the quality side of material flows such as the toxicity of substances. But propagators of the MIPS methodology usually argue that it is difficult to predict the total anthropogenic impact and effects resulting from the reactions between various inputs. Despite this, the concept is broadly used and it is considered as having a potential to reduce the scale of resource consumption and economy throughput and consequently the potential environmental impacts of economic activity.

Dematerialisation targets (factor 4-10) are therefore crucial for both the implementation of new policy measures for society and company strategies to improve resource productivity, but the concept per se is insufficient to actually bring about the scale of change necessary for sustainable development. In order to be operational, it needs to be combined with other approaches, e.g. sociological, consumption theories, etc.

5.5 Policy instruments

5.5.1 Public procurement

Public procurement accounts for 12 % of EU GDP on average (OECD 1999). It is therefore important that public authorities and institutions are aware about their large role in influencing both corporate decisions and public perceptions. Public procurement is especially important as markets are sending wrong signals due to only partial internalisation of costs of resource use and environmental degradation. Public procurement is thus

an important and market-oriented instrument to environmental protection, in which public authorities act as trendsetters for other buyers in society. Public procurement can directly reduce environmental impact through reduced consumption, and it can indirectly promote environmental product innovations through increasing demand for environmentally apt products and services, as well as shifting to new approaches of function provision and saving cost of disposal.

The Green paper on IPP states that “Public authorities need to take their responsibility and be the first in creating demand for greener products. The stronger this demand, the faster and more massive will be the shift toward a more sustainable consumption” (European Commission 2001). To become more proactive, public procurement can facilitate the shift toward functional thinking through purchasing guidelines. Public authorities may, in their own policies priorities functional arrangements, leasing and choose environmentally preferable products, that are supported by collection, reuse, and recycling infrastructure. In order to realise that, appropriate knowledge base is of course needed. Currently developed public procurement manuals could include criteria for choosing alternative solutions with least environmental life cycle impact or criteria for choosing products for which assets recovery schemes exist.

5.5.2 Consumer information

Different types of environmental labelling may help purchasers and consumers to reach well-informed decisions. Eco-labelling may help in promoting closed loop concept and functional thinking is for example, eco-labelling criteria could include requirements, in response to which producers would need to show that there are collection points and technologies in place for collection, renovation, reuse and recycling of their products. Eco-labels could become a driver for companies to look for potential solutions for the end-of-life problem already at the product design stage, or at least when producers are interested in labelling their products. Eco-labelling may also stimulate comparative analyses between traditional sale-based business models and alternative – function-based business models.

EPDs have also a potential to enhance the environmental performance of products by improving business-to-business communication along the supply chain. The need to improve communication cannot be met by means of environmental labelling alone. For some products, the environmental impacts arise mainly during the use phase. It is, therefore, imperative that other ways of improving the provision of information on the correct use of products to minimise their environmental impact are explored. The consumer choice can be informed among other things through public information campaigns run by companies and industry associations. However, products from different companies differ substantially and therefore specific information should be provided about specific products.

5.5.3 Economic instruments

There are several economic tools that could be used to facilitate introduction of functional thinking at national and company level.

In contrast to resource prices, labour costs are high in most industrialised countries and they are frequently the reason why firms shed labour and replace it with resource-intensive equipment. In the EU, more than 80% of all taxes are income related (Paleocrassas 1999). To a considerable extent, the high cost of labour (not salaries) is the consequence of deliberate policies. An attractive proposal could be to shift the tax burden from labour to the environmental impact. In Denmark, an essential part of a major tax reform passed in 1993 was the redistribution of taxes from labour to natural resources and pollution. The reform provided for marginal income taxes to be lowered by about 8-10% from 1994-1998, and for the phasing in of new green taxes. In the case of Swedish tax reform, the tax shift between the labour and energy accounted for 4%. The reason for the tax reform was mainly the need to reduce high marginal tax rates on labour income (EEA 2000).

Getting resource prices right is also mentioned in the Green paper on Integrated Product Policy as a means to create economic drivers to companies to shift to developing more environmentally apt products. Taxes are named as potentially the most effective mechanisms of doing so (European Commission 2001). Opponents of these measures warn against internalisation of external costs without a careful prior evaluation of the effects on the competitiveness of industry. Moreover, concerns are raised about the application of differentiated tax rates to labelled and non-labelled products. It is stressed that such tax should be based on “extended assessment of the environmental performance of products, which to date is not possible since there is neither a clear methodology nor sufficient data available. Without clear and objective criteria that allow comparison of environmental impacts of products throughout their life cycle, there is no foundation for differentiated taxation” (UNICE 2001). It could be argued, however, that eco-labelling criteria provide sufficient, or currently best available scientifically based data, which are constantly being developed, and therefore, should constitute an adequate basis for the differentiated tax. Tax differentiation was effective in phasing out unwanted additives and promoting safer substitutes, such as for lead in petrol or in packaging. Therefore, in order to promote recycling or substitution, taxes on virgin materials could be envisioned. Tax reduction can also be used to facilitate services and repair shops in order to prolong products lives.

When environmental externalities are not included in prices, they create large distortions in the market by encouraging activities that are costly to society in the long run. Subsidies can also become a means to reduce such distortions, as mentioned by the (European Commission 2001) in the Green paper. For example, as was shown by experiences of the DSD (Duales System Deutschland), virgin material may often be cheaper than secondary material, due to costs of collection and sorting of waste material and subsidies of virgin material through cheap oil and cheap transport costs. In this case recycling needs to be subsidised or the (hidden) subsidies for virgin material will have to be abandoned or compensated by “green taxes” (Schmidt-Bleek 2000).

There are also some economic and accounting approaches that might facilitate introduction of functional thinking into business activities. For example, appropriate pricing of the end-of-life disposal may potentially compensate for the higher costs in the more time-consuming design process and for the loss of economy of scale through a rationalized remanufacturing process.

Another approach concerns accounting practices - a write-off from profits before changing taxes. This tool is usually considered in relation to capital goods, i.e. productive investments such as buildings and machinery. In this case, tax authorities need to calculate “economic depreciation” (often called service-life) of these assets because they need to specify the number of years over which the depreciation of the assets may be deducted from profits before charging taxes. The measurement of economic depreciation typically determines the service-life of manufacturing assets (or capital goods). It is dependent on company’s stock of orders, the goods productive capacity, its need of labour and service, wear of tools, energy consumption, etc. All these factors are monitored, considered, and compared to new products performing the same task, and when calculations show that it is beneficial to make a replacement, the company ultimately will do so. Capital goods are strongly tied to economic preconditions, which means that economic depreciation will be the dominant form of obsolescence.

Consumer products, in the case they would become capital assets, could contribute to write-offs, and thus could become economically stimulating for companies. Therefore, appropriate economic mechanisms and taxing rules, stimulating the perception of products as capital assets could lead to increased durability of products and prolonged product life, which would ultimately reduce environmental impact through reduced material flow through society. It is been reported that business metrics are often designed to recognise revenue growth, but not profit growth. Remanufactured products generate less revenues, but their profits, both in absolute and as a % of sales, often are greater than those generated by new-condition products (Giuntini 2001). Giuntini also notes that tax credits for product purchases and manufacturing equipment often focus only on new-condition products, therefore, promotion of tax credits for reconditioned products would also promote remanufacturing activities.

5.6 Policy tools

5.6.1 Standards

Standards and regulations play an important role of gatekeepers to prevent an influx of sub-quality products or hazardous products and substances to the market. In the circumstances of changing from linear and material-based economies towards functional economies, the same standards and regulations can become barriers. They can hinder commercialisation of innovative solutions for which standards are not yet developed, as for example, happened in the case of Siemens fax 550, a multifunctional electronic machine, for which there were no international telecom standards, meaning that it could not be sold abroad (Umweltministerium 1995). The product was refused access to the European and international market for several years and by the time the product was admitted to the market, many competitors had similar goods on offer; the first mover advantage was lost.

Another example illustrates allocation of responsibility for fulfilling the quality standard. German TÜV quality control of car exhaust gases puts the burden of maintenance liability on the car owner. The USA quality control of car exhaust gases is based on

the manufactures' obligation to recall and correct, at their expense, all vehicles of any type that is found to violate anti-pollution standards (Stahel 1994). In the latter case producers, who have possibility to influence the content and amount of exhaust gases at the design stage, are made responsible for that.

In the area of promoting voluntary standards, the latest development of the first standard that allocates attention to the functionality – ISO 14062 - is encouraging. The standard says that "anticipating and identifying the environmental aspects of a product throughout its life cycle may be complex. It is important to consider its function within the context of the system where it will be used. A product's environmental aspect must also be balanced against other factors, such as the product's intended function, performance, safety and health, cost, marketability, quality, and legal and regulatory requirements" (ISO 2002). Of course as is the case with every standard, it is open to interpretation and therefore practical implementation of standards varies greatly. One can hope that the line about importance of the function to be considered within the context of the system where it will be used will also imply incorporation of considerations about environmental features of the system and infrastructures that support the product in providing its function and closing its life cycle.

The crucial statement in the ISO 14062 standard concerns the product development phase. The standard states, "When developing products and services, there may be considerable value in thinking in terms of functionality (function, performance and useful lifetime) rather than in terms of a specific technical solution. It is therefore important to take a broad approach when searching for new options and to highlight the functionality required in order to fulfil customer or user demands and needs". It is vital in functional sales and in PSS that the starting point for the system development would start from function to go out of the boundaries of a specific technical fix. Only with such an approach really innovative solutions could be developed.

Another important feature of the standard is that it acknowledges the importance of increasing product durability and extending services associated with that in reducing environmental impacts.

The standard has also moved one step closer to functional thinking by providing examples of solutions to customers' needs not based on private ownership (See help box no.3 in the standard, where an example of photocopier leasing is provided). Nevertheless, it could be pointed out that important issue in the leasing example is whether the producer of the photocopier treats the photocopier as a capital asset, increasing its durability, developing services to do that, designing upgrading possibilities, etc. What is needed is that the environmental and economic feasibility of developing an entire photocopier system be considered, not just a separate product designed from the start, even if it would be leased afterwards.

The standard could have pointed out that the way the additional services are organised may also be environmentally damaging and that is why it is important that service design is given attention to. This point becomes even more important because services, although having been mentioned at the beginning of the standard (N1, note says that the term "product" is understood to cover goods and services), silently disappears from it. If services were included, additional impacts would be considered, not just impacts directly linked to a product life cycle, but from the product system, including evaluation of

environmental impacts from different “scenarios” of how function could be delivered to customer, e.g. impact from the product system, in which product is sold, versus the impact from the system, in which product is leased.

There are also other weak points and terminological unclarity in the ISO 14062 standard. It, for example, distinguishes between “tangible, product-oriented solutions”, implying that there are completely intangible, service-based solutions. Such terminology might be very confusing to the inexperienced reader who may think that there are indeed completely immaterial, non-tangible solutions available.

The final point refers to the section 7.3.1 of the standard on conservation of resources, recycling and energy recovery. The standard states that the “objective is to optimize the use of resources required for the product (material and energy) without having an adverse effect on its performance, its durability, etc”. Again, the optimisation should be done per unit of function (per service unit, as MIPS suggest), but definitely not per product. This is a clear contradiction with the section about functionality and importance to consider function. If our starting point is product, than designers are thinking of reducing environmental impact of this particular technical solution, without considering the possibility to fulfil the function in another less environmentally damaging manner, because they have already locked their search into the product at hand. If our evaluation starts from function, then we are not yet tied to a particular technical solution, so we have some choice of how to fulfil the function and can still project what will be the impacts associated with each solution we could find.

Concern arises, of course, as to how this standard will be applied and its guidelines implemented, but the fact that it explicitly defines functionality and its role in product development is promising.

5.6.2 Indicators

The introduction of the functional economy means that competitiveness cannot be measured by comparing the productivity in manufacturing only, but by comparing the economic efficiency of the entire societal system. The drive for higher competitiveness in the functional economy may lead to a more efficient system utilisation, through remanufacturing, selling functions instead of products, and a fast technological upgrading of existing products. Accordingly, indicators would need to be developed that would be able to show the progress in both environmental and economic terms. The importance of introducing an alternative national accounting system and performance measures was discussed in previous work (Mont 2001).

The low suitability of currently used indicators of economic activity, including GDP, in monitoring progress in terms of wealth and well-being was shown by several authors. Lehner, et.al. show that standard of living measured by GDP per capita in the EU is lower than both the USA and Japan. However, looking at real income, the picture is reversed - in the USA the real income was declining between 1978 and 1995, while in Japan and many European countries it was increasing. If other non-monetary indicators are taken into consideration (e.g. life expectancy, access to sanitation, criminal rate, etc.), European industry performs better than GDP per capita indicates (Lehner, Bierter et al. 1999).

5.6.3 Product panels

The Green Paper refers to product panels as a way to stimulate environmental improvement through coordination and integration of interests and initiation of dialogue between different stakeholder groups. It is envisioned that product panels would involve representatives from the entire product chain including suppliers, producers, retailers, consumers, and recyclers. It is expected that the entire range of companies from a product life cycle would be brought together and that environmental improvements would be found and accomplished based on the holistic perspective of improving environmental characteristic of the entire product chain.

The Green Paper, however, does not mention the importance of considering functional side of products as a starting point for establishing product panels. The Nordic Council of Ministers specifically recommends the establishment of common Nordic pilot projects in which product functionality is considered. The purpose of this functional approach is to reveal solutions with the lowest environmental impact and to integrate market issues. The proposal even calls these product groups - product functionality groups (Nordic Council of Ministers 1999).

Beside absence of the consideration of function for the choice and operation of product panel, there is another issue of concern. The stakeholder dialogue suggested in the Green Paper is undoubtedly vital in the development and implementation of IPP. What remains unclear is the role of the Commission, who reduced its leading role of the gatekeeper of societal and collective values to merely to the role of facilitator. It is even more peculiar that very little guidance is given in the Green Paper on how to develop and establish the product panels, how to balance voices of different stakeholders, how to make sure that the voice of “the environment” is represented, and how to ensure the results from these multi-stakeholder dialogues are incorporated into the IPP.

6. Functional thinking for IPP

Functional thinking is considered to be a developing area of environmental management and policy. At the company level, examples more often come from proactive companies, with decades of experience working with environmental issues. If Integrated Product Policy is considered to be a proactive policy, comprising instruments and tools that target frontrunners and stimulate innovation, it is not clear why functional thinking takes such a modest position. If IPP is devoted to cutting off the laggards to stop production of the worst performing products, then functional thinking is probably not the best option to achieve this. If IPP's role is to gradually improve the performance of the major bulk of products, then it could have at least mentioned the development of functional arrangements as an alternative way for companies to generate profit. The problem in the Green Paper on IPP is really that it does not clearly identify what organisations are targeted - laggards, status quo, frontrunners - from an environmental performance standpoint. Policy instruments and tools to promote functional thinking and to be included into IPP depend on this choice. As was concluded in section 3.3, the goal for IPP should be the question of how a sustainable society could be reach with functional arrangements as one of its features, not to how to reach a function-oriented society per se. This section looks at IPP as if it were to target frontrunners, and thus functional thinking is considered an appropriate concept to stimulate innovation potential in such companies. For laggards, more immediate targets, such as take back, could have been considered.

The Green paper on IPP says that "Products of the future shall use less resources, have lower impacts and risks to the environment and prevent waste generation already at the conception stage" (European Commission 2001). The last point – the fact that products shall prevent waste generation already at the conception stage - is at the very core of the PSS concept, which argues that environmental impacts of the entire life cycle should be considered at the design stage. What is different is that PSS concept implies that not only environmental impacts of products, but also of services and systems in the society that help close material loops should be taken into consideration at the product design stage. And with this extension of the design focus, not just products or services would be designed, but systems. These ideas should of course be harmonised with the WTO trade rules, because currently many of them are in conflict with WTO's understanding and requirements. For example, WTO trade rules restrict the choice of environmental product policy instruments governments can employ to influence the life cycle of products. The rules restrict, first of all, the ability to influence the entire life cycle of products, especially upstream, and secondly, they restrict the ability to act based on the precautionary principle in order to limit the risks associated with uncertainty and limited knowledge. Some studies show that regulatory and mandatory information instruments are the most significantly restricted by the WTO rules. Economic instruments (product taxes, public procurement) and voluntary information instruments, such as eco-labelling, are given more freedom (WTO 1994).

The Green paper also states that the IPP would "refocus product-related environmental policies". The question arises – refocus on what. So far, all the tools and instruments included have the same focus as in their separate areas and have the same narrow focus

on products. When it comes to services, it is mentioned that the way the IPP is defined so far, it can be applied to improve environmental profiles of services, but they are not the primary focus of IPP. With a statistically supported shift towards service industries that contribute the lion's part to GNP and employ up to 75% of labour force (Ayres 1998), it might not be very foresighted to exclude the largest sector from IPP. Besides, with the current trend among manufacturing companies to outsource production to other countries and to redefine their business, moving towards providing services - becoming document companies or comfort providers – there is a danger that by the time IPP is finalised, there will not be sufficient amount of manufacturers, especially in EU, to apply it to. Therefore, the suggestion of considering refocusing product-related environmental policies into functional thinking might be of value for IPP. First of all, functional thinking takes attention from a specific product – a particular technical solution, through which product function is realised. Secondly, the focus on function delivered to the customer assumes that there is a mix of products and services participating in delivering the satisfaction. However, it does not pose the question of which should be improved in environmental terms. The goal is to improve the entire system, consisting of products, services, networks, and infrastructures (throughout the entire life cycle) from an environmental point of view. The demarcation line between products and services illustrates that the Green paper clearly falls into the common trap of seeing services as environmentally innocent, admitting that "services may play an important role in partly or entirely replacing products (e.g. car sharing; voice mail instead of answering machines; dematerialisation potential of the "new economy")". It might be unreasonable to leave services outside IPP and at the same time, provide examples of schemes that clearly comprise both product and services.

The Green paper states that IPP shall try to help consumers use products in an "environmentally friendly way" (European Commission 2001). First of all, the phrase "environmentally friendly" is called in the ISO 14021 a misleading environmental claim and the standard suggests that such excessive claims should be avoided. Secondly, the Green Paper states that the challenges of making products more environmentally apt is in hands of "businesses and consumers as the main decisions on the environmental impacts of products are taken at the design table and in the shops" (p.3), assuming most probably that companies should take care of product design and consumers should improve product characteristics in shops. By what means? What kinds of tools are suggested to help consumers stimulate the design of green products? Only "information and creation of incentives for an efficient take-up and use of greener products", meaning that labels should inform consumers and stimulate purchases of labelled goods. However, the largest impact of many products that use consumables during their use phase, such as water and electricity, occurs during the use phase. What kind of information is provided to consumers about how they should use the products and by what means is it provided to them? To start with, not much information is provided on how to use products efficiently. Furthermore, if it is provided, it is usually not effective, because it is usually limited to a short message on packaging. The potential of sales personnel being involved in the provision of this information is not mentioned at all. Moreover, usually no alternative ways, to not buying the product and still get its function, are provided. It is stated that design efforts of producers will be in vain if consumers do not buy greener products.

However, will we be better off if we will buy 3-4 times more of material goods than today comforting ourselves with the fact that we are buying green products. There is an example of inconsistency of such thinking, when for instance, refrigerators labelled with Energy Star were promoted, showing that they are much more efficient per litre of refrigerator. What was not shown is that usually the new more energy efficient refrigerators are bigger by volume and thus in total they have higher electricity consumption. And last point is that there are usually no life cycle costs calculated and presented to the customers, which would clearly indicate to them how much the product use would cost them to show that sometimes it is better to invest in a more expensive, but durable product or to lease that product and have the possibility to upgrade it all together.

The Green Paper argues that the role of public authorities within the IPP approach should be to "facilitate rather than direct intervention". It is seen that IPP should set objectives and provide incentives. There is so far no mentioning and no incentive to producers to think about the functional side of their products and about alternatives to selling their products. Producers are also not urged to consider and find new and innovative ways of generating profit based on less environmentally harmful activities and offers.

It is also suggested that IPP provides opportunity for businesses to make decisions about the environment "within companies and sectors" (p. 7). In order to stimulate the design of entire systems, the sector-based perspective should be extended to a system-based perspective. As was shown in the report of (Mont 2001), the design of a product should include also development of a system, which would help maintain the product, upgrade it, collect it at the end of the product life, transport to the remanufacturing facility, reuse, refurbish, renovate, recycle and finally dispose of. In order to do this, companies and partners such as recyclers, remanufactures, collectors, municipalities – those who we would not consider to be from the same sector as original equipment manufacturer comes from. That is why it is important to stress cross-sectoral approach and cross-sectoral networks in IPP.

The Green paper is clear in stating the need to internalise external costs. Only when costs reflect true prices, can environmentally aware and proactive producers be rewarded and so can environmentally conscious consumers.

It is also claimed in the Green paper that IPP will require that research and development would provide new solutions to satisfy human needs with less environmental resources. However, the VI Multinational Framework Programme 2002-2006 of the European Community primarily focuses on technical solutions and not on ways of influencing and changing unsustainable consumption patterns (Commission of the European Communities 2001).

To summarise, the potential of a function-oriented approach is not systematically exploited in the Green Paper on IPP. It is especially disappointing with regard to ever increasing levels of consumption – the very idea of halting which lies in the centre of the functional thinking and product service system concepts. The product-oriented instruments and tools suggested in IPP aim at improving resource productivity and eco-efficiency of products, which may be reduced or totally negated by ever increasing levels of consumption, growing population, and decreasing prices (Khazzoom 1980), (Brookes 1990; Brookes 1993; Brookes 2000). Therefore, levels of material consumption should

also be included into the scope of IPP. There is a policy dimension in consumption levels and patterns, which should be strategically addressed within IPP framework.

7. Recommendations

This section provides recommendations to the Swedish Environmental Protection Agency with regard to the questions investigated in this study: definition and vision of the function-oriented society, feasibility of facilitating the shift to or developing a function-oriented society, implications of a function oriented society for companies, existence and relevance of tools for promoting the development of a function oriented society, the place and potential role of IPP in facilitating the shift towards a function oriented society, and suggestions for future research directions.

Envisioning a function-oriented society

This study showed a lack of consensus about the definition of a function-oriented society. There is however a relative agreement about the major elements of such a society – dematerialised society, in which the sale of services dominates the sale of material products. Many also explicitly state that it is a closed loop society with functional or service arrangements. It seems that the definition of the functional economy provided by Stahel in 1997 is still the most appropriate, and therefore it is suggested for further use:

Functional economy is an economy that "optimises the use (or function) of goods and services and thus the management of existing wealth (goods, knowledge, and nature). The economic objective of the functional economy is to create the highest possible use value for the longest possible time while consuming as few material resources and energy as possible. The functional economy is therefore more sustainable, or dematerialised, than the present economy, which is focused on production as its principal means to create wealth and material flow"(Stahel 1997).

The vision presented in this study is based on the opinions of a small group of mostly academic researchers and consultants, and thus in order to become accepted in society it needs to be further developed and substantiated. Specific focus should be given to the social and behavioural changes a function-oriented society may lead to or require. The development of such visions could follow the path of the Swedish Technical Foresight - a forum through which societal groups can generate new ideas and learn about the expectation of relevant actors for competitiveness within the functional framework. It should be stressed again that during this foresight forum two groups (on Production and on Material flows) independently from each other were discussing and envisioning elements of a function-oriented society, such as circular business models, functional sales, closed loop production systems, etc. Thus, there is already experience gained during the Swedish Technical Foresight in 2000, which could be utilised to facilitate further incorporation of societal and environmental actors with business managers into working groups, which could together develop visions for a function-oriented society.

Feasibility of developing a function-oriented society

A clear trend can be seen in some companies - a trend of shifting business focus and marketing strategy into more function-oriented models by meeting customer needs through service-based offers than by selling pure hardware. For example, Xerox promotes

its products as “document facility management”; Siemens heavily invests in energy saving services; and Mercedes Benz promotes vehicle management arrangements.

However, the question of the feasibility of the shift toward a function-based society is still open. There are little data available that could show how widespread this trend really is. Currently there are a handful of proactive companies moving into this direction, boasting increased returns and improved environmental profile. Some of them, such as Xerox, have being moving and operating in this area for more than a decade now, and yet it is still not clear whether more companies will follow this trend on a broader - sectoral or industry - level. Most of the known examples are in the business-to-business area and potential hinders are discussed by researchers and experienced by some companies when it comes to changes in behaviour of private consumers required to introduce this line of thinking and acting into everyday life. Therefore, in order to investigate the feasibility of introducing functional thinking at the societal level, a multi-disciplinary research initiative should be conducted that would answer all open-ended questions to date and suggest ways in which this function-oriented society could be arranged, so that successful business examples would be translated into everyday life and to the broader societal level.

A function-oriented society can be one way of addressing problems associated with increasing consumption and consumption-based economies. But it is not a panacea in itself, and it does not exclude the possibility that other ways exist of addressing the aforementioned problem. It has, as was pointed out in section 3.3, limitations as well. Therefore, in order to address limited sociological and psychological features of functional thinking and to take the holistic perspective on development for the entire society, one should strive for a sustainable society with triple-bottom line equally addressed, considering function-oriented society as a way of addressing problems stemming from ownership-based consumption and considering the closed loop economy as an integral part, and a prerequisite of a sustainable society.

Based on the conclusions above, clearly more multi-disciplinary, cross-sectoral research is needed in order to evaluate the feasibility of the shift toward a function-oriented society. With regard to the research, the following is recommended:

- To stimulate development of functional arrangements on a broader scale, a detailed analysis of examples and solutions for introducing functional thinking to the sectoral level in industries should precede development of specific policies and policy instruments facilitating the transition towards function-oriented society (see recommendations regarding specific tools below in this section).
- To address the possibility of introducing functional thinking into everyday life, specific funds should be designated for development of function-based strategies for the societal level with practical development of, for example, function-oriented communities with a number of sharing and leasing services in place (car sharing, renting or sharing of do-it-yourself and gardening tools, IT-based services, washing centres, etc.).
- To contribute to the theoretical knowledge and support it with real life data, clear priorities should be set for academia and research to incorporate and aim at developing strategies for a function-based society. For example, environmental potential and economic feasibility of function-based business models should be further evaluated,

and results should lay background for foresight forums (see previous recommendations); eco-design research should be based on principles that stimulate the shift toward a function-based society, and include design for function provision, flexibility, durability, adaptability, and closed material loops.

- To facilitate cooperation among companies, research institutes, and other actors in research and real life projects, support should be provided to projects that identify modes of co-operation, collaboration, and participation by actors and develop approaches for the sharing of new knowledge. Authorities could develop a favoured funding opportunity for research applications on functional applications that involve several actors, including industry and NGOs.

Implications for companies

This study showed a number of successful companies that have shifted toward a function-oriented business models in their operations and marketing strategies. The companies are from different sectors and of different size. They developed different schemes and services ranging from simple functional sales in business-to-business to more elaborated models, which combine functional sales with closed loop strategies, moving closer to what could be called in this case product service systems. However, great limitations still exist, namely feasibility of these experiences and successes for the market of private consumers. On the one hand, improvements should be made at the micro-level (company level), and on the other hand, investigation is needed to look at possibilities to multiply successful examples into sectoral/industry level.

The biggest contribution to facilitate the development of this area would be a clear priority given by authorities to function-oriented arrangements. The best choice would probably be to introduce these ideas based not only on expected environmental potential, but to also connect it to companies' competitiveness and innovation framework. More in-depth research is needed on these linkages. Undoubtedly, the clear position should also be supported by other measures, such as policy framework and economic instruments (see section 5.5.3 and recommendations below).

To stimulate action at the company level, authorities could assist in addressing knowledge transfer problems and organisational barriers for companies, who want to adopt competitive functional strategies. Collection of good practice examples from the area of functional thinking, which would broaden the knowledge base in manufacturing companies, both in technical, environmental, and economic terms, and could stimulate other companies to follow or try this innovation path. Authorities can invest in designing schemes to develop in-company competences in designing for function-oriented performance through organisation and support of seminars and workshops. Especially these efforts are needed for SMEs. Development of databases and resource guides on good practices can potentially improve involvement of SMEs in developing competitive functional arrangements. SMEs have good opportunities to play vital role especially in activities of reverse logistics, but also in provision of functions and services at the local level.

An important area to explore and influence would also be identifying and overcoming barriers arising from the demand for venture capital oriented toward competitive projects

based on functional ideas. Stimulating venture capitalists to invest in such projects can greatly help overcome many problems.

At the cross-company level, authorities could support co-operation between companies, especially in the area of reverse supply chains, take-back schemes, and of function-based projects. It is of utmost importance to support initiatives that bring together not only companies within one sector, but cross-sectoral partners (required to create PSSs) and stimulate identification of cross-sectoral interests and business as well as environmental opportunities.

Tools for promoting functional thinking

A short evaluation of tools conducted in this and previous studies revealed that there are a number of tools that could potentially be used to promote functional thinking. Few of existing tools are explicit about addressing or incorporating functional thinking into their scope, among them are ISO 14062 and IPP. Sections 5.6.1, and 5.4.1 and 6 of the study specifically evaluate these approaches and provide a discussion on the relevance of the provided definition of functionality to the current investigation on the function-oriented society. Chapter 6 critically looked at the IPP and the possibility of integrating more explicitly the functional thinking into it.

When it comes to other tools, which were evaluated here, they do not explicitly identify functional thinking as their primary focus or expected outcome. Instead, they can implicitly, potentially drive towards functional thinking once it is believed to be the least environmental damaging option and the one that is most economically feasible. The essence of this discussion is the fact that perhaps strategies and instruments should not necessarily be developed and specifically target functional thinking per se. What is needed is the formulation of strategies and instruments in such a way that closed loop product service systems based on functional arrangements is a possible outcome.

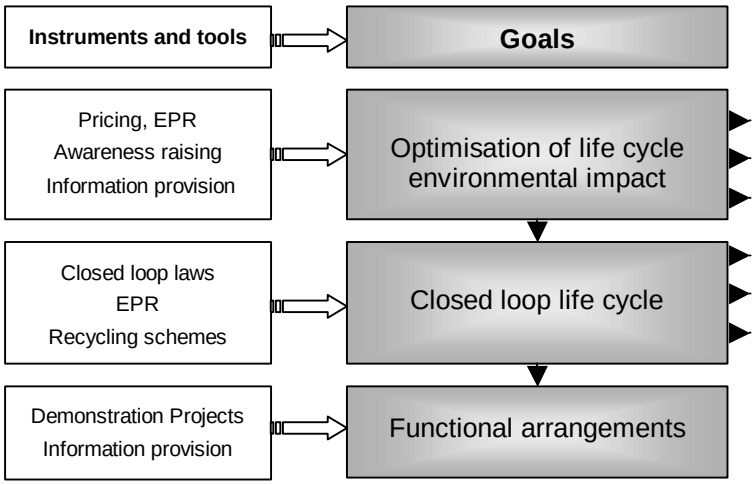

Figure 3 Example of a hierarchy of instruments and tools to facilitate the development of functional arrangements

For example, a policy or strategy could aim at the optimisation of life cycle environmental impact (*Figure 3*). This can be facilitated by different instruments and tools, such

as pricing mechanisms, awareness raising programmes and information dissemination. There are many ways of how a life cycle optimisation can be reached. This depends on the economic and environmental feasibility, which is evaluated by companies and other decision-makers and action-takers. One of the ways life cycle environmental impact can be reduced is the closed-loop strategy, for which a number of instruments exist, such as EPR principle, laws for closing the loop, and numerous recycling programmes for various product groups. None of these specifically address or promote functional thinking, but implicitly functional arrangements could be the outcome of these tools if functional arrangements provide the best solution in environmental and economic terms. Thus, what is really needed is to put the option of functional thinking on the table for action-takers to consider and to set frameworks so that functional arrangements could indeed be feasible. Once successful schemes are developed and their results are reported, demonstration projects and information provision could be facilitated to disseminate the idea.

Functional thinking for IPP

A non-prescriptive regulatory framework set by government is needed, which would create terms of references for companies to find business opportunities through the provision of function and adding value to consumers with the final goal of improving quality of life by less material ways of satisfying needs (Mont 2001). Integrated product policy is seen as an example of policy, which has a certain potential to facilitate the shift towards a functional economy via its integrated nature. However, the current stage of IPP development does not include explicitly functions into its scope. IPP should not only be targeted at innovation at the product or product group level. This would narrow the scope of possible solutions and hence, miss many innovation opportunities. To be a long-term strategy towards a sustainable society, IPP may need to expand its focus from products, and implicitly services, to functions.

Sections that currently mention function from the design point of view (section 4.3.2 of the Green Paper on IPP) should include suggestions for considering development of alternatives to ownership-based consumption. The final decision should be taken by producers based on the environmental and economic evaluations, but they should be advised to consider alternatives.

IPP should clearly communicate that environmental impacts associated not only with products, but with product systems should be reduced, otherwise there is a risk that it addresses only eco-efficiency and resource productivity improvements and leaves environmental impacts connected to consumption outside the scope.

As was shown in section 6, eco-efficiency improvements can be negated due to increasing consumption. Therefore, levels of material-based consumption should also be addressed by IPP. To reduce life cycle environmental impacts, design of product service systems should be facilitated in IPP, based on the cross-sectoral collaboration in search for business opportunities, not just “within companies and sectors”.

The Green Paper should also be clear about the types of tools that could be used to facilitate efficient use of products at the use phase by private consumers. The role of sales personnel should be strengthened; alternatives of providing function without actually owning the material product should be presented to consumers, substantiated with financial and environmental parameters.

A differentiated approach to companies can be recommended. Frontrunners should be introduced to the development of closed loop function-based schemes, while companies of relatively poor performance should be urged to improve their life cycle impacts starting with less demanding approaches.

8. Conclusions

This study provided the state-of-the-art overview in the area of functional thinking. Based on the experts' opinion, a vision of a function-oriented society is outlined. It is agreed that the function-oriented society recognises the value of utilisation, and the consumer pays for utilisation of the product. Producers retain ownership of products and therefore treat them as capital assets. They become more concerned about the durability and maintenance costs of products, and thus products are produced from a mixture of new and reused / recycled modules and materials. Products are developed to consume the lowest possible resources and energy during the use phase, and are designed to be suitable for remanufacturing. Considerable savings in raw material and waste disposal are envisioned.

The study also considered the feasibility of shifting towards a more function-oriented society. There were some shortcomings identified within the concept per se, such as consumer acceptance of consumption that is not based on ownership. Besides, there is lack of knowledge about possibilities to transfer business-to-business examples to a societal level. It is clear that functional thinking will not allow us to reach sustainability on its own. It may, however, help producers to close the loops, in order to reduce life cycle environmental impacts, or it may help to make consumers aware about impacts associated with consumption. The transition towards an economic system envisioned in this study will require migration from a culture of material throughput to a closed loop function-oriented society with utilisation as the basis for growth through added value.

In order to fully utilise benefits of a function-oriented society, companies will need to find new profit centres based on value added to customers, provided through dematerialised solutions, establish long-term relations with customers and take responsibility for life cycle impacts of their offers. Producers will become function providers and their core businesses will include design of product service systems, based on cross-sectoral actors' networks and accompanying services, such as training, operation, maintenance, recycling, financing, development, and disposal.

In this report it is argued that a function oriented society will have to be built on a more integrated arena for competitive and sustainable production and consumption systems than has hitherto been envisioned. For this, clear priorities should be set in terms of goals, which should then be translated into a hierarchy of policies, instruments, and tools. Existing range of approaches may be considered sufficient in order to develop a more function-oriented society. However, the formulation of strategies and instruments should be done in such a way as to stimulate the most effective and efficient solutions in each specific case, guided by economic and environmental parameters. In this respect, IPP has a potential to become a policy that could stimulate optimisation of life cycle environmental impacts through innovation at company and societal level. However, in its present formulation, it is hard to envision how this could be accomplished due to the narrow focus on products, lack of systematic address of consumption levels and inconsistency of tools included with the necessity to stimulate development of alternatives to products. The IPP should have a clear and consistent direction to encourage companies and individuals to invest in alternative solutions and make sure that closed loop product service systems based on functional arrangements could be a possible outcome.

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Rapport 5233

Functional Thinking

– The role of functional sales and product service systems for a function-based society

För att utveckla funktionstänkande i förhållande till den integrerade produktpolitiken och dess potential för minskad miljöbelastning behövs ökad kunskap om hur funktionstänkande och produktservicesystem (PSS) bidrar till utvecklingen av ett funktionsbaserat samhälle.

I denna rapport ges en översikt över området funktionellt tänkande och en vision för ett funktionsorienterat samhälle. Rapporten redovisar också förutsättningarna för att samhället ska bli mer funktionsorienterat och ger rekommendationer om incitament för företag och individer som möjliggör utveckling av produktservicesystem och funktionstänkande.

Denna rapport är underlagsrapport till ”Funktionsperspektiv på varor och tjänster” rapport 5230 om hur kombinationen av varor och tjänster utifrån ett funktionsperspektiv kan bidra till miljövinster och utveckling av miljöanpassade produktsystem.

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