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Value-inspired challenges for sustainability in manufacturing economy

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As the result of Ecodesign activities for 20 years, we still have pessimistic view on energy and resource shortages. Uniqueness of this paper is introduction of business view in the discussion of sustainability. This point of view is rarely the subject of scientific and engineering research. But needless to say it must be the major hidden impact on consumption. After reviewing EcoDesign activity and technical progress of electric and electronic industries, an economical view is given on a recycle system. Showing this basic resource saving activity, a clear understanding that is, saving could be eliminated by stimulated consumption, will be realized. One suggestion for challenging activity to establish sustainability is given. That is deceleration of new product demand by extending lifetime of existing products. The suggestion follows the way to recent CSR and SRI movement and also meets to keeping ecology. The activity will lead the industry to establish an ultimate sustainable society.

Keywords: EcoDesign, Value, Business, Sustainability, Ecology

1 Introduction

Industry has been facing with difficulties to find solutions for keeping resource for the future and suppressing spreading environmental destruction to human and natural creatures. This is the resultant of free and self-motivated way of business. The subject of this research is finding solutions in the free economic system. To think about human behaviour in this economic system, value-up mechanism is of great importance. We start discussion by reviewing technical progress of Electric and Electronic Industry (EEI) from the view of sustainability. EEI is considered as representative industry sector as the scale of the industry is considerably big and growing. A lot of developments are shown effective for sustainable actions. Then systematic approaches to save resource consumption are reviewed. Holistic concepts "Sustainable system" and "Ecodesign" are objectives and responding activities. Awareness for these holistic concepts has its origin on the rapid growth of industry and artificial products having protrusive network out of biogenetic order [7, 46, 47, 63, 105]. Therefore it is natural to expect solutions on product design and production method as responding activities and stimulated LCA (Lifecycle Assessment), LCE (Lifecycle Engineering) and DfE (Design for Environment) [1, 22, 91, 98, 107]. But artificial products are produced to improve human activities in a social system. All findings must be applied in economic activities. Value based discussion is necessary. Especially business behaviour of companies in industrial system must be discussed. Through these discussions in this paper, controversial issues such as the conflict between environmentally consciousness and sustainability, the conflict between economic growth and sustainability and protection of ecological environment are understood. Human behaviour is not discussed totally because it has very wide meaning such as raison d'etre and even fuzzy concepts [94]. But it must be put on discussion in future.

2 Electronic and Electric Industry (EEI)

2.1 Scale of Industry

The electronics industry represented 10% of global manufacturing added value in 2008 [17]. The production has experienced big drop in 2009 by financial crises but immediately recovered until 2011. The amount in 2013 is estimated about 20% increase from 2011 and 5% increase in 2014 [52].

2.2 Sustainability built-in industrial system

The importance of the industry sector has bilateral meaning. One is impact to the environment by consuming various resources in products the other is reducing impact by creating value without consuming resource, creating energy and influential in many industrial sectors providing information tools and energy sources. Fossil fuel (FE) consumption has been considered the major part of greenhouse gas (GHG) emission. Introduction of electric vehicle (EV) and hybrid electric vehicle (HEV) has been expected to reduce consumption of FE [11]. The battery system on the vehicle is also collecting expectation to construct smart grid power distribution system (Smart Grid) that is able to include renewal energy additional to conventional generation system. Tight interactive and collaborative industrial relation with electric and electronic industry is expected. Automotive cannot be made as little as mobile electronic equipment. Therefore we will be encouraged to solve environmental issue under the severe material restriction.

2.3 Innovative resource saving technology

We are now on the way of improvement having very hopeful results such as big progress in semiconductor industry, optical communication and computer technology. These industries expanded our capability of immediate and pervasive accessing to information at a low cost. We also had big progress in renewable energy for power supply and harvested energy for sensing. Light Emitting Diode (LED) lighting has reached at the level of household use replacing incandescent light bulb. Combined heat and power (CHP) system has been operated and proved its performance. Electric vehicles (EV) and Hybrid electric vehicles (HEV) are getting popularity and Probe-car system with Global Positioning System (GPS) [2] is in progress. These technologies give us freedom of energy source selection. Global issue to include renewable energy in the power distributing grid is now active issue globally. There are a lot of engineering issues are under development. By general classification one is system the other is technical [58, 76]. Recycling system in Japan proved high recovery performance and pushed up material efficiency. All these are improving industrial efficiency.

2.4 Status of resource sustainability

Resource sustainability has 2 aspects. One is material sustainability. EEI consumes many kinds of elements such as rare metals, precious metals and transition metals. Their amount of deposit is limited and mines are also limited geographical location. They are used in many applications to improve energy efficiency and generation. Their shortage affect very much on saving energy and reducing GHG emission [28]. Forecast is very pessimistic and in danger[51]. The other is energy sustainability. This issue is also deeply related to global warming. Forecasting shows also pessimistic future[12, 70].

3 Systematic approaches to establish sustainability in industry

We cannot make sustainable society principally if the earth is a closed system (2nd Law of thermodynamics [20]). But the earth is not a closed system that receives energy of sun and radiates energy to the space. Theoretically we can establish a sustainable system on the earth. Even though there are a lot of issues technologically and economically. Sustainability is a concept of suspending

consumption of natural resource and limiting the quantity within the amount of renewable resource. On the other hand economic development is a concept of growth and expansion. This economic concept is implying contradiction to sustainability (decoupling issue). Before going to economical issue, we will review industrial models proposed for direct material saving.

There are three kind of models are proposed. One concept is Inverse Factory or Inverse Manufacturing. This concept is just like natural recycling system. Second concept is Remanufacturing. This concept is extended reuse concept. Third one is Servicizing. Ownership of products is disconnected from services. The user does not care about material flow [3, 59, 112].

3.1 Inverse manufacturing

Inverse manufacturing is a concept of reverse way of manufacturing. That is the process from product to material. A recycling system is formed by combining manufacturing (Arterial flow) and inverse manufacturing (Venous flow). But it is very often to use recycling as the same meaning of inverse manufacturing. By this system we can use material after quit using product again. Expectation is eternal loop for material supply! Japan adopted this concept in "Law for Promotion of Effective Utilization of Resources" aiming cyclic use of material and regulating waste treatment. After 10 years operation this law system was reviewed and confirmed effectiveness to improve material utilization ratio. In the case of common metal and common plastics recovery rate for Electric Equipment in Japan is around 85%. Recently the regulation system is amended for another small electric equipment to recycle rare metals. Resource productivity (GDP/Natural resource input) in FY2007 was about 37% up from2000 [8].

3.2 Remanufacturing

Remanufacturing is an extended business of repair and maintenance. In 1970th, the era of mass production and mass destruction, business models to produce new product by using old product [25, 39, 69, 84, 90] had increasingly been important models. Components used in old products are refurbished to extend product lifetime. Later this model is well incorporated in servicizing business model or incorporated in recycling business model. Remanufacturing Industrial Council (R.I.T) in USA [79] has long history. As stated above an old product can extend its lifetime by partial replacement or refurbishing of components. Material usage is limited but the key issue is the cost for remanufacturing. Therefore applicability is depending on the value of old product. The most common product categories of R.I.T members are aircraft components, automotive parts, electrical and electronic equipment, engines and components, medical equipment, office furniture, printing equipment, restaurant and food-service equipment.

3.3 Servicizing

Servicizing is a business model to provide service without the ownership of product by consumer [82]. The servicizing model can be considered as double loop system. First loop is only the service flow where no actual product but information is involved the other loop is real recycling system but totally formed in manufacturer's ownership. Applying this model the consumer enjoys the latest service or quits using without discarding old product. A returned product can be re-used by another customer as long as the service is not out of date. This business model is more competitive if the recycling system has additional service operation in it. Developing, printing and enlargement service for film camera is one good example. In this service a camera is a product but actually the ownership is temporal [61]. Highly technical equipment such as medical electronics, construction machine, aviation equipment, household equipment, agricultural equipment is adopting servicizing model with maintenance service. Product lifetime is prolonged in this system therefore resource consumption is suppressed.

4 Economic Issues

Artificial products are made by human as a result of economical activities. Expansion or suppression of activities is not governed by autokinetic mechanism but economic motivation. Applying a simple wording analogy of "2nd Law" in Thermodynamics, "Law of increasing value" to maximize profit could be used for understanding the direction of economical activities. The increasing value mechanism in economical activities such as production, distribution, inverse distribution and resource recycling will be reviewed. The way of suppressing resource consumption must be in accordance with the law. There are many important economic terms and principles to motivate people for economic activity. Only the mechanism of increasing value [31, 37] and profit with cost are explained. Economics are still in progress with a lot of controversies. [4, 15, 48, 54, 60, 65, 81, 87, 88].

4.1 Value increase in arterial (production) system

The common business model is shown in Fig. 1 schematically. That is, every company purchases commodity from somewhere another company and add process (energy and man-power) on it to produce her own commodity.

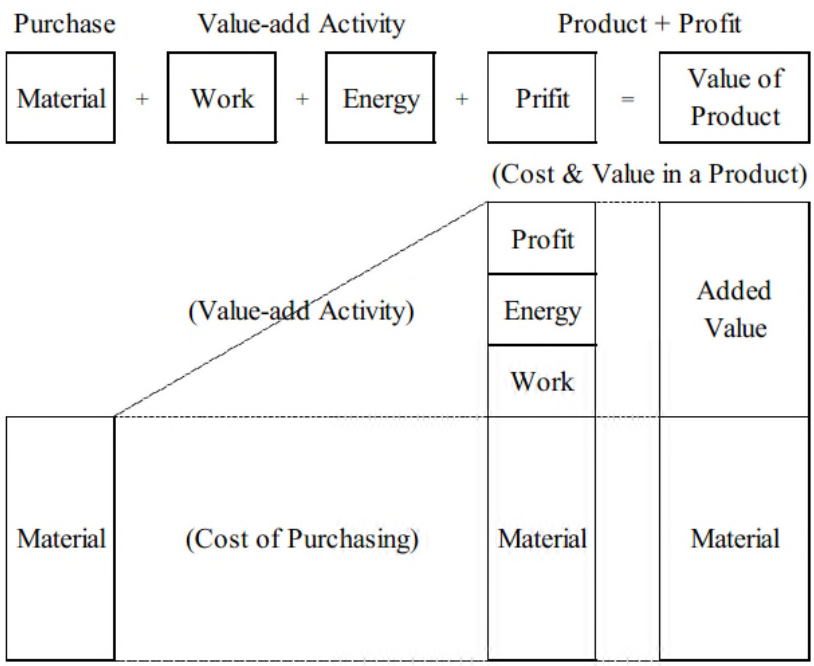

Figure 1 Production Business Model (Activity to get Profit)

Of course it is no need to purchase commodity if she has her own resource. Some portion of material is scraped during the above process. The product is sold to the other company as a part of the other product including the scrap as cost but no actual material. The relation is cascaded until final commodity that is purchased by consumer. Fig. 2 shows this relation. Therefore the material portion is reduced in every cascading step.

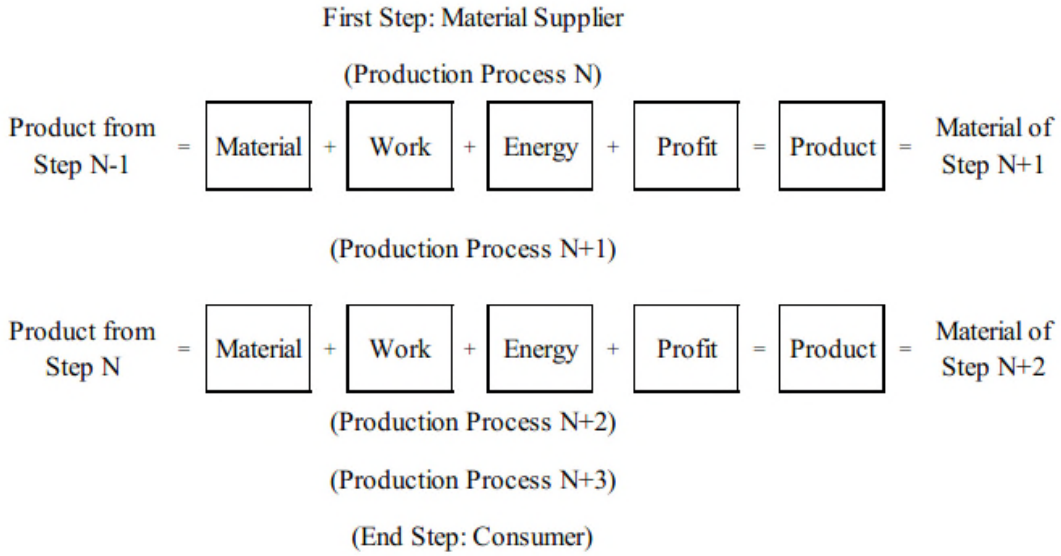

Figure 2 Cascade Production System

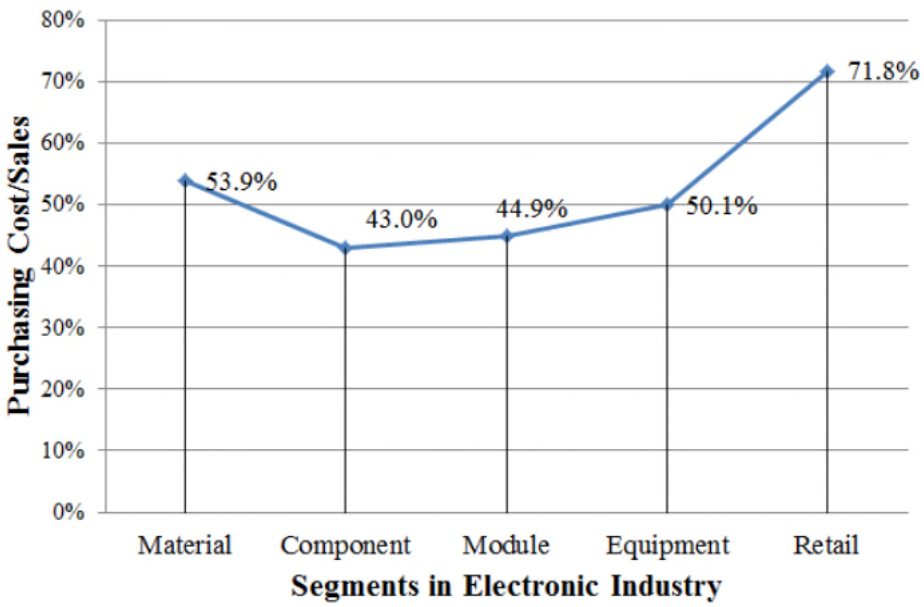

Figure 3 Purchasing Cost/Sales (FY2006), 8 Japanese Companies for each Segment

The reduction of material portion is calculated by examining financial data of each company. Exact calculation is very difficult without accessing to company secret, but we can approach to some extent by financial data that is available in the financial chart of public companies [21]. The financial data for 40 companies, each 8 companies for material, electronic components, electronic module, electronic

equipment, retail, are shown (Fig. 3). Almost same value is added on purchased commodity except retailing. The material portion in sales value Fig. 4 is obtained by using this data assuming cascade material supply of business relation (Fig. 2). In is relation, the material purchased by a company is included in a product of the company in the preceding step and just transferred to the product. Therefore the ratio of material value/product value is decreasing by the purchased value / product value in every production step. As a manufacturing company purchases many products from many companies in preceding step, the supply chain is very complicated. We showed a schematic material supply chain in Fig. 4 for generalized multiple supply flow with abbreviated expression. Fig. 5 is a simplified view for a single product for next production step. Typical additional materials used in each production steps are indicated for reference. In this calculation we suppose all material is used in each process without loss.

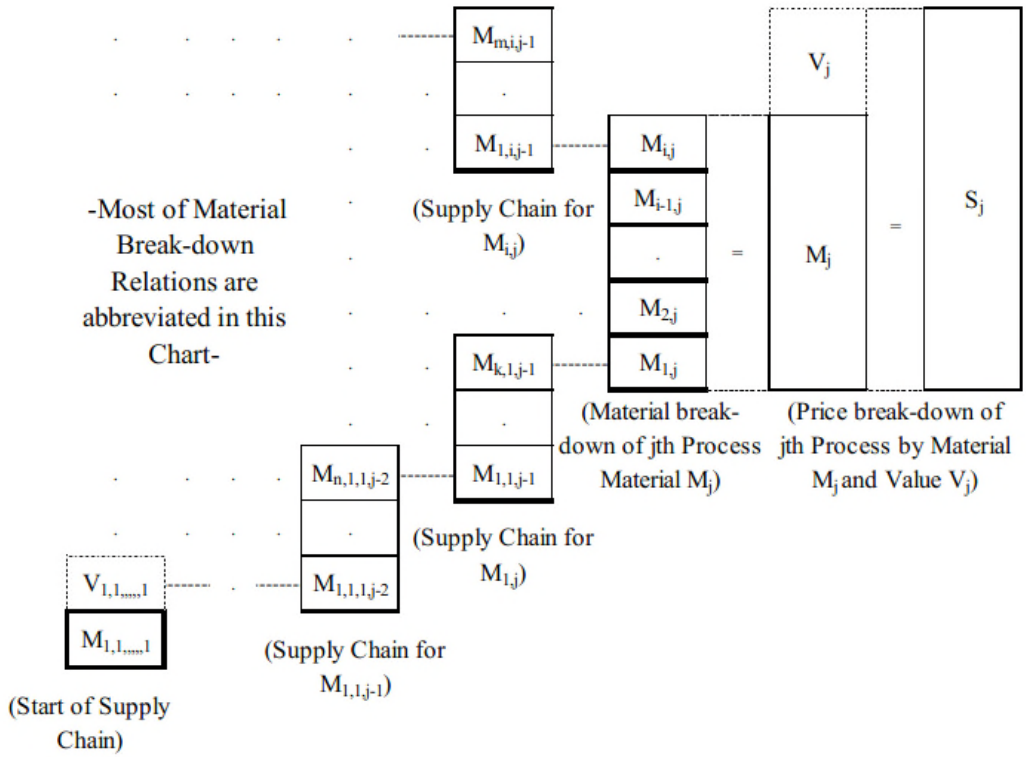

Figure 4 Material Supply Chain of Cascade Production Model

This assumption ignores the loss during process then the actual value will be less than this assumption. There are three other assumptions in calculation.

1. All purchasing cost is material cost.
2. All purchased material is transferred to commodity.
3. All purchased material is transferred to next process.

Therefore material portion will be considerably over estimated [38]. The more exact value chain is shown in Fig. 5. We can calculate more exact material portion if we are available more detailed company data.
It is very difficult to get exact reduction of material value / product value, but we can estimate sum up ratio from the result of regulation data in Japan [64] and many other recycling data [113].

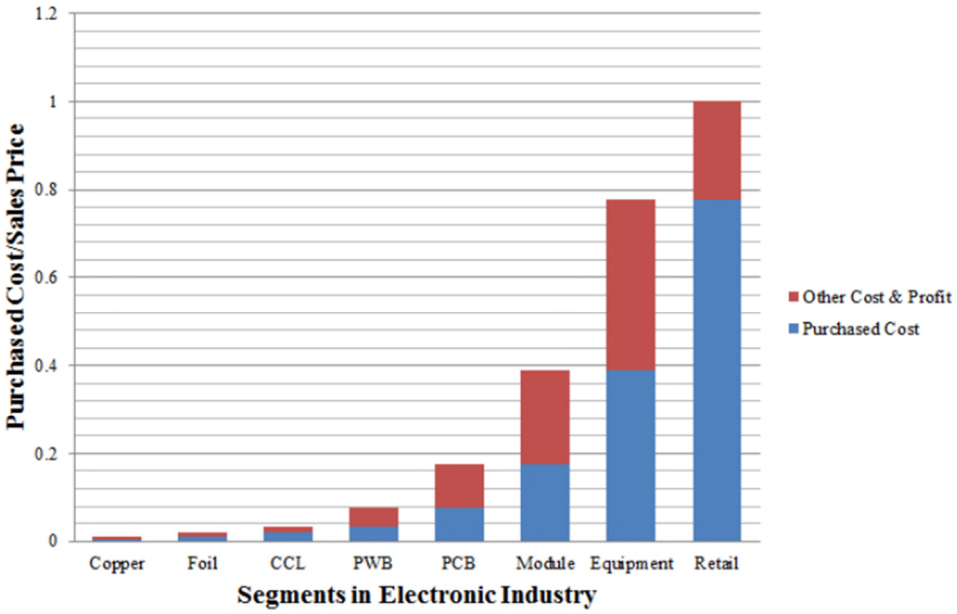

Figure 5 Purchasing Cost/Sales Portion by Segment in Electronic Industry

Table 1 Number (Unit) of Wasted EEE and Weight vs. Content of useful Metals (*)

Equipment (**)	Recycled Equipment		Recovered Useful Metals		
	Million Unit	Kilo Ton	Kilo Ton	Million Yen	Yen/Unit
Mobile Phone	40.1	5.6	1.6	10,632	265
DVD Player	6.2	21.6	15.3	4,602	742
Desktop PC	5.0	40.9	20.9	15,843	3,169
Note PC	6.7	14.0	3.0	11,763	1,756
Printer	5.6	56.5	30.1	5,538	989
Microwave Oven	3.5	43.2	22.2	1,206	345
Lighting Equipment	59.8	77.1	41.5	4,493	75
Electric Drill	2.7	5.8	3.1	327	121
63 Items Total	1,115.7	650.5	279.3	84,360	76

About 1% of product value is recovered by recycling. 4th or longer cascading in supply chain is feasible.

4.2 Increasing value in inverse production

It is said that the issue for the inverse process is increase value even though the process is opposite direction of value increase in production system. However all the value of product is released when the owner of the product has discarded product. Therefore the original value of product has zero value at this timing. Fig. 6 shows the relation.

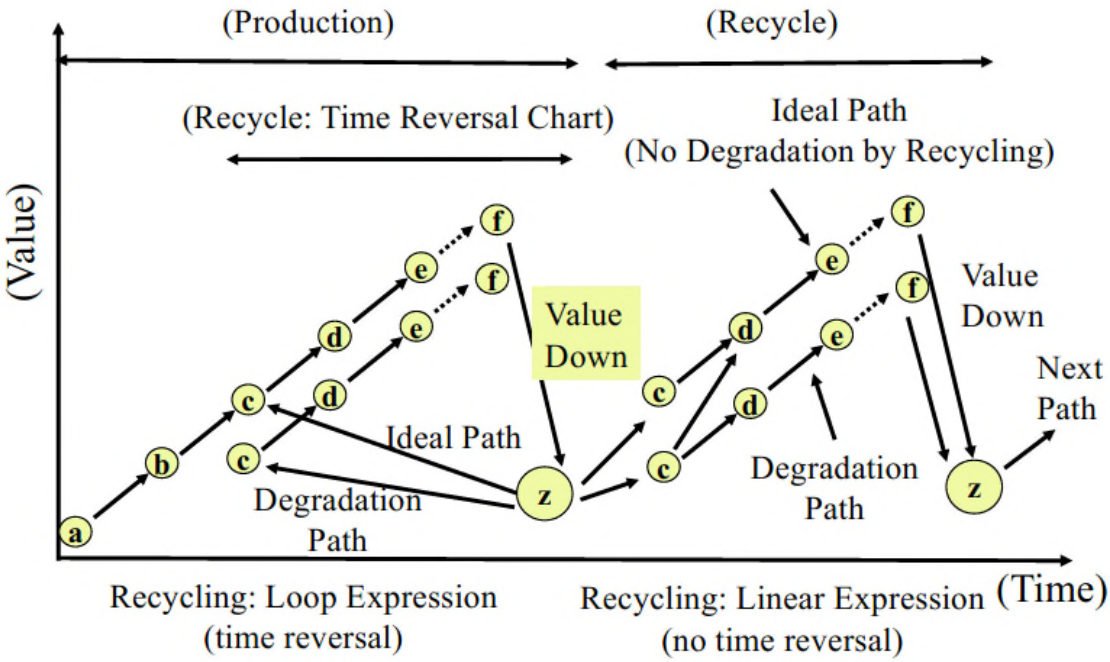

Figure 6 Value-add and down Relation in Production and Recycling

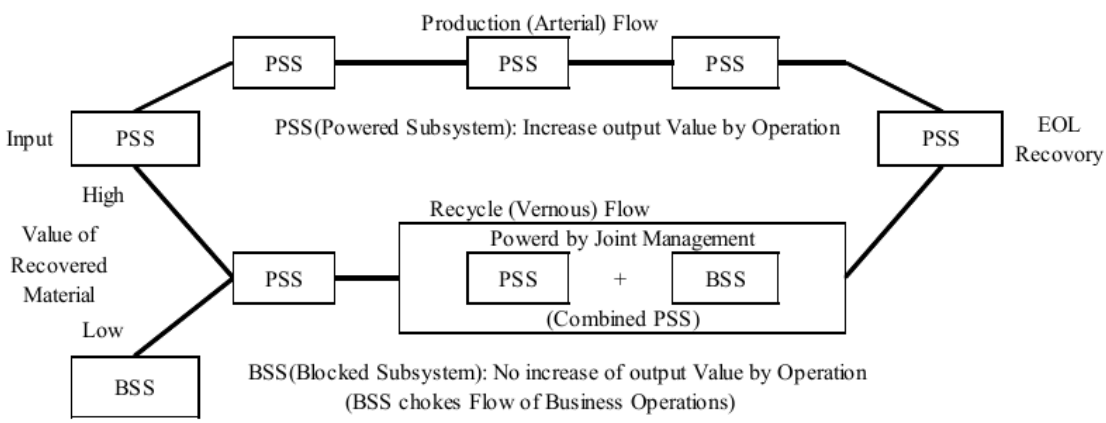

Figure 7 Facilitation Scheme of Recycling Loop by Joint Management

In recycling system all the value that is inherited from the initial production system has been released, then follows the increasing cycle again. If it could increase value up to the same level of production cycle, the cycle could last endlessly. If the level of value increase is reduced from the level of production cycle, the recycling cycle cannot follow the level of production cycle and follow lower cycle. (One time path) Fig. 7 shows the recycling system from the view of self-sustainability. The PSS means the subsystem that could increase output value from input value. Upper part of Fig. 7 belongs to the production system and all the subsystems are shown by PSS. PSS stands for Powered Subsystem. Lower part of Fig. 7 belongs to shows venous system. The block shown by BSS means the subsystem that could not increase output value from input value. BSS stands for Blocked Subsystem. This part could not be sustainable and blocks the flow in the system. If we could not change BSS to PSS, total system could not be operated.

The BSS shown in Fig. 7 could be changed to PSS by including one BSS into another PSS. For example, even if the collection system is BSS, the BSS could be changed into PSS if the following reproduction system is PSS that has enough value to include BSS. It is very simple idea but very useful to develop much better especially when the time factor is considered. There is very distinct difference in value-add potential between arterial system and venous system. There is no limitation in the arterial system but there is a limit in the venous system that is limited by arterial value. Especially in material portion is always reduced. Therefore processing cost is always pulling down profitability of venous system. The effective business strategy to reduce cost is to increase the quantity of recycled product! Essential vicious cycle is included in mass production business principle. There are many business strategies in arterial system. But increase quantity is easiest way. The expected effects are increasing productivity, reduction of outsourcing cost [93], reducing delivery cost and increasing advertising margin. So it is very often in business plan to decide selling quantity first and then price. As the players in market are reducing the quantity of products are increasing.

4.3 Value up in distribution

The commodity value is given by the market. The distributor and retailer (D&R) purchase products and increase their value by introducing them to demanding markets. D&R add value on the products by such as displaying them in store, credit guarantee, these are immaterial value add, or packaging, instruction manual, repairing guide, these are value add by material, and so on. The materials used to value up are usually provided by manufacturers of products reflecting the requirement of D&R. Recently selling by internet system is increasing.

4.4 Resource consumption and Profit

In production system, profit is price minus cost. Therefore we can choose two ways to increase profit. One is reducing cost, the other is increasing price. The latter is critical for market but former is not because the market does not care about product cost. Improving resource or material efficiency could be a clear target of the technological breakthrough as in semiconductor industry. One very simple solution can be found in a product design such as saving material in a product by eliminating redundant structure. To miniaturize product is on the same way. We have a lot of these kinds of products in common use. Material selection and structural design can find solutions for the products like vehicles that cannot be produced in smaller size than human size.

5 Potential impacts to increase resource consumption in economic activity

The clear potential impact is seen in the principal motivation of business activity. That is, getting higher profit to assure distribution of dividend to shareholders. Basically increasing sales amount is very feasible

way of business companies. It will lead to increase resource consumption. But at the same time they must be careful on a risk to lose market by the consumer's attitude. Recently the risk to be spotted by consumers as environmentally-unfriendly company is increasing [81]. Therefore it may not be profitable to increasing sales simply. Even though following five factors must be considered to avoid increase resource consumption.

5.1 Earning structure of inverse factory (venous process)

The business model of inverse factory is subject to production (arterial) model. The idea is introduced to save material usage in the industry. But the process is essentially the same process used in arterial process. It requires bigger amount of wasted material to get bigger profit. Therefore motivation of venous process is encouraged by a lot of waste of discarding products. Material saving in a product, long life product design, and repairable design discourage the motivation of venous process lead. Short life product design and recyclable design will encourage motivation. The latter type of products will contribute to increase sales amount of arterial process and also encouraged by venous process. Profitability of both arterial and venous process will be increased, increasing resource consumption. An unwelcomed effect for venous process is feasible that is related to production system as follows. The material portion is increased by elevated material price in production. As the material portion is vital issue of profitability of a company, the company management acts against the situation to keep profitability of the company. There are three typical actions among many options [24]. (1) Add on the price. (2) Find alternative source. (3) Develop technology to reduce material usage or use alternative material. By these actions the portion of material in quantity comes down gradually suppressing the profitability of venous process.

5.2 Rebound effect

EcoDesign itself is an activity to save resource. It can contribute to save resource and also money. This saving can increase strength of a company and promote development of another saving. On the way of this activity the amount of business will increase and increase resource consumption in total. This kind of increase is called as direct rebound effect [110]. It is likely to occur cyclical and lead to even more consumption. If increasing is bigger than saving the effect is called backfire [85, 96] and form virtuous circle of Ecodesign. Saved money could stimulate a consumer to spend on another products or services. This kind of consumption is called indirect rebound effect [86]. These rebound effects are pure economical issues [9, 18, 104]. Internet contributes to save energy used for travelling. But it stimulates travelling. Shopping is also activated [5, 19, 40, 41, 49, 68, 78, 100].

5.3 Software Issue

Software has been considered as ultimate de-materialization way. Because software is the product of brain work and it can be operated just installed in hardware. Then in case of improvement, needed work is just reinstallation. This is the very ideal procedure for software improvement. As software is invisible in function until testing, reliability of complex software is very difficult to develop [50]. But it is easy to combine subprograms with each other. By this way, software is easily grown-up in size and adding functionality up to the limit of hardware. In this sense software is sensitive to hardware and not so well considered software cannot run on the same hardware. This sequence has the risk to be involved in a vicious circle. Sometimes needless development is done to develop additional functions that are not used by most users just for create market. For example, the heaviest load of processing is video data. If the number of pixel is increased in movie the processing speed is increased very much. If the density is rough the processing speed could be low. Well descripted data format that can manage to extract course picture out of high density picture the load of terminal could be reduced. Of course there are many reasonable developments. One example is practically applied in a digital terrestrial broadcasting system [57, 92].

This kind of discarding risk for hardware must be considered for servicizing business model. In servicizing business model, hardware is kept in service provider's ownership. The user just care about functionality without care about the cost of hardware. Under the fierce competition, a marketing promotion with adding new function is sometimes applied by service providers and hardware lifetime will be cut in short timing.

5.4 Pricing effect

Price of product or service is important variable of business. The price of a product is not the value of the product but consumers' awareness of keeping the product to long is lost. Therefore a low price product is easily discarded and again produced. The recycling system is designed to protect environment and save material by consuming resource. Price down by mass production is mostly welcomed by consumers but lead to wasting of high-income people. Related EEI the Used Electric and Electronic Equipment (UEEE) finds users mostly in developing countries [53, 111].

5.5 Product lifetime

Optimum design of product lifetime is important from sustainability and many researches have been proposed [103]. All of these researches are intending to reduce environmental burden and reduce energy consumption. But still they are successful partially in the industrial products blocked by business barrier. As already mentioned in the former sections, primary view point of business is getting profit. Therefore products must expand or at least keep market gathering customers' attention. In most developed countries, it is very hard to keep customers in the same market with long life products. To break this situation, it is effective to introduce new models. As a result product production lifetime is shortened. As in mobile IT products, the faster technical progress the shorter the production lifetime is. Possible measures to suppress resource consumption are modify sold product at the point of sales and modify stocked products and put them in the market. The issue "keeping market" suppressing resource consumption is still very tough issue for business firm but depending on market segment [108].

6 New challenge to establish sustainability

It might be implicitly presumed that there is an absolute scale for terrestrial surface. But, this is not the right understanding because we cannot cultivate or use all surface for artificial purposes [95, 106]. It is very essential understanding to consider ecological issue such as biodiversity [73, 102]. To establish sustainability in our industrialized society the portion of usable surface is also important controversial issue globally including derelict land after development and area for landfill [15, 45, 72]. Engineering activity in EEI has been contributed to save resource usage in products and still expanding its potentiality useful to establish sustainability. If this activity is enough to establish sustainability, we are able to just watch the outcome of the industry.

6.1 Direction of technological development in EEI

It is clear that every technical development is directing to save resources. In this sense development is supporting to establish sustainable world. Material saving, energy saving, reducing loss, getting higher yield, shorten process, compress inventory and all of wasteful factors will be eliminated in manufacturing at the best effort. There are technologies that have been grown since last century. Electronic device, high density interconnect (Jisso) [49], optical fiber and telecommunication system [68], computer software [10], RF technology and satellite communication [71] and sensing as GPS system. These technical infrastructures are useful to construct our society [66]. We can use positioning data and device identification data to construct very efficient living environment with high energy performance. It is also

applicable to construct pervasive and effective EPR system. These technical issues will be improved day by day and as good as EcoDesign measure. Because saving loss is the same direction of profiting activity. The performance / resource of each product will be improved in the business activity. But is the above situation leading us to the right way to establish sustainability? The power consumption in internet system is increasingly going upward [15, 42]. Shortage of rare metals and rare earth promote amount of mining [26, 27, 114]. These kinds of volume based impact are the focal point of the new challenge.

6.2 Origin of volume based impact

As new product has higher performance than old products [43], the origin of volume based impact implies resultant of mismatch between improvement of resource saving and demand increase by excessive number of products. Challenging activity to establish sustainability will be just to act for suppressing excessive demand for new products as all technological developments stated in the last section are self-motivated by business firm. The challenging activity could not be relied solely on technical actions but strategical business actions because it is not self-motivated by business firm. The strategy motivates business people to rely on stability of their business and profit enhancement by sustainable way of business. Corporate Social Responsibility (CSR) [23] is commonly required to all business firms and Socially Responsible Investment (SRI) [13] is adopted in equity market to save cost of qualification. As social responsible movements are expanding in more generalized way such as human right and ecological harmonization [6] to suppress resource consumption will be much more focused in company action. Technical issues to extend product lifetime has great importance.

6.3 Technical issues for lifetime extension of equipment

The issues for extension of products include two aspects. One is keeping quality without degradation. This aspect is reliability issue. There are a lot of works that include material design [67, 109] and component design [62] and many other categories [89]. The second is improving functionality or performance to keep value of products. The lifetime issues for emerging products are dominant on the first aspect and a lot of work is shared for development. The second aspect is dominant for matured products to solve volume based issues by extending lifetime of equipment. Technologies out of numerous researches that span design, process and traceability of products are summarized as follows. They are extending modular design of mechanical part, modular design of electrical part, modification method on the idle part of components, keeping traceability. In modular design of mechanical part, all components used in equipment are clustered by physical dimension, functional relationship, and lifetime attribute prior to decide modular structure [56, 97]. By this clustering components and modules of similar attributes such as LCOP (Lifecycle Options), are closely arranged. This components arrangement is beneficial to fix or add new functionality and to extend lifetime of products implementing performance. Interconnection for each component is very important. Reversible interconnect in normal environment is best and challenging. Biomimetic interconnect is hot now [44]. Modular design of electrical part has freedom on physical dimension. Circuits can be modified choosing space between components. However, advanced circuits are built in or on the material. Break-thru is required. Flexible Printed Circuit (FPC) can be used for circuit modification [30]. From the High Density Interconnect (HDI) requirement, printed circuit is embedded by electronic components, in this design it is very tough to expose components out of embedded circuit board. Therefore laminated structure or skeleton structure is preferable. Tough issues are interconnection and insulation from the view of reliability [33, 34]. For the adding functionality process, we have been trying new method useful to extend printed circuit functionalities. This method is utilizing proton beam as fabrication tool and extend surface of Flexible Printed Circuit (FPC) by direct patterning with micro proton beam [36]. This technology is at the very early stage and cannot be applied to whole process of FPC. But it is a hopeful technology to add functionality on the surface area of extra

redundancy. The area is not intentionally reserved part. Same kinds of function-adding methods are hopeful extra fabrication method to be developed. For keeping traceability, accelerated proton beam is useful to identify element in a material. The beam of 1 MeV can penetrate up to about 30 micrometer deep inside of plastics. The depth is enough to protect material to use for identification from damage. Using PIXE (Particle Induced X-ray Emission) the embedded element can be identified in sub-micrometer scale [14, 83]. Modular segmentation of ICs by function is another key technical issue.

6.4 Marketing &Business Strategy

The next issue against the volume based impact is business strategy. There are many options for making business models depending on products. But interaction with market is always of vital importance. The system "Integrated inverse distribution and production system" (IIDPS) (Fig. 8) is supposing partial improvement during remanufacturing phase. In this model, important key issue is to improve performance of product especially energy performance as in Japanese Top Runner Standard [75]. The profit that is the highest concern of manufacturer will be reduced by this model as the number of new products will be covered by refurbished products. Where is the profit of manufacturer? The answer is in the market created by loyal customers in future and also in the equity market of high rating. This kind of rewarding is of course depends on the original quality of product and good performance of refurbishing system. The engineering effort and brush up effort of system management ability are vital. This system could be applied to the developing countries.

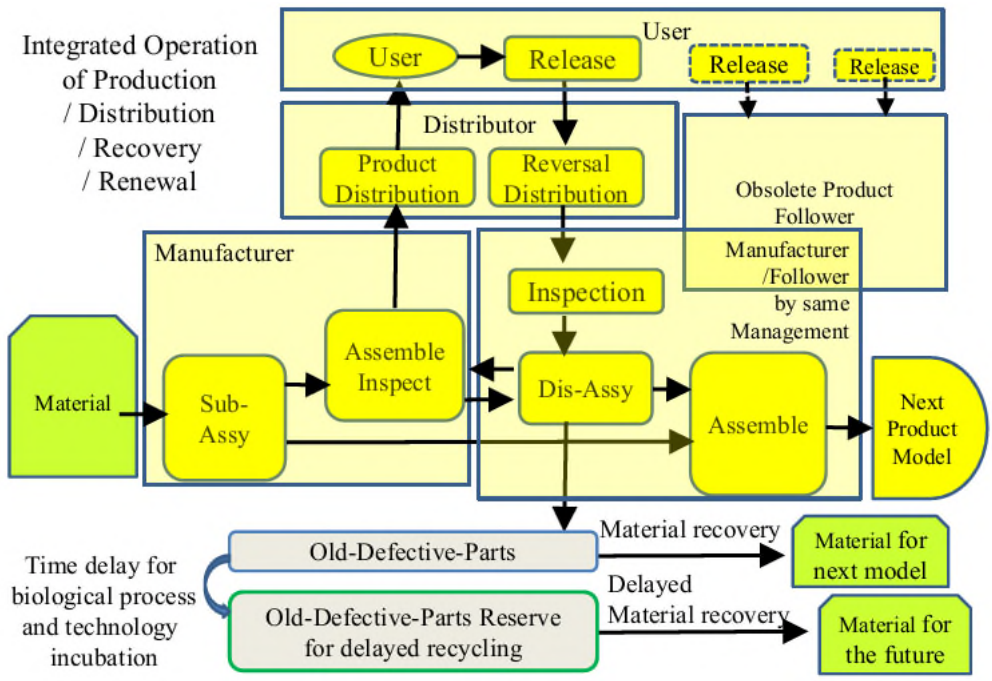

Figure 8 Integrated Inverse Distribution and Production System (IIDPS)

As the disparity in buying power is more than 100 times in the world, this system will provide suitable products for them if operated by themselves [35]. Technology transfer must be done to operate this system clearing IP issue. For this purpose black box module must be used in a product. The IP right of

original manufacturer is secured and also return profit will be given. This system can serve for reducing disparity of country gradually and steadily. If operators in this system they can construct country specific manufacturing site that is operated by them. There is actual demand for used equipment [32]. The environmental pollution caused by improper operation will be reduced.

6.5 Ecological issue

The technological goal for protection of ecological environment and sustainability is overlapped but not always the same. For example reducing resource totally is the same but eliminating lead from electric products is not the same. Lifetime extension is also in the above situation. If we simply extend lifetime ecological impact caused by low energy efficiency and harmful material in the old components may increase. The IIDPS is a proposal to count ecological issue. Ecology combined sustainability issue is frequently seen in new technology development. Shortage of critical material issue is one of the typical examples [77, 99]. Emerging new technologies in EEI and automotive industry have been searching alternative materials. Another ecology combined sustainability issue is seen in the mining industry like copper. In this issue resource shortage is not so critical [75] but environmental degrading by new mine is spreading [29, 55]. For the ecology combined sustainability, lifetime extension and recycling is effective. Ecological degrading by released waste is mitigated by suppressing resource consumption [101].

7 Conclusion

It is clear that resource saving technology must be developed to share artificial outcome with the people worldwide. But at the same time it is clear that we cannot make world sustainable only by the technological innovation. Uniqueness of this paper is introduction of value increase mechanism in sustainability discussion. The discussion is important business issue. But even for the sustainability discussion, value increasing mechanism is of great importance. Profit motivates people to work. The saving gained by technical innovation can stimulate consumption to get profit. This is rebound effect. We are not ready to eliminate this effect but it is very important to be sensible. After reviewing innovative resource saving technology in EEI (Electric and Electronic Industry) and systematic approach to establish sustainability, value increase mechanism in manufacturing and invers process is discussed. Finally new challenges to establish sustainability are suggested to be self-motivated actions in the same sense of business. The view point from business and value will increase weight of importance for sustainable development.

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International Journal of *Design Sciences and Technology*
Design Sciences, Advanced Technologies and Design Innovations
Towards a better, stronger and sustainable built environment

Aims and scope

Today's design strongly seeks ways to change itself into a more competitive and innovative discipline taking advantage of the emerging advanced technologies as well as evolution of design research disciplines with their profound effects on emerging design theories, methods and techniques. A number of reform programmes have been initiated by national governments, research institutes, universities and design practices. Although the objectives of different reform programmes show many more differences than commonalities, they all agree that the adoption of advanced information, communication and knowledge technologies is a key enabler for achieving the long-term objectives of these programmes and thus providing the basis for a better, stronger and sustainable future for all design disciplines. The term sustainability - in its environmental usage - refers to the conservation of the natural environment and resources for future generations. The application of sustainability refers to approaches such as Green Design, Sustainable Architecture etc. The concept of sustainability in design has evolved over many years. In the early years, the focus was mainly on how to deal with the issue of increasingly scarce resources and on how to reduce the design impact on the natural environment. It is now recognized that "sustainable" or "green" approaches should take into account the so-called triple bottom line of economic viability, social responsibility and environmental impact. In other words: the sustainable solutions need to be socially equitable, economically viable and environmentally sound.

IJDST promotes the advancement of information and communication technology and effective application of advanced technologies for all design disciplines related to the built environment including but not limited to architecture, building design, civil engineering, urban planning and industrial design. Based on these objectives the journal challenges design researchers and design professionals from all over the world to submit papers on how the application of advanced technologies (theories, methods, experiments and techniques) can address the long-term ambitions of the design disciplines in order to enhance its competitive qualities and to provide solutions for the increasing demand from society for more sustainable design products. In addition, IJDST challenges authors to submit research papers on the subject of green design. In this context "green design" is regarded as the application of sustainability in design by means of the advanced technologies (theories, methods, experiments and techniques), which focuses on the research, education and practice of design which is capable of using resources efficiently and effectively. The main objective of this approach is to develop new products and services for corporations and their clients in order to reduce their energy consumption.

The main goal of the *International Journal of Design Sciences and Technology* (IJDST) is to disseminate design knowledge. The design of new products drives to solve problems that their solutions are still partial and their tools and methods are rudimentary. Design is applied in extremely various fields and implies numerous agents during the entire process of elaboration and realisation. The International Journal of Design Sciences and Technology is a multidisciplinary forum dealing with all facets and fields of design. It endeavours to provide a framework with which to support debates on different social, economic, political, historical, pedagogical, philosophical, scientific and technological issues surrounding design and their implications for both professional and educational design environments. The focus is on both general as well as specific design issues, at the level of design ideas, experiments and applications. Besides examining the concepts and the questions raised by academic and professional communities, IJDST also addresses the concerns and approaches of different academic, industrial and professional design disciplines. IJDST seeks to follow the growth of the universe of design theories, methods and techniques in order to observe, to interpret and to contribute to design's dynamic and expanding sciences

and technology. IJDST will examine design in its broadest context. Papers are expected to clearly address design research, applications and methods. Conclusions need to be sufficiently supported by both evidence from existing research (reference to existing design research knowledge) as well as strong case-studies from any design discipline. A paper must contain at least one chapter on research questions, methodology of research and methods of analysis (the minimum length is 1500 words). The concluding chapter (the minimum length is 1000 words) will summarise the paper and its results. The concluding chapter also examines and discuss applications, advantage, shortcomings and implications of the investigation for both professional and educational design communities as well as for the people and the society. Also authors are also encouraged to include in this chapter a discussion of the possible future research that is required or is possible in order to enhance the research findings.

The papers considered for IJDST cover a wide range of research areas including but not limited to the following topics: Design research, design science, design thinking, design knowledge, design history, design taxonomy, design technology, design praxeology, design modelling, design metrology, design axiology, design philosophy, design epistemology, design pedagogy, design management, design policy, design politics, design sociology, design economics, design aesthetics, design semantics, design decision-making, design decisions, design evaluation, design sustainability, design logic, design ontology, design logistics, design syntaxis, design ethics, design objective, design responsibility, design environment, design awareness, design informatics, design organization, design communication, design intelligence, design evaluation, design education, design theories, design techniques, design methods, design operations, design processes, design products, design users, design participation, design innovation, design inspired by nature, design case studies, design experiments, etc.

The *International Journal of Design Sciences and Technology* is devoted to further exploration of all themes and issues that are directly or indirectly relevant to the exploration, introduction, discussion of design sciences and technology, cross referencing domains and any other themes emerging in the future.

Instructions for Authors and Review Process

Pre-review Stage (Editor Global Review): Papers can only be considered for review when they deal with a subject relevant to the content of the journal. In addition all papers submitted must follow the journal's paper structure and author instructions before they can be considered for review. These instructions also affect the content of the paper. The preferred size of a paper is about 10000 words (The minimum length of a paper is about 7000 words). The title must not be longer than seven words. Subtitles are not permitted. The maximum length of the abstract is 150 words. The paper must contain an introductory chapter with extensive literature review of similar research (the minimum length of the introduction chapter is about 1000 words). The paper devotes at least one chapter to detailed discussion of research questions, research analysis and research contributions (the minimum length of this chapter is about 1000 words). The conclusion will summarise the research and its results. In addition this chapter includes a detailed discussion of applications, advantage, shortcomings and implications of the investigation as well as future research for both design professionals and the design education (the minimum length of conclusions is about 1000 words). Submit a paper at this stage as PDF.

Review Stage (Peer Review): Only papers meeting all IJDST requirements can be considered for review. All papers are reviewed by at least two expert reviewers. The main author of a reviewed and accepted paper will be notified with instructions to resubmit the paper. All reviewed and accepted papers have to be resubmitted, implementing reviewers and editors comments and/or suggestions. Only accepted papers conforming to instructions will be considered for publication in the International Journal of Design Sciences and Technology. A paper should follow the IJDST paper structure. The review process will be repeated until all requirements are met.

The first page of the paper must contain the full title of the paper as well as the Name+Surname (no initials), affiliation, address, telephone, fax and email of the corresponding author to whom all correspondence to be directed. Also mention the Name+Surname (no initials), affiliation, postal address, telephone, fax and email of the co-authors (if any).

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[2] **Blackman, DA** (2001) Does a Learning Organisation Facilitate Knowledge Acquisition and Transfer? Electronic Journal of Radical Organization Theory, 7:2 [www.mngt.waikato.ac.nz/Research/ejrot/Vol7_1/Vol7_1articles/blackman.asp]

[3] **Buxton, W** (1997) Living in Augmented Reality: Ubiquitous Media and Reflective Environments. In: Finne K, Sellen A and Wilber S eds, Video Mediated Communication, Erlbaum, Hillsdale NJ, 363-384

[4] **Dixon, NM** (2000) Common Knowledge: How companies thrive by sharing what they know, Harvard

Business School Press, Boston, MA
[5] **Djenidi H**, **Ramdane-Cherif A**, **Tadj C** and **Levy N** (2004). Generic Pipelined Multi-Agents Architecture for Multimedia Multimodal Software Environment, Journal of Object Technology, 3:8, 147-169
[6] **Gorard, S** and **Selwynn, N** (1999) Switching on to the learning society? Questioning the role of technology in widening participation in lifelong learning, Journal of Education Policy, 14:5, 523-534
[7] **World Bank** (2002) Social assessment as a method for social analysis, World Bank Group [www.worldbank.org/gender/resources/assessment/samethod.htm]

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