NET-EFFICIENCY SURVILANCE IN A NON-LINEAR PAPERMAKING PROCESS METHODOLOGY FOR WATER CIRCULATION AND PURIFYING SYSTEMS

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Abstract. Most of the papermaking processes intensively looking for a better solution to improve their net-efficiency score at its wet-end and overall profit in the end product on reel. Papermakers have been trying to bring new technologies in control systems and mechanical arrangements including process chemicals to avoid sucking up in between; and have been successful too in certain extent; but to do more! Paper engineers are looking principally on their "home-made-solutions." They consult on very popular issues; with machine builders or academic sources; to ensure their thinking are on the right TRACK or not. However, when a new thing appears in the market; they try to avoid it, due to "so-called proto-users." This conspiracy is a long-lasting immune for centuries; and would remain generation to generation; at the mill site. We execute sophisticated technologies in predicting, changing and controlling money-minds!

In this presentation; I would offer a methodology that might lend a hand in understanding the well-known savvy; the control of water input, water cleaning; and its circulation phenomenon. Fundamental issues are; how to control the non-linear behavior before the headbox inlet flow systems? And how to mirror the water – chemicals and fiber supra-molecular intimacies; complimentary effects and manage to redirect them; into self-regulating channels; not to the pit; but take them away; into separate means; Clean them "on-line" and put them back to process; save energy, labor, and input chemicals!

This approach would; let one to improve the net-efficiency, runnabililty of the paper or board machine; less or no breaks and chemicals; cheaper investment prospective and all-in-all better profit at the reel than before. A segment; where one could focus though the needs for effective engineering skills to adapt.

1 Introduction

As anticipated by the title, this presentation covers aspects of paper production, ranging from waterway modeling, transmission techniques, communication, localization and signal processing issues. Hard to use, impractical, difficult to learn, crude, and slow – all these expressions have been used to describe in papermaking where water, chemicals, and fiber are the factor to model. The majority of available books and articles provide extensive descriptions of algorithms and protocols; learnt from the literature, while minor relevance is given to their performance evaluation; and to the description of tools, techniques and methodologies needed to set the most important parameters of such algorithms and protocols. By threading the vision, the study may in future concentrate on cutting-edge at industry cases. A flash search will be conducted on the Industry needs and their product development capability and Systems. While surveying the requirements of the industry, we penetrate to verify the capabilities of Finnish Paper Producing Industries. We mirror them with US-industries and their peers, such as government and universities. We try to include the funding practices, product development sequences, and industry concentrations. It also foresees the innovation cycles and patented cases. The survival mechanisms and life cycle of individual projects in product development schemes are assumed to be the part of the study.

2 Water Circulation Environment

The fundamental issue here is to discuss briefly on the Water Circulation Environment (WCE); its compassion to papermaking processes, mechanical configurations and setups; process automation requirements and controls engineering annotators. We trap the Manufacturer to Peer with end-to-end solution. Therefore, let us see the concepts and principles as in Figure 1.

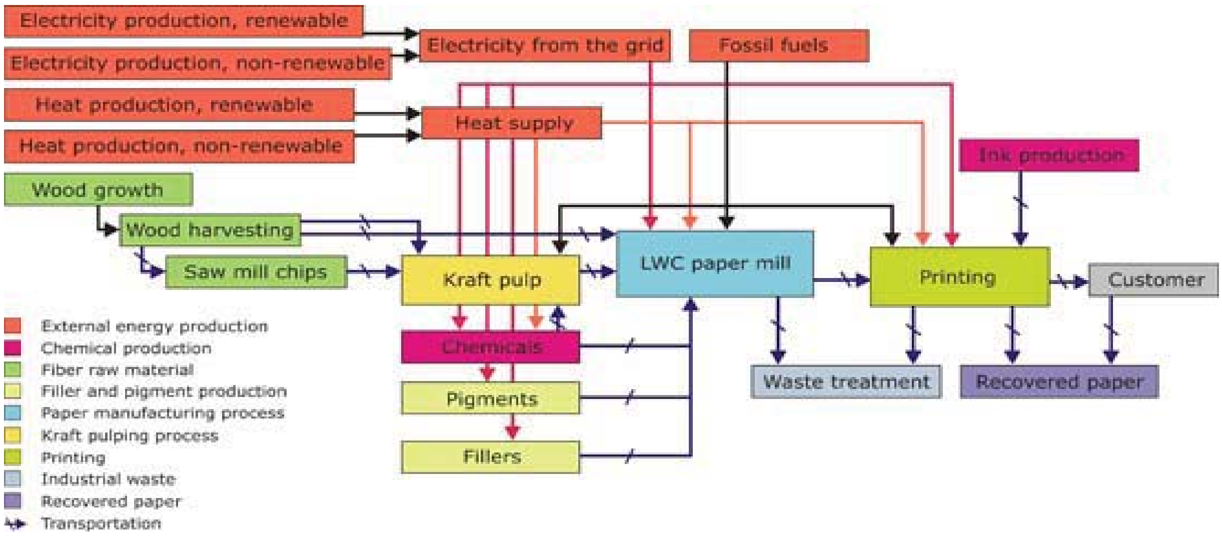

Figure 1. The overall process in producing paper and its recycle phases including ingredients inputs, adapted with thanks from the files of Central Paper Research Lab of Finland, Espoo.

It clearly indicates that the system need electricity (renewable or not), heat, fossil fuels, wood plantation, wood harvesting, Chipping, pulping and chemicals; a variety of quality of outputs draws as Kraft, lightweight coated or uncoated paper, and one sort would be printing to the end-user; and recovery system to re-use the waste paper or board to the process. To track the system; please see the paper machine photo in Figure 2.

Figure 2. A typical paper machine, To the Courtesy of the Stora Enso Corporation is a Finnish conglomerate; and it is their News Print paper machine at Langerbrugge; Paper Machine Number 4. This machine was built by the Metso Paper Machine Building Group is also from Finland.

3 Technical concentration

We concentrate here on three specific areas of interest:

- Wet end configuration of a Paper Machine
- Water treatment (in – and out – systems)
- A methodology – to manage seamlessly the control systems.

3.1 Wet end configuration of a Paper Machine

Figure 3 shows the wet-end configuration of a typical paper machine, which runs on a speed range between 1500 meter/minutes and 2 000 m/min and produces LWC (Light Weight Coated) newsprint paper qualities (45 g/m² to 65 g/m²). The flow-diagram presented here is a generic one; where the wet-end configuration and the process-steps are focused. Stock preparation starts, if the mill is not integrated one, then from the ground floor of the mill where dried pulp sheets are conveyed to a mixing tank, which is connected to several pre-processes before entering to the short circulation phase. They include the following phases:

- Mixing
- Screening
- Cleaning
- broke systems; and
- Approach flow systems to the Head box.

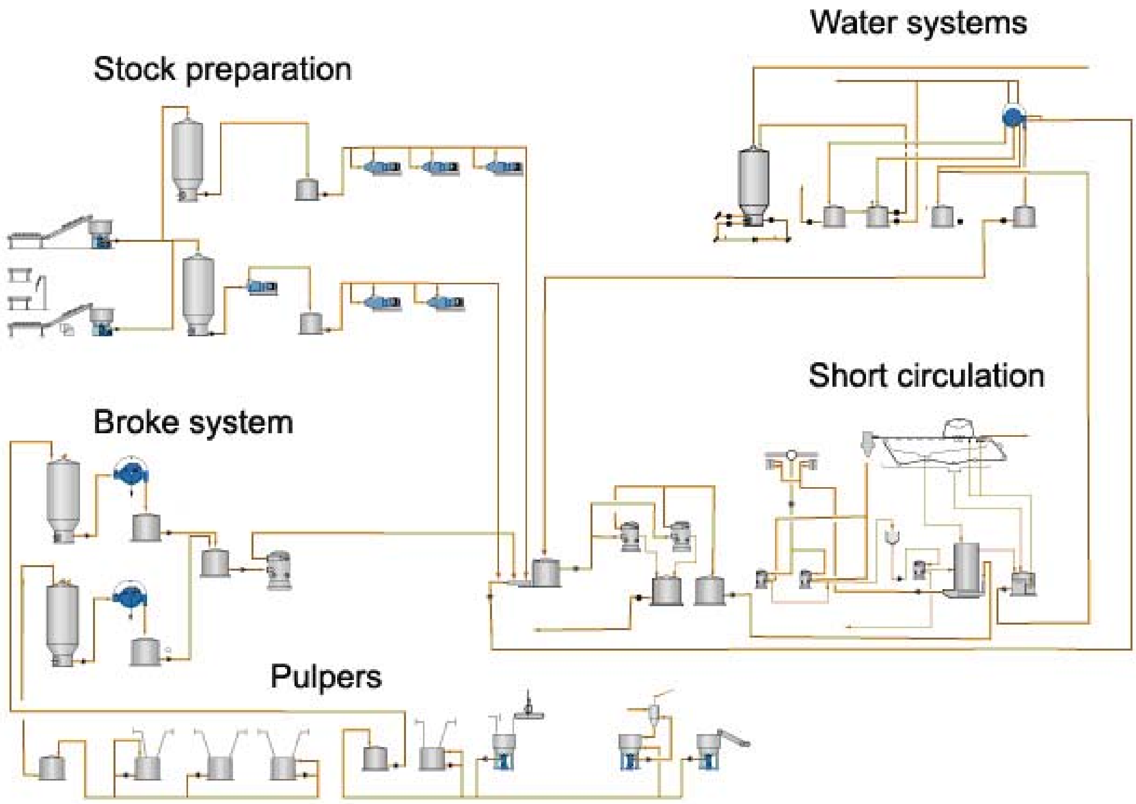

Figure 3. Flow-diagram of paper mill Stock preparation system.

The mixing, cleaning, screening stages are very import before it is conveyed all the way to the approach-flow-systems and at the end into headbox inlet where from it is transported again to wire section. Before the stock moves to the final destination; the system need the Broke configuration should perform properly. As you may see from Figure 3, the system consumes immense of water in different stages of its function on the process; mixing, cleaning and screening the prime consumer to those steps.

3.2 Water treatment (in – and out – systems)

In Finland, pulp and paper industry is still the backbone of industrial development; the national economy; and taking care of the forest resources has always been one of Finland's top priorities. The Convention on Environmental Impact Assessment (EIA) regulation executed first time, in 1991 February [1]. There it has been drafted to reduce and recycle the wastes in a harmonizing treaty with the European Council requirements; and that too to specifically the industrial wastewater. The pulp and paper industry accumulates for about 90 % of the load of industrial wastewater. The remaining is either pumped to municipal treatment plants or handled at other sources. Finland had about 50 pulp and paper mills during in1990s. Most of them are situated in south and central Finland. Pulp and paper mills are aware of their responsibility to success the EIA commitments. They contributed several fundamental improvement factors:

- monitoring the pollution and impacts;
- national water and air pollution programs;
- intensive research on environmental technology.

The pragmatic goal however, has been to reduce the discharge of oxygen consuming compounds: Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), suspended solids and phosphorus. Paper mills produce a variety of products and pursue different course of action that fit in individual mills and use most suitable treatment methods. Wastewater technology has been implemented and improved for the last 40 years or more. The Mills have now activated sludge plants and they are also equipped with biological treatment facilities. Aerated lagoons, trickling filters and many other types of anaerobic treatment have also been used. The general principles of cleaning technology; is drawn in Figure 4.

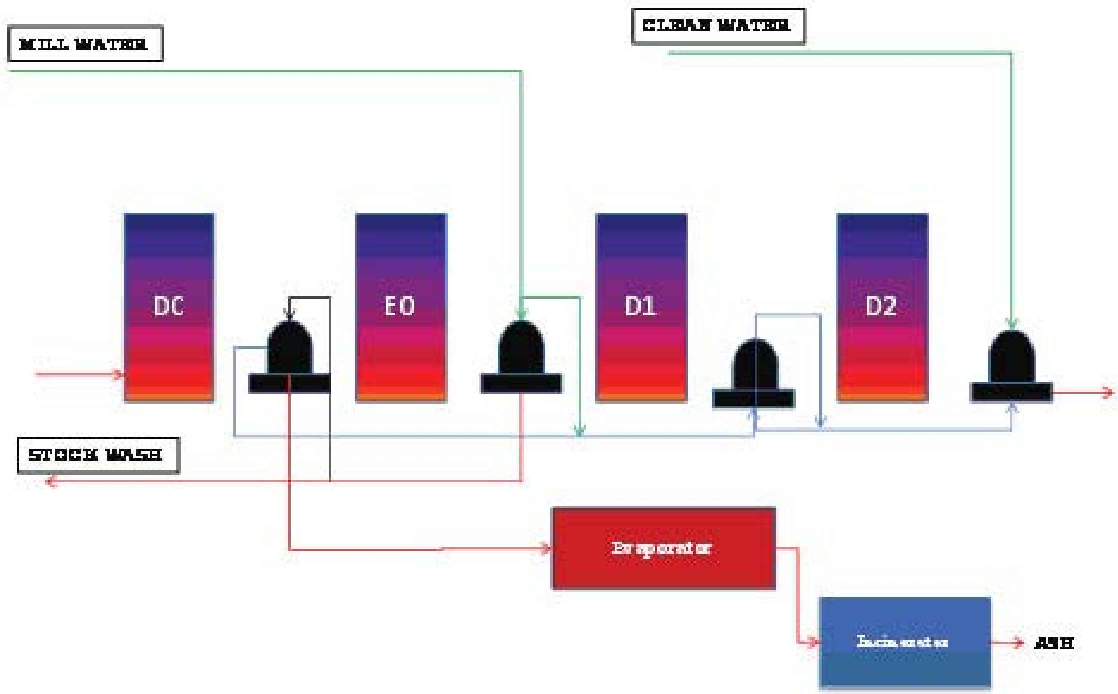

Figure 4. Closed Water System and Mill Water Concept.

During the operation, the wet end input consumes characteristically thousands of liters of water with the stock. Fiber is mixed at the pulpers; the logistic continues to the broke systems; circulates to next phase. Finally it transports by means of headbox of the paper machine via breast roll; to wire (short or long wire) and then the first pick-up roll start squeezing the web, in this process, meaning - "the wet paper sheet". The next phase of process is; sucking the water out; drying first at press part; conveying to the make-up (for example, pigmenting); sometimes the sizing; and to the drying section towards the reel; or calendaring and to the reel.

However, the main objective focused on to the input water; in different phases of the processes at its wet-end configuration; and then removing the water from the web to dry with an expected percentage of moisture at the reel; before to the subsequent level of process; that is for example the printing stage.

Water is consumed in three various ways; mixed with the pulp; make-up water; and cleaning water within the system. Make-up water is coming from the system to dilute certain chemicals; to modify the pH-values; and or tail-tip controls. Third-type of water flowing into the system is the cleaning one that is sprayed into doctor-blade cleaning; roll cleaning, wire showering, etc. This is again conveyed to the pit duck for purifying system. There are several steps in cleaning; the dirt collection, biological treatment, and waste handlings.

4 A methodology – to manage seamlessly the control systems

Product data management (PDM) is the discipline overriding the control of the product data and processes; used during the entire life cycle of a dynamic system. Nevertheless, the software configuration management is the regulation encircling the control; in parallel with little or no communication; between various others those are integrated, tagged within systems and machine configurations. Indeed, at this point many paper mills experience serious problems; information integration is found to be difficult to achieve; especially when managed by different tools from a mixture of domains. Why is this? There are many reasons; technical and nontechnical. Technically; it is complicated to convey the information between systems; in a capable mode, and to keep the information in many systems consistent. The interoperability could consequently; be a key factor in the competent management of the entire system information. However, water management including the treatment; that is “in and out” of the system; need immense of manpower and resources plus the engineering capability to handle and minimize the use of water and its purifying systems. The reduction segment has been overwhelmingly discussed in many platforms; though the result is yet to be ever reached.

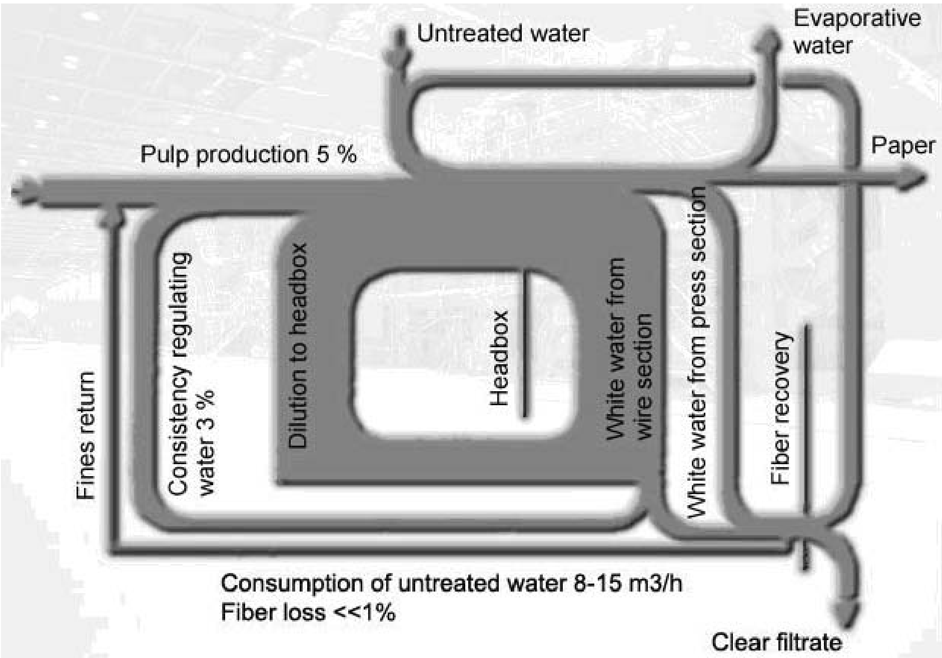

Figure 5. A typical Paper Machine Water circulation system.

The methodology introduced; to shed the incoming flows and channeling them through not the pit as usual but differently. This is a model-based disintegrating the water inlets and outlets; in their own channel directly from where it begins and ends at its distribution and purifying. The non-linear flows are maintained by simulating; “as and when needed”; online-basis; kept in “virtual-reality” mode. This system models pretty a numerous times. The perfections based on algorithms; are subjectively referred with internally built-in “authentic models”. This perfection models or images clearly liaison; simulate the fluctuations, modify them to need, notify the change, test, and record all the nonlinear activities within a timeframe of nanoseconds.

Unfortunately, it is difficult to implement any on hand; so to say, “typical” models or available tools on the market. The tools have their own specific API (Application Program Interface), and the functionality of many of these APIs does not completely match the functionality of the need. The repository layers are tightly integrated with the business layers, and it is therefore, impossible to build a common repository; by means of the repositories per se of the tools.

In this case; a loose integration operate more independently of each other and store data, exchange, in their own repository; and deliver and hook the meaningful data packs that comes from the perception models to a temporary folder for further function on-line, see Figure 6 for this purposes.

For a loose integration; it is necessary to crack semantic related function and data redundancy. It must also be detected which data each should manage, where the different data should be archived, and used to simulate; build, hold perception models, and re-direct the semantic knowledge-intensive meta-data to the next segment of action arbitrarily generated. The decision tree up in figure 6; looks complicated though they are punctually integrated to meet the process protocol of the domain systems of paper making.

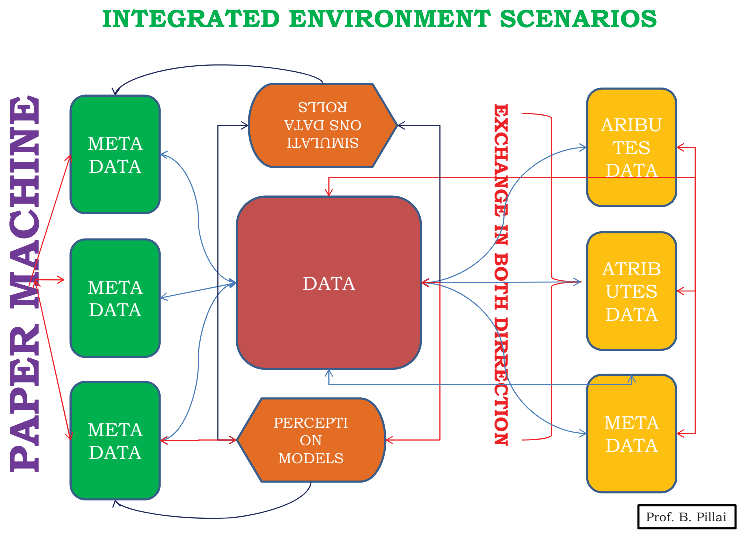

Figure 6. A specific Application Program Interface where different scenarios in an integrated environment

The data-set sharing here are rather interesting; due to information management and their re-use potentials. The repository systems cover many tiers of documents. Information contains one-way traffic of meta-data, exchanges of import/export and their import sequences. The system would also locate the hardware component data stacks; its interoperability scenarios, re-usable processed-data and their convergences. To illustrate the phenomena, you may see Figure 7.

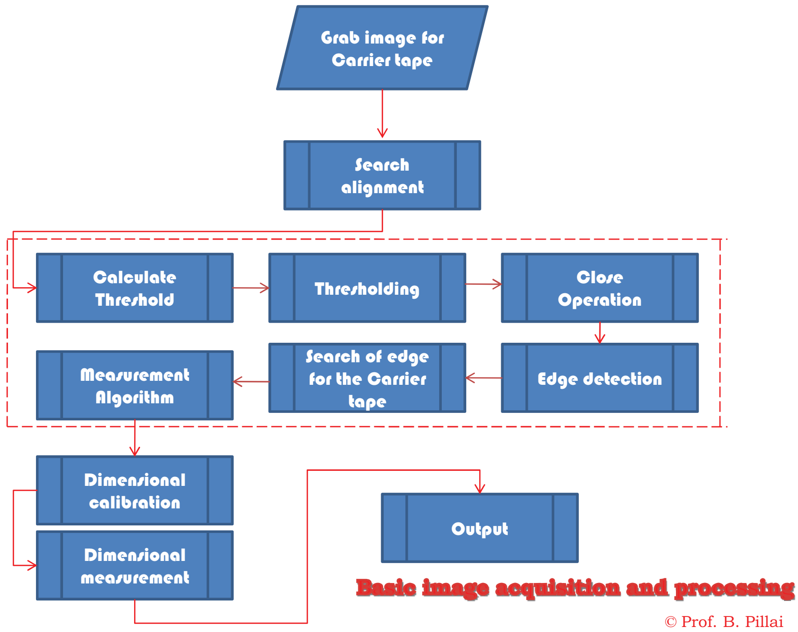

Figure 7. This diagram presents a type of image detection inserts in the system that uses surface reflections.

The above flow-diagram illustrates that the data stack trapping for a specific function where this now dictates us to an image collection in two-dimensional virtual reality format; rectifies the opportunity of application intense of this tool; when the entire paper machine is in full swing. This function adapts very effectually when modeling the perceptions; while keeping the complete process in-line, without a break or loose of efficiency. The wet-end process efficiency rate for a high speed newsprint paper machine theoretically 94 %; however, one could merely go beyond these calculated properties; due to threshold at its wet-end mechanical configurations, and geometry of the machine.

Generic PLC models can be implemented in different ways. XML is used for the specification of formats of data; exchanging data for protocols between different knowledge-based components; storing them and specification of new languages; including the information management processes.

And practically no water goes to environments; though all are being reused at the process system. The Euro (€) investment necessities are minimized; and also time-saving to put into action; meaning the shut-down time of the paper machine is significantly small.

This report is fundamentally done; based on practical experiments and implementation at a paper mill; with practical experiences of Professor, Dr. Sc.(in Technology), Balan Pillai, who worked at the paper producing mills for more than two-and-half decades. Therefore, not to be seen here, any specific references to attach the mission of this work.

5 Conclusions

In this presentation; we have exercised a typical paper mill site with on-line simulation, modeling, perception stamina, etc. The proposal here assumed was that the new system should eliminate the draw-backs of net-efficiency loss of the paper machine wet-end. We proposed here an embedded type of in-expensive and flexible system earmarked as

- Paper machine wet-end configuration arrangements
- Inlet and outlet water flow systems
- Water purifying methods
- Make improvements that should encourage the net-efficiency of the Wet-end to better level than today
- Proposing a new way of using the Information technology and communication protocols.

Information is a source of learning. But unless it is organized, processed, and available to the right people in a format for decision-making, it is a burden, not a benefit [2]. There are many types of technologies out there in the market; though the implementation face-outs are very seldom due to the popularized conservatism of the Paper Mill crew. A number of novel things come out in the market; they are the sales stories of the machine-builders. There are very few new technologies are being applied and or accepted by the Paper Mills; this is again the ignorance of the process engineers, who are out of touch in mechanical, electrical and control engineering disciplines. They have the *"nih (not invented here)"*- syndrome.

This article intended; to offering a realistic groundwork; in designing interoperability schemes; at the industrial environment for the future. We specified the requirements; and its challenges. Manufacturing industry has numerous setbacks; in developing systems and software for a smart environment is daunting task. There is sensor hardware and software perceiving the environment; application software that interprets and reasons about that perception data; and the effecter control software acting on the environment; as well as many support systems; makes the challenges to standards in posting them to Semantic Infrastructure or *per se* Semantic Web. This software is commonly called "*middleware"*. This middleware is the connectivity element; who joins applications through communication mechanisms creating transparency, scalability, and interoperability. It lies between the software applications it assists and the platform it is based on. Middleware classically resides; in a layer built directly on other layers of middleware; characteristically forming higher abstractions with each additional layer. Middleware must be designed by the API [*Application Programming Interface]* it provides to applications that utilize it and the protocol(s) it supports [3].

The proposed method was very successful one in a paper mill. The net-efficiency rate was greater than before in the initial phase; was one digit, and later improved nearly to two digits.

6 References

[1] *Advanced Environmental Technology from Finland*, published by the Government of Finland - Ministries of Foreign Affairs, Environment and Trade and Industry, 1993.

[2] Pollard, W: I*mplementing and Integrating PDM and Software Management*, Artech House, Boston, 2003.

[3] Bernstein, P.A.: Middleware: a model for distributed system services. Communication of the ACM, 39(1996)2, 86 – 98.