Information technology and potential positive environmental effects thereof in processing industries

Jochem Jantzen

Abstract

For most medium sized enterprises Information Technology has a positive side effect on the environmental performance of production processes. The effects on energy use and environment are relatively small compared to issues as production speed, quality, flexibility and cost-savings. It appears that more focus on the potential of IT applications in processes when aiming at reducing use of energy and raw materials and emissions could increase the “value” of IT applications in process industry for environment.

1. Introduction

Processes used in industry are main contributors to the pollution of the environment. Pollution occurs because not all process inputs are used in the output (products). Process optimisation helps to reduce the environmental pressure caused by these processes. It is clear that in process optimisation the role of Information Technology (IT) is growing. So it is interesting to investigate how the application of IT in production processes interacts with the environmental pressure: is there any effect or does the application of IT not influence environmental performance of enterprises?

This was the main question addressed in a project (partly funded by NOVEM, the Dutch Organisation For Energy and Environment) carried out by TME, the Institute for Applied Environmental Economics. The project focussed on the use of IT in processes in Medium Sized Enterprises as to find out what the potential positive effects of Information Technology on environment might be.

For this purpose a postal inquiry was held under approximately 400 enterprises in the process industry\(^2\) (TME, 2000a). About 50 firms replied to the inquiry. Addi-

---

1 Jochem Jantzen, M Sc, director of the Institute for Applied Environmental Economics (TME), Louis Couperusplein 2, 2514 HP The Hague, The Netherlands, + 31 70 3464422, tme@tme.nu, www.tme.nu

2 Limited to food and beverage, paper, chemical and metal industries, with 100-500 employees
tionally, some in depth interviews were carried out to investigate the day to day practice in the use of information technology and their influence on environmental issues.

2. **IT in production processes**

The use of IT in production processes can be classified in three layers:

- Process management and monitoring (measurement and control);
- Process optimisation (modelling and simulation algorithm);
- Process design.

The first layer refers directly to a process, where continuous feedback makes it possible to optimise a process unit (e.g. constant quality of inputs, controlling mixtures, etc.). The second layer relates to process steps and linkages between process units. For example if a machine is used for various different products for different clients, process optimisation enables efficient planning of batches, reducing costs, losses, etc. The third layer relates to the design of production processes. IT enables visualisation of a process at a detail that cannot be achieved in another way.

Nowadays, IT applications can be found in almost all production processes in Medium Sized Enterprises. On average the respondent to the inquiry use about 10 processes, of which the most common are: heating, transport, dosing, cooling, mixing. These processes are used by almost all respondents. Next to this some more specific processes are used like vaporising, distillation, crystallisation, freezing, chemical reactions.

In most processes IT is applied. This is in general limited to the “first layer”: PLC-SCADA is applied by 70% of the respondents, equivalent IT-applications (DCS, APC) much less. For process optimisation use is made of Quality Management, Process management or Data Collection/Acquisition. Such IT-applications however are limited to certain processes. 30% of the enterprises did not have any IT application from the “second layer”.

The reason why enterprises apply IT in processes are summarised in the following table:
As could be expected, process control is on the top of the list, but also monitoring, optimisation and cost-savings are important reasons to apply IT. One of the enterprises interviewed mentioned that in the current economic situation in the Netherlands (fast growing demand, friction on the labour market) IT was used to facilitate the rapid growth of production without needing more labour (Purac Biochem, 2000). The rapid growth of production during the last years is also a reason that the focus of Purac is on increasing production capacity. Little attention – given the circumstances – can be given to IT applications from the “second layer”. This is also confirmed by other enterprises interviewed: facilitating production growth is a main concern, other uses of IT do have less attention.

Environmental and energy concerns are not a main reason to apply IT, but still in 10% of the cases IT was specifically applied for to reduce or control pollution or energy-use.

The main effects of IT-applications are an improved production speed, quality, flexibility and financial profit. About 30% of the enterprises report that these effects are “large” (more than 10% improvement).

### 3. Environmental effects of IT in processes

The effects of IT-applications on the environmental performance of enterprises are relatively small as shown in the next figure.
It appears that the majority of enterprises report some positive environmental effects of IT-applications, though the effects are in general small. Only about 10% of the enterprises report large positive effects on use of energy and raw materials and waste. The results of the inquiry suggest that there is at least a weak link between the reason to apply IT in processes and the reported environmental effects. If the reason to invest in IT is “energy” or “environment”, reported effects are on average larger than for enterprises that do not apply IT for these reasons.

So as a first conclusion it can be stated that IT-applications in process industry do have a positive effect on the environmental performance of companies. This positive effect is in most cases small (can be regarded as a side effect) and in few cases large. As most enterprises state other reasons than “environmental concerns” to invest in IT, the positive environmental effects could largely be regarded as an “external effect” of IT-applications. Moreover, the results suggest that in the future there is a larger potential for positive environmental effects than shown in the results, as only few enterprises focused on environmental concerns when applying IT. It could be argued that more attention for the environmental dimension of the processes when applying IT would increase environmental improvements.

4. Environmental improvements and the use of IT in processes

From a theoretical viewpoint at least three areas where IT could have a positive influence on the environmental performance of processes can be distinguished:

- The IT-application replaces a process unit. As a result the pollution that occurred by using the replaced process no longer exists. An example hereof is the
“computer to plate” technology in the printing industry. In the common production first a lay-out is made, this is put on film, and the film is used to produce the plate. The plate is used to print. In the innovated process, the lay-out – made on a computer – is directly put to the plate, making the step “lay-out to film” redundant. This saves the use of developer, films and fixative and thus emissions, waste and water-pollution with heavy metals (TME, 1996);

• By the IT-application the process is optimised, minimising the use of raw materials and pollution. This can be achieved by applying PLC-SCADA to measure exactly process conditions. An example of this type of IT-application was given by the DOC cheese factory: by applying IT to control process condition they were able to reduce the use of water in the process of cheese production by 40% and the chemical oxygen demand (measure of organic pollution of wast water) by 60% (DOC, 2000). Another example is the reduction of VOC-emissions as continuous remote sensoring is applied to measure air-quality in the petrochemical industry to optimise maintenance of valves etc. (Jacobs/Comprimo, 2000). A last example is the monitoring of the functioning of process installations and datastorage and analyses. By doing so the maintenance can be optimised, it leads to less breakdowns of the installation and thus less pollution (Jacobs/Comprimo, 2000);

• Application of IT facilitates an innovation, that can only be achieved through the application of IT. Examples are printing of textiles with ink-jet technology (saves ink, jets can only be applied by the grace of IT) (Procos, 2000); application of reverse osmosis as additional step in a drying process (to save energy, where reverse osmosis can only be applied by grace of IT) (Frico Cheese, 2000). In the future van Doorne Transmissions needs to lower concentrations of heavy metals in waste water. This can be achieved by recycling these heavy metals and re-introduced them in the production process. For this continuous measurement of concentrations is necessary, that can only be achieved by IT-applications (VDT, 2000)

From the postal inquiry and the interview it is clear that in the vast majority of cases when IT is implemented, no specific attention is given to environment. It also seems that if specific attention is given to the environmental aspects of a process (“cleaner production”; “eco-design”) solutions can only be implemented if also some (new) IT applications are included, to enable the innovation. In this case IT is not directly responsible for the environmental improvement but indirectly: the innovation is made possible by the use of IT.
5. How can environment profit further from IT applications in processes?

Most enterprises report that in the future they aim at further reductions of energy use (70% of enterprises), water use and waste water (50%), waste (40%) and emissions to air (dust, odour (20%)). So, these enterprises will have to focus some of their attention towards these environmental improvements. A clean production strategy that would profit optimally from IT applications in this sense could be as follows:

- Make an inventory of process steps that have a potential to be improved (from an environmental point of view);
- Investigate possible technological modifications needed to improve the processes (“cleaner production”);
- Investigate to what extent IT applications can help to enable the technological modifications.

An example could be the reduction of pollution when changing batches (for example in the paint industry). The changing of batches leads to pollution and waste as the process installation has to be cleaned and part of the inputs are “washed” away. The technological modification then would be to limit the loss of inputs, by knowing exactly how much inputs are needed for the batch (better dosing), and by knowing when the installation is clean (by precise measurement of the contamination). IT applications could be in measuring and dosing inputs and measuring contamination and dosing detergents.

Following this schedule to identify potential IT applications with a positive environmental effect will not be an easy task as it appears that specialists from the IT-sector do have little or no knowledge on environment or even the processes they are working on. On the other hand environmental specialist hardly have any knowledge of what is possible with IT-applications.

The inquiry also asked enterprises which parties are involved in implementing IT-solutions. It appears that in most cases (90%) there is some or much involvement of external advisors. An important role could be played by the suppliers of production equipment and installation companies, in 50% of all IT-applications there was an involvement of these (“process”) suppliers. As the knowledge of these suppliers covers the processes and the IT-applications therein, and the suppliers often also have insight in the environmental performance of “their” process, these suppliers may hold the “key” for environmental optimisation of processes by applying IT (or embedded IT).

Software engineers also play an important role in the implementation of IT in processes. However, it can be argued that their role in process optimisation is less profound than for the suppliers, as they have less insight in the physical side of the production process and (mostly) completely lack knowledge of environment.
6. Conclusions

As the research was limited and the subject of the research is complex it was not possible to quantify precisely the positive effect on environmental performance in the process industry of IT-applications.

However, some general conclusions on the application of IT in processes can be drawn from the examples discussed with industries:

- Process control by IT-application in general will help to improve environmental performance of companies. As the basics of the processes will not change (cheese will be made from milk) the environmental improvements are limited to physical boundaries (cheese has a higher dry substance content than milk and thus in general leads to waste water);

- IT-technology is very important when production process routes are changed. Using filtration technologies instead of drying to increase dry substance contents of half) products is only possible when IT is applied; using new painting/printing technologies (inkjet) is only possible with IT applications. IT-applications are therefore often a “must” to implement new production technologies;

- IT-technologies can sometimes replace physical technologies (in printing industry the “computer to plate” technology makes the step “developing of films” redundant and thus reduces environmental pressure of printing (heavy metal emissions, waste films);

- Use of IT-technology in product development replaces often expensive (physical) tests and can predict the performance of new products. Two examples: a new diesel engine design was developed in America by applying simulation models without any physical testing. It appeared by running various variations that environmental performance as well as energy use can be substantially be reduced by one of the many tested designs. An enterprise specialised in the production of lactic acid uses IT to design new production processes, saving money and environment.

The overall conclusion is that IT-applications potentially can have a large positive influence on environmental performance of production processes. To achieve these benefits it seems that a special focus on the environmental aspects of IT-applications in process industry should be more on the foreground. An active approach an integration of environmental concerns when new IT-applications are implemented (or when new – IT-dependent production technologies are applied) instead of the current approach (mainly “side effects”) would be a prerequisite to achieve these benefits.
Bibliography

DOC (2000): Interview with Mr. Faber of DOC Cheese, Hoogeveen, 2 May 2000
Jacobs/Comprimo (2000): Interview with Mr. Cronenberg of Jacobs/Comprimo, Amsterdam, 10 May 2000.
Procos (2000): Interview with Mr. Hendriks and Mosselman of Procos (software engineers), Gorinchem, March 2000.
Purac Biochem (2000): Interview with J vd Perk, Gorinchem, 13 April 2000
VDT (2000): Interview with Mr. Van Zundert of van Doorne Transmissions (subsidiary of Bosch), Tilburg, 4 May 2000.