Interactions between Energy, Information and Growth

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ABSTRACT

My talk will have four sections. The introduction connects my topic to the conference theme. In part two, I will talk about energy conservation; the mutual substitutability of energy, time and information; and some fundamental aspects of the nature of these three quantities. In the third part I will present some results of empirical analyses of this mutual substitutability. Finally, in the fourth section, I will speculate on what these results may mean in term of ICT's effects on sustainability, mindful of the role of time and economic growth in this interaction.

ICT holds great potential to contribute to sustainable development. Doing things in a more controlled and intelligent manner can be an essential ingredient for a long-term viable future. Often energy consumption is used as a proxy for sustainability. The theme of this conference, then, is the effect of ICT on energy consumption.

In the 1970s I thought about energy conservation and postulated that in order to conserve energy, either time or information or both were needed. To do any given job, some amounts of energy, time, and information are required. Reducing the energy input is achieved by increasing the time and/or information input for the job. The various ways of doing a job are then represented by points in an equilateral triangle, the distance to the sides measuring the amounts of the three inputs applied to the job.

I will present one application of this idea in order to give the audience a feel for this triangle. It involves positioning economic sectors within this equilateral triangle by calculating for each sector the cumulated energy and cumulated time (labor) input to produce a good or service worth a dollar and then examining what the relative, cumulative information input is, assuming no other input is necessary. Standard economic theory would suggest that besides labor, capital is the most important input, supplemented perhaps by additional resources other than energy. However, focusing on physical inputs at the level of the triangle, one can argue that energy is reasonably good proxy for any resource and that capital is money earned at some earlier time period and therefore not much different from cumulated labor. Marx called capital "geronnene Arbeit," labor hardened like blood.

The result of plotting economic sectors in such a triangle (Fig. 1) is supportive of the idea of substitutability and also hints at the meaning of cumulated information [1]. Cumulated information turns out to be high in modern, high-tech industrial sectors.

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Research my group did in the 1980s involved looking carefully at the effect of introducing computers in various parts of textile industry. The heart of the research, the PhD thesis of Rolf Bergrath, was an examination of the energy conservation potential of electronics used for air conditioning spinning mills. As it turned out, the energy conservation potential was huge.

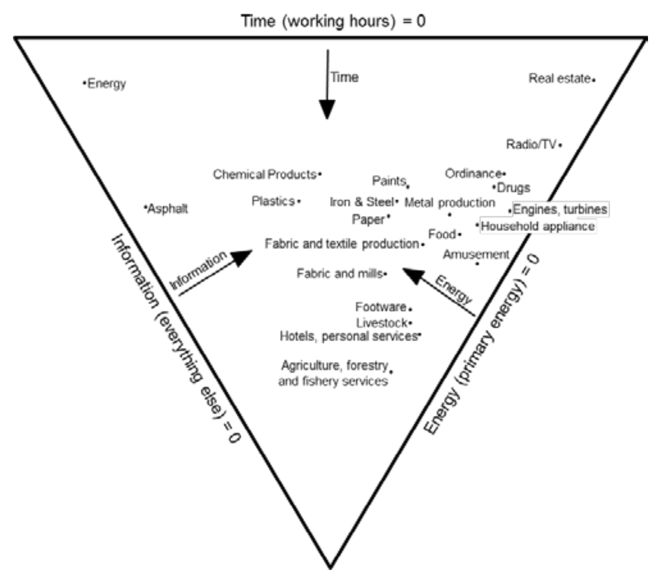

Figure 1: Industrial activities require the energy, time and information inputs in various proportions [1].

The automated control in all corners of the mill allowed the safety margins to be reduced and thus the temperature at which the climate had to be set could be increased. As the electricity requirement for air conditioning is a large part of the cost of spinning, this reduction in the cooling requirement proved to be economically important.

However, as it turned out, electronics also improved the spinning machines. The much more tightly controlled spinning process allowed higher speeds without increasing the frequency of yarn ruptures, a decisive factor for the productivity of the mill. The higher speed caused much more heat, and thus the energy requirement for air conditioning did not decrease. The energy requirement per yarn may have decreased, but the energy requirement in the now more productive mill increased rather than decreased.

Similar effects could be observed in all parts of the textile industry. However, with the introduction of computers everywhere in the industry, including the commercial side, the industry as a whole could react more quickly to the wishes and whims of the market, thus greatly speeding-up fashion cycles and increasing demand. The overall effect of the early introduction of modern IT in the textile industry was so profound that it could not be rigorously quantified. It was difficult to isolate the effect from changes that occurred in the global economy as a whole [2]. The only definite conclusion is that IT — and certainly also ICT — greatly amplifies the potential for both increases and decreases in energy consumption; they enable both significant energy conservation measures, on the one hand, and new business opportunities and new ways of speeding-up production and demand on the other.

A technology assessment of the potential for new power electronics to reduce energy demand came to the same conclusion: although power electronics does reduce the energy requirement of a given application, on the level of the economy as a whole the effect is more likely to be a speeding-up of industrial production, travel and consumption and thus an overall increase in economic activity and energy demand, even if energy efficiency has been improved at many points [3].

In my opinion many discussions of the rebound effect do not pass a reality check. Pure energy conservation measures are rare. Most technological innovations called energy efficiency innovations are innovations that among other things improve energy efficiency. Often the innovation also includes some co-benefits such as reduced cost and higher convenience (e.g., time savings for the user) which will generate economic growth. More often than not, as with ICT in the textile industry or power electronics, the energy efficiency effect at the level of one application does not lead to energy conservation on the macro level.

Time is money. As long as time costs more than energy, ICT will likely be applied to save time rather than energy. The time saved may be labor on the production side or it may be time saved, i.e. greater convenience, on the consumer side. Economic growth is often regarded as the remedy for unemployment. However, promoting ICT applications indiscriminately is not a good way to combat unemployment. ICT, although very suitable to push economic growth, often contributes to growth by saving labor.

Only if ICT is applied discriminately to do things smarter, wary of automation and higher speeds, will its increased use lead to higher economic growth, without reducing the labor intensity of products and services. This type of growth has the potential to be less resource intensive as well. The debate on aiming at qualitative growth rather than quantitative growth held in the 1980s has almost been forgotten but needs to be revived.

REFERENCES

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