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The Environmental Impacts of E-Commerce

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In just a few years, the Internet has grown from an obscure academic tool to a worldwide community of some 300 million people. It has also emerged as an important medium of trade, particularly among businesses. Notwithstanding the recent dot-com collapse, worldwide business-to-business (B2B) e-commerce sales will grow to $8.5 trillion by 2005, and represent some 75% to 85% of the world's total e-commerce revenue (Cohen 2001).

B2B E-commerce, 2000 – 2005 (in $billions)

2000	2001	2002	2003	2004	2005
$433	$919	$1,900	$3,600	$5,900	$8,500

source: The Gartner Group, 2001

B2B e-commerce will continue to expand because it is a powerful technology that can improve the efficiency of producing and distributing goods and services. It has the potential to streamline the supply chain, from the point of resource extraction to manufacturing, shipping and residuals management. By automating production, tracking inventory more effectively, making transportation more efficient, and improving cradle to grave management, B2B solutions can result in significant environmental benefits while reducing costs.

Industrial Efficiencies

For example, firms can use the Internet to forecast demand more accurately, thereby reducing inventory and product waste, as well as the energy and materials required to warehouse and transport products. Using web-based programs, firms can find out exactly what product a consumer wants before it is produced, and thanks to more efficient communication via e-mail, how it is working and what modifications or maintenance is needed after it is purchased.

To achieve these gains, however, transportation systems must be efficient and the e-commerce system – from the sourcing of supplies to the end-of-life management of products – must be designed with environmental considerations in mind. One stu-

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dy of computer manufacturing illustrates the importance of transportation choices and product take back and recycling to reducing energy consumption (Caudill et al. 2000). The study's baseline analysis was a traditional commerce model for desktop computers, in which manufacturers predict demand based on sales data, mass produce machines, and then warehouse them and then ship them to intermediary warehouses, where they are then transported to retail stores. In this scenario, consumers are assumed to do comparative shopping and transport their purchase home by car. The entire cycle from the manufacturer to the home consumes an estimated 6004 Mega Joules (MJ) of energy.

An integrated e-commerce scenario combines retail online sales with B2B e-commerce methods for procurement of materials and components, along with management of the computer at the end of life to encourage reuse and recycling. Integrating B2B and B2C results in energy savings from reduced manufacturing waste, overproduction, and warehousing, as well as savings in materials reclaimed from old computers taken back by the producer. In this scenario, energy consumption is 5823 MJ if shipped by air and 5320 if delivered by truck a 3% or 11% energy savings. Of course, e-commerce merely facilitates efficient manufacturing, transport, and product take back. The development of a recycling infrastructure to recover products after their useful lives, and product take back requirements, are necessary to realize these gains.

Hypothetical Energy Consumption for Computer Production and Sales (in MJ)

	Traditional Model	Integrated Model with Air Shipping	Integrated Model with Ground Shipping
Materials	2913	2622	2622
Manufacturing - warehouse	2	1.6	1.6
- production	2920	2628	2628
Distribution (transportation from manufacturer to distributor to retailer)	105	587	84
Retail Store	4	3.5	3.5
Delivery to Consumer	60	2	2
Reuse/Recovery	0	-21	-21
Total Energy Consumed	6004	5823	5320
Percent Energy Saved		3% saved	11% saved

source: Caudill et al., 2000

The savings from internet-enabled logistics are more than just hypothetical. Toyota's just-in-time delivery system uses the internet to determine which parts are required where, and at what time, and then converts this information into orders for hundreds of suppliers. The system is able to reduce plant inventories by 28% and energy-consuming warehouse space by 37% (Romm, 1999). Ernst & Young has estimated that collaborative planning systems between manufacturers and suppliers could reduce inventories by $250 to $350 billion across the economy (Ibid).
One of the best opportunities for reducing energy consumption is through the use of the internet to improve shipping systems. Mark Greenleaf, e-commerce strategy manager at Ford Motor Company, has noted that in the automobile business, trucks travel at only 40% capacity at any given time. Ford is investing in internet-based logistics solutions and telematics to dramatically increase the capacity utilization of its shippers, reducing the transportation energy required per item shipped (Greenleaf 2000). According to a recent white paper published by the Volpe institute, US firms have been able to cut logistics expenditures in half by incorporating information technology. Experts estimate that IT has played a significant role in reducing expenditures on logistics from 20% of US GDP in 1960 to 10.5% as of 1996 (Downey 2000).

Dematerialization

The Internet is beginning to displace a wide range of printed materials, from textbooks and corporate brochures to encyclopedias. The technology for displaying text on a computer screen will have to improve before electronic books make substantial inroads into the market for printed text, but as dedicated electronic reading devices are improved and made more user-friendly, more and more people will opt to read electronic versions of paper documents.

With paper one of the most energy- and resource-intensive industries in the economy, the environmental savings could be substantial. Including transportation, production and raw materials, the carbon dioxide reductions achieved for each ton of paper avoided are estimated at 3.3 metric tons for newspapers and 3.8 for office paper. According to one study by the Boston Consulting Group, the internet will reduce demand for paper in the US by 2.7 million tons by 2003 (Romm et al. 1999). Calculations by the Center for Energy & Climate Solutions estimates such a reduction would be the equivalent of removing 2 million cars from the road, cutting annual emissions of carbon dioxide by 10 million metric tons.

One example, the lowly telephone book, illustrates the possibilities. Approximately 470,000 tons of telephone books are discarded each year in the United States, yet only 10 percent are recycled (Cohen 1999). The main functions of the telephone book—data storage and retrieval—are performed far more efficiently online than on paper. Telephone books go out of date each year, but electronic versions, like France's Minitel, can be updated continuously. Online directories are national in scope, offer various searching capabilities, and require no ink, paper, or delivery vehicles.

Travel guides, textbooks, and instruction manuals are other documents well suited for electronic formats. They require constant updating, a process that can be performed electronically without producing waste. Custom publishing, one of the fastest-growing areas of the college textbook business, is another example of how e-commerce business models can also result in waste reduction. As publishing on demand expands, the industry may be able to eliminate overstock in sectors other than textbooks.

The Paperless Office Redux

While paper consumption is unlikely to decrease in the near future, electronic business applications can help stem the *increase* in paper use, and related energy and materials consumed to print, store, transport and dispose of bills, contracts, and other physical records of internal business transactions. The Universal Postal Union estimates that e-mail will displace 12 percent of the flow of business-to-business mail in Western Europe and North America by 2005, and 5 percent of business-to-consumer mail. And electronic billing is growing in acceptance, in large measure because it saves an estimated 50 to 75 cents per bill in envelopes and postage, and another $1 in handling costs (Walker 1999).

For example, Ericsson is changing its corporate procurement into a paperless, automated system that is saving money and cutting paper consumption. The centerpiece of the system is a wallet-sized plastic card, known as a purchasing or p-card. Staff use p-cards to pay for purchases according to predefined parameters. The cost savings are enormous, with an average cost per p-card transaction of $15, compared to $91 using traditional methods of payment. A large gain was realized when Ericsson moved its procurement system onto a corporate intranet, which eliminated much of the paperwork. At the end of every month, Ericsson receives two electronic files from its p-card provider, American Express -- an invoice, along with a breakdown of spending card by card, department by department, cost center by cost center (Saran 2001).

The British insurance company Royal & SunAlliance claims that its online procurement system has improved the efficiency of its purchasing and is saving 1.7 million sheets of paper a year (Wilsdon 2001, see also pp. 58-64 in this volume). According to the Center for Energy & Climate Solutions, Cisco estimated it saved $50 million a year by storing its product and pricing information on the Web. Digital Equipment Corporation estimated that putting its promotional materials online saved $4.5 million annually in catalog and mailing costs. AT&T has cut annual paper consumption by more than 400 tons by changing from a 1,500 page paper personnel guide to an online resource (Romm et al. 1999).

Annual US Consumer Electronic Bills Paid, 1999 to 2004

	Total Households Enrolled in Electronic Bill Presentment and Payment (millions)	Electronic bills paid as % of total consumer bills
1999	.13	0.01%
2000	.62	0.04%
2001	2.12	0.56%
2002	6.0	2.98%
2003	13.04	7.61%
2004	20.70	13.08%

source: PriceWaterhouseCoopers, 2000

The impacts of moving transactions online may extend to the physical structures traditionally used to process paper. According to James Culberson, President of the American Bankers Association, half of all financial transactions in the U.S. will soon be conducted electronically, with one-third of all bank branches closing as a result. The number of travel agencies in the US has declined dramatically over the past several years, in large measure due to the use of online booking services (Wilson 2001). Consolidating the functions of banks, insurance offices, and ticket agencies into fewer physical structures will reduce the energy consumed by these facilities.

Smart Green Products

Forward-thinking companies are redesigning products so that they can receive information from the Internet and be controlled externally. This technology has the potential to make products far more effective, efficient, safe, and long-lasting, with all the attendant environmental and health benefits.

One recent example is the use of internet-connected thermostats to shave peak load energy demand to avert the need to construct new power generating facilities. In Long Island, New York, the power authority has just instituted a program using wireless technology to remotely control central air conditioners via two-way, internet-based system. Under the program, 5,000 residential customers will receive an internet-connected thermostat made by the Carrier Corporation that will enable them to fine tune their air conditioners, as well as allow the utility to remotely control the units on peak summer demand days. The authority estimates that the thermostats will enable consumers to save 10-15% of their energy costs and save 5 megawatts of electricity during each peak period. When the program is fully operational, 30,000 residential and small businesses will participate, saving an estimated 30 megawatts of summer peak demand –an amount equivalent to an additional turbine generator.[2]

Rome-based Merloni Elettrodomestici, the fourth largest household-appliance vendor in Europe, has developed a line of digital refrigerators, washing machines and dishwashers with remote Internet-control features that save energy by allowing homeowners and local utilities to monitor the power consumption of each appliance. Using web-based micro-management, individual appliances can be powered-down during peak loads and programmed to operate during off-peak periods when utilities have excess generating capacity. With the right economic incentives, this can save consumers money, cut energy use, avert the need for utility grid brownouts and blackouts and relieve pressure to build new generators.

The development of inexpensive radio frequency tags to identify the products to which they are attached may enable us to more accurately track their movement through commerce and into final recycling, reuse, or disposal systems, automating producer responsibility programs. According to John Seeley Brown and David Rejeski, manufacturing systems could be designed to keep track of products, manage inventories better, alert operators when products need repair or replacement, and enable manufacturers to ensure that they make their way back to the appropriate facility for remanufacturing or recycling. Other environmental applications are being developed, from vehicles equipped with sensors that monitor and control their emissions to sensors to help farmers optimize their water and fertilizer use and minimize the use of chemical pesticides (Brown/Rejesky 2000).

The Internet also makes it easier for firms to continue providing customers with information and advice after they make a purchase. Suppliers can provide product updates, recall information, and instructions on safe product use, proper maintenance for optimal performance and energy efficiency, and options for recycling, refurbishing, and disposal.

“Servicizing” for Efficient Use

The internet helps businesses to shift from simply selling products to offering the functionality of their products, which the Boston-based Tellus Institute has called 'servicizing,' on a more environmentally-efficient fee-for-service basis. For example, Electrolux is piloting a service-oriented business model with a view toward offering competitive products that reduce the environmental impacts associated with their use. One offering that has emerged from this is a digital pay-per-use washing machine that provides the functionality of clothes washing without actual ownership of the appliance.

[2] Carrier Corporation Website.

In a pilot program on the Swedish island of Gotland that was launched in November 1999, 50 households were provided with Electrolux's energy-efficient digital washer. Participants are charged approximately $55 for the installation plus $1.12 per wash - a variable fee that appears on their monthly electric bill. Computers connect the machines to a central database and so-called 'smart energy meters' in every home. This allows the local energy utility and Electrolux to track usage and to analyze energy consumption. Electrolux services the machines and replaces them after 1,000 washes (about 4-5 years for a normal family). Used washers will be recycled or refurbished and resold by distributors (Cohen 2000).

According to research conducted by Electrolux, families with "pay per wash" plan their laundry more effectively. For families, this means savings. For the environment, this means reduced energy use. According to research for the European Commission, roughly 90 percent of the environmental impacts of a washing machine come from actual use, not manufacturing or disposal. Encouraging more efficient washing practices, and regularly upgrading machines, is likely to save energy, water and detergent and also to extend the life of the appliance. In locations with high peak electricity demand, utilities could also offer incentives for consumers to run the machines off-peak, thus helping to shave peak energy demand and averting the need to build more generating capacity (Cohen 2000).

Green Buying

The industrial secondary materials market has also migrated to the Web. Numerous sites help companies find buyers for materials they no longer need, reducing waste disposal costs and generating revenue at the same time. One company, RecycleNet Corp., is a B2B exchange in which companies can list materials for sale or purchase. At the end of 2000, the company reported $2 million in revenues for the year, a 250% increase over fiscal 1999. A wide range of materials can be bought and sold at the company's Web site, recycle.net, including scrap metals, plastics, paper, used equipment and surplus inventory. Users can log into the website to find either buyers or sellers of products.

E-commerce solutions can also make ecological purchasing much easier for businesses and government agencies who have institutional commitments or regulatory mandates to buy green. Green B2B websites can give ecological comparison shopping an entirely new dimension, both automating it and making it virtually transparent to purchasing agents. First generation websites like www.greenorder.com offer comprehensive catalogues of green products. In the future, computer search engines may be able to scour web sites by key words, concepts, amounts, or virtually any criterion that can be defined by words or numbers – including green characteristics like energy efficiency and recyclability.

The sheer ease with which the Internet allows for searching, sorting, and filtering information also makes it much easier for environmental organizations or socially responsible investment firms running a “green” search engine to target a bad product or a company whose practices are environmentally unsound for boycotts.

What are the Rebound Effects?

Futurists have failed miserably at predicting the impacts of technology. Forecasts in the 1970s of the paperless office were clearly wrong. Between 1988 and 1998, as the computer became not only ubiquitous but also capable of storing far greater amounts of data, the average per capita consumption of printing and writing paper in industrial countries shot up by 24%. Paper consumption continues to increase on a per capita basis and in absolute tons even during the late 1990s, a time when personal computers diffused widely through businesses (see Abramovitz/Mattoon 1999).

Office Paper Consumption in the US, 1997 to 1999 (in thousands of tons)

1997	14,169.9
1998	14,275.5
1999	14,829.7

source: American Forest and Paper Association, 2000 (cited in PaperCom 2000)

At this early stage in the transition to e-commerce, precise predictions of its environmental consequences are impossible to make. Both the practice of e-commerce and its underlying technology are evolving rapidly. As a result, the long-term impacts of e-commerce — including its effects on product design, packaging, energy, transportation, and land use — are still unknown.

Limiting our analysis to too narrow a geographic area can also result in distorted results. While e-commerce has the potential to improve efficiency at the firm level, its ability to facilitate global production in dispersed locations may have negative environmental impacts. Shifting production processes to countries with lower labor costs can lead to an increased volume of transport. And, efficiencies achieved by multinational firms may be achieved at the expense of smaller suppliers who may have to maintain *larger* inventories in their facilities to ensure just-in-time deliveries of parts. Furthermore, just-in-time systems rely on overnight air freight movement, which is much more energy intensive than slower transport modes (Fichter 2000, see also pp. 109-118 in this volume).

And, we should not underestimate the power of physical interaction in physical space. While some analysts have forecast that the internet would reduce demand for commercial real estate as online ventures substituted for traditional downtown businesses like travel agencies, banks, insurance companies and bookstores, there is little empirical evidence to support this theory. In fact, the trend is in the opposite direction. As Berkeley geographer Matthew Zook has pointed out, in 1999 50 of the top 100 revenue-producing dot com firms were pure play internet companies (with no storefronts). In 2000, only 30 of the top 100 internet firms had no physical presence. Indeed, some of the urban areas that have benefited most from the internet economy have actually seen a huge demand for offices, server farms, and warehouse space (Zook 2000).

An even larger unanswered question is whether there will be a "rebound effect" resulting from the efficiency improvements. If e-commerce streamlines business and lowers costs, will it lower prices, increase aggregate consumption, and thereby wipe out any environmental benefits? Moreover, some of the efficiency gains achievable through internet-enabled processes are simply marginal improvements to inherently unsustainable production and distribution systems.[3] For example, using telematic applications to increase freight capacity may save diesel fuel in the short run, but ultimately only a transportation system based on renewable, non-polluting resources – perhaps fuel cells powered by solar-generated hydrogen -- will be truly sustainable.

[3] The hardware comprising the internet is not environmentally benign. Figures from the European Union's waste electrical and electronic equipment (WEEE) directive show that in 1998, 6 million tons of waste electrical and electronic equipment were generated in Europe, amounting to 4% of the municipal waste stream, a volume that is expected to increase by at least 3-5% per annum.

Designing a Sustainable Digital Economy

An awareness of both the benefits and potential environmental pitfalls of e-commerce can help us avoid the most adverse effects. Proactive steps taken by consumers, industry, and government can ensure that the new business models of the wired economy improve on traditional business practices rather than make matters worse.

Because business-to-business e-commerce accounts for the lion's share of total e-commerce revenue, some of the biggest environmental gains will be achieved by greening online practices in the B2B sector. An important step would be the adoption of an e-commerce code of practice that improves transportation logistics, reduces packaging and product waste, and increases environmental transparency, committing companies to the following ten steps:

1. Using the most energy-efficient product delivery systems.
2. Encouraging shippers to use alternative fuels.
3. Developing environmentally sound, reusable and recyclable packaging.
4. Designing products that are efficient to ship (e.g., concentrates).
5. Marketing the environmental benefits of electronic versions of physical products such as digital images, music, and books.
6. Encouraging electronic payment of bills and putting manuals and forms on-line.
7. Committing to product take back programs and designing internet-based product tracking systems.
8. Developing a consistent set of product descriptors that define the environmental characteristics of products sold on-line so that purchasing agents can scan for qualities like energy efficiency and chemical composition.
9. Developing an international code of practices to prevent the illegal trade in hazardous substances, banned products, or pharmaceuticals.
10. Tracking and reporting the impacts of e-commerce systems in annual environmental reports. Only with comprehensive data on transportation patterns and shipping logistics, product design, consumer behavior, and resource consumption will we be able to put in place the programs and policies to ensure that electronic commerce produces positive environmental impacts.

Consumers also can play a role by demanding that online vendors provide products, packaging, and delivery systems that are as environmentally sound as possible. When Amazon.com partnered with Federal Express to deliver more than a quarter of a million copies of *Harry Potter and the Goblet of Fire* across the United States on its release date, the effort required a dedicated fleet of 100 airplanes and 9000 trucks to move the books packaged in individual corrugated cartons (Hendrickson et al. 2000). Consumers must ask online vendors to not only avoid such environmentally wasteful practices, but to design reusable packaging and demand that their shippers avoid air transport and use alternatively-fueled delivery vehicles. Ultimately, consumers must use the internet to substitute for, not augment, automobile-based shopping trips.

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Environmental impact is possibly the highest cost of e-commerceâ€™s productsâ€™ returns. As online shopping increases, returns do too. How to handle them? Contents hide. 1 E-commerce & returns: an old and complicated relationship.Â E-commerce & returns: an old and complicated relationship. Since the early days of e-commerce, companies like Amazon have offered free shipping and returns to juice growth and help customers overcome their hesitations about ordering online. Giving consumers the security of being able to return easily the unwanted products has always been indeed a driver for conversion, and retention of clients. Today, free returns have become the expected norm, as almost 80% of people in the US and UK check returns policies before placing an order. Here, Environmental Impacts of E-Commerce are considered for case study and survey. It is very tempting to know that the marketing on the Internet is beneficial to the environment. The literature study revealed some possibly negative effects as well as positive effects of e-commerce.Â IMPACTS OF E-COMMERCE ON ENVIRONMENT The overwhelming sustainable development and major technological innovations have not only brought fundamental change to the economic system but also extensive environmental impacts, for better or worse. The environmental implications, in most cases are a reflection of human economic activities as mediated by technology. Although great potential exists to harness information technology in general and the Internet in particular and improve the environment, possible negative impacts of e-commerce on the environment should also be considered and dealt with. In this forum, we discuss both the potential positive and negative impacts of e-commerce. Drawing from insights gained from the complexity theory, we also delineate some broad contours for environmental policies in the information age. Given the paradoxical nature of technological innovations, we want to caution the scientific community and policymakers not to The environmental impact of e-commerce appears to be positive. Offline shopping results in between 1.5 and 2.9 times more greenhouse gas emissions than online shopping. While e-commerce needs delivery vans to circulate, these reduce car traffic by between four and nine times the amount they generate. Land use for e-commerce is lower than for physical retail, when logistics, selling space, and related parking space are included. CO2e impact of a product purchased through different sale channels in Europe (Average case). Ingrams of CO2 equivalent emissions for an average non-food product. Source Nevertheless, the determination of the environmental impact of E-Commerce is complicated by a range of considerations, including local transportation practices, and the type of delivery vehicles used by merchants, among others. The high return rates and short-term sales events of online retail increase environmental impact. The high return rate of fashion items, one of the leading categories of B2C E-Commerce globally, attracts the attention of those concerned about the environmental consequences of online shopping. A January 2019 survey cited in the publication reflected that over a third of