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ECOLOGIES OF FABRICATION

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Are contemporary media sustainable? To the extent that our dominant technical media bear the stamp of the political-economic regime that gave them birth, they can sustain themselves only as long as capital can sustain itself. The top one percent of the world's population owns over half of its wealth; this is not a sustainable ratio.[1] As the authors of the 2011 UN Human Development Report note, "inequitable development can never be sustainable human development." Their definition of sustainable development bears careful analysis: we define "sustainable human development" as "the expansion of the substantive freedoms of people today while making reasonable efforts to avoid seriously compromising those of future generations."[2] The overall definition of development given by the UN Development Programme (UNDP) is tied to the idea of freedom as choice, a form of words that shows the wrangling that must have occurred to commit the UNDP to a model of consumerism. This definition asks us to consider sustainable media in light of what impacts they may have on future generations. The question is then whether consumerism is a sustainable model for media. This chapter investigates one aspect of this question: whether the number and scale of media technologies that we use in the developed countries can be expanded to the rest of the world, and whether that expansion can be sustained. The development perspective places greater demands on tactics of sustainable design because it asks whether there are enough materials and energy available in the finite system of the planet to provide them, in the forms we are now familiar with in the wealthy world, to the three billion people still living beyond the range of our most fundamental technologies.

The still-current crisis of capital that began in 2008 is technically over at time of writing in 2014 because gross domestic product (GDP) in the core metropolitan countries is once again showing growth, albeit at a reduced level compared to precrisis figures. The GDP is, however, a crude yardstick which notoriously

ignores internal difference within nations, as well as the vast and increasing, if occasionally controversial, evidence (see the storm over Piketty's 2014 attempt to use economic accountancy's own tools against it) that that difference has accelerated as a result of the crisis, even compared to the growing gulf between rich and poor that preceded it.[3] Austerity measures of the kind once reserved for developing nations by the International Monetary Fund (IMF) are now employed by European Union and North American polities to ensure the effects of crisis are felt most by those least able to bear them. Sustainable media theses then have to deal also with the impoverishment of metropolitan populations as well as those in developing nations.

Campaigns by labor organizations and environmental groups addressing the sweatshop conditions of workers and the ecological impacts of electronic industries have recently begun to impact on eco-critical media studies (see, for example, the chapter by Gabrys in this volume). The question of sustainability points us directly to the immense use of energy in the manufacture and use of digital media; the immense quantities of, in some cases, rapidly diminishing stocks of minerals for their making; and the immense challenges of dealing with waste electronic goods. This chapter singles out manufacture, specifically of integrated circuits and subassemblies, as a critical node in this environmental cycle. Its main ambition is to argue that environmentalists need to expand their political horizons to include human victims of anti-ecological practices, and to argue that these include not only workers and those living in the immediate vicinity, but everyone involved in the circuits of neoliberal capital. To make media committed to sustainability, to sustain the very media we use, and to make a world where media are sustenance requires a commitment to solidarity and community between different classes of human victims with the nonhuman environment, without which green politics, for lack of global human commitment, cannot sustain itself. The chapter works on the premise that an understanding of the industrial-consumption cycle of electronic commodities is a necessary first step in building such communities.

There are three large-scale mechanisms driving crises of capital. Rosa Luxemburg may have been the first to recognize that accumulation not only named the brutal expropriation of common land at the origin of modern capitalism in Europe but also continued as the equally brutal dispossession of colonized peoples.[4] Accumulation by dispossession, in David Harvey's usage, is the continuing employment of enclosure, through seizures of common goods such as land and geology, seabeds, water and air, and public goods such as health, welfare, and security by capital.[5] The second mechanism is financialization, whose essential characteristic is the trade in risk, intended to reduce the intrinsic insecurity of investment by trading in future values. This trade in futures, itself dependent on computers and network communications, both closes down options for change and simultaneously creates conditions of debt peonage, while increasing the rate of transfer of wealth from poor to rich.[6] The third mechanism is the application of extended reproduction whose theory Marx propounded in *Capital*, volume 2:

the devotion of economic resources to growth rather than to satisfying fundamental needs. It is this feature that underwrites the other two mechanisms, both of them responses to earlier crises produced by excessive or failed growth, crises of overproduction or overaccumulation. It is growth itself, the engine of capital, that opposes sustainability.

Expanded reproduction in the twenty-first century has been characterized as cognitive or immaterial by writers as diverse as Hardt and Negri and André Gorz.[7] Typical accounts of this analysis concentrate on the exchange of symbols (intellectual property, electronic cash flow) but omit or diminish the continuing role of material production and distribution on which this new development rests. Without the infrastructure of processors, memory and outputs, and the network of cables, routers, cellular networks, and satellite communications, there would be no cognitive capitalism, since it would lack the means to create its products and services and the ways to get them to market. Engineering and design, closely allied with software and content, are the high-value industries of the twenty-first century, but their realization depends upon the existence of this infrastructure and its capacity for innovation in waves driven by the synergistic demands of both tiers: new designs demanding new forms of content; new content demanding new forms of software; and new software demanding new hardware designs, in a spiral that promises the level of growth that neoliberalism demands. In this sense the immaterial sector of the economy is as committed to growth, and as equally unsustainable, as the material.

Indeed, separating the two is only an analytical exercise: empirically they act entirely in consort. As other authors in this collection have argued, this material infrastructure and its perpetual innovations incur immense environmental costs in terms of materials, energy use, and waste. Like them, I want to argue that the environmental costs of (digital) media are also human costs, on the ecological principle that human societies are entirely integrated into their environments. In this chapter I want to concentrate on manufacture: the material production of goods and the labor required to produce them, along with the extra-economic consequences of manufacture. Products like semiconductors have been the objects of intense investment from which they emerge as intellectual capital in the form of patents. They require physical production in factories (semiconductor plants prefer the term "fabrication" to "manufacture": facilities for their production are known in the industry as "fabs"). As a consequence of the mechanisms of accumulation, financialization and extended reproduction, these fabs have migrated in two intertwined but distinguishable forms: outsourcing and offshoring. Outsourcing refers to the practice of subcontracting elements of manufacture to smaller companies, often outside the contracting company's country; offshoring to building fab plants and other facilities beyond the home country's borders where wages, health and safety costs, environmental controls, and the tax burden required to educate workers are far lower than those won by working-class movements in the contracting parties' country of origin. Implicit

in both outsourcing and offshoring are the environmental costs of transporting semi-finished goods or subassemblies to centralized final assembly plants, along with biopolitical aspects of the policing of intellectual property when subassembly is entrusted to subcontractors.[8] Before these can be addressed, we must first engage with the nature of component fabrication and the dispersed structure of the manufacture of subassemblies.

The labor of producing semiconductors can be divided between high-value design (cognitive labor) and low-value manufacture and assembly (physical labor). The policing of patents operates on the same principle as that ascribed to al-Qaeda cells: each subcontractor operates in ignorance of the central planning within which his/her separate activities alone make sense. As a result, labor in subassembly plants and component manufacture is kept in as great a state of ignorance as is compatible with the efficient production of the units involved. This ignorance is not a native state but one that must be constantly produced, since any passage of the cognitive capital involved to the workers would arm them with the capacity to seize control of the means of production.

It is also important to note that many factory workers, even in sweatshops, prefer the wage labor of factory employment to the even more precarious and brutal conditions of a demeaned agricultural sector, which offers the only alternative for displaced populations such as those of Indonesia, India, and China.[9] Whenever we argue against the subcontractual regimes of outsourcing and offshoring, we need to remember that the alternatives to sweatshop labor need to be better rather than worse than the existing state of affairs, not only from our perspective but from that of the workers themselves. The challenge of sustainability requires us to face an ethical problem should we determine to promote the well-being of the environment over the well-being, real or imagined, of the sweatshop labor force. For ecological utilitarians, our acts are to be judged by their outcomes, and the best outcome is the one that increases well-being for the largest number, not limited to humans. The problem of this consequentialist ethos is that it is prepared to sacrifice the well-being of the minority to the well-being of the majority. For a materialist ethics, there can be no sacrifice of even one entity. In the deontological perspective of eco-philosophers like Paul Taylor, every living thing has its intrinsic worth, compelling us to recognize its claim to live and be happy, so chiming with the materialist ethos, while however concentrating on the individual.[10] Ecology, as the study of the connectedness of everything, and ecomedia, as the study of the intermediation of everything, cannot rest on individuality but must work on the level of community, communication and communion. Thus a political analysis of sustainable media must not restrict itself to the human beneficiaries, like the UNDP, or to the environment at the expense of the human, as in deep ecology, but faces instead the greater intellectual and political challenge of creating an ethos that embraces both the nonhuman and the human. Likewise it must deal with well-being not only as a biopolitical measure of successful rule, but as expressed in the aspirations, desires, and demands of human and nonhuman agents

alike. Ultimately this is political to the extent that the ethical concerns what I should do, where the political concerns what we should do. From this it follows that the term "corporate ethics" is an oxymoron, a fact demonstrable in the recent history of improvements to manufacturing conditions.

By no means can all fabs or assembly plants be treated as sweatshops. Many companies have been forced by consumer boycotts and campaigns to ameliorate working conditions in the computer industry as they have in at least some cases in the garment trade. Similarly, even in head offices, there can be deep inequalities between classes of employees. Dell Computer, for example, agreed in a $9 million class action settlement in 2009 that it had failed to offer women employees equal access to training, equal pay, or promotions, and established a Global Diversity Council to monitor its policies thereafter, extending them down its international supply chain. Such companies are to be applauded for their eventual acceptance of community values, but not for the preceding decades of oppression, nor for the lives their previous policies stunted. In a similar vein, while many companies have attempted to clean up their atmospheric emissions, waste material dumping and water pollution policies in the last five to ten years, the legacy of their previous actions is not thereby cleansed. Some perfluorocompounds (PFCs, emitted as gases from chemical vapor deposition and plasma etching procedures in fabrication plants) persist in the atmosphere for thousands if not tens of thousands of years, and have up to twenty thousand times more impact per part than carbon dioxide on the greenhouse effect.[11] Other mineral and solid waste, much of it composed of known carcinogens and other compounds whose long-term effects are unknown, will persist in the vicinity of the plants for equally lengthy periods of time. For the many female employees who bear children, those effects last long after they might terminate their employment, and affect children with otherwise no connection to the plants, present or past. To the extent that today's media restrict the lives of future adults, they are unsustainable in the UNDP's terms; to the extent that they restrict the vitality of regional environments, they inhibit the emergence of human-ecological community. This unsustainability of the computer industry extends geographically to include the connectedness of by-products to aquifers, ocean currents, and atmospheric circulation connecting distant places with the source of pollution.[12] Sustainability points us towards the legacies of long-abandoned factories in close and remote places, near and distant futures.

In a 2011 overview of the industry's environmental and health hazards, Corky Chew notes that PFCs are less frequently used in semiconductor fabrication than previously, but that remaining dangerous chemicals include heavy metals, rare earths, solvents, epoxy, corrosives and caustics, fluorides, ammonia, and lead.[13] Process redesign focuses on treatment of solid, liquid, and gas wastes, which themselves use acids and caustics to neutralize pH levels in wastewater, and include incineration and landfill. Some of the energy required comes from flammable by-products, but even with this saving, the costs of these processes are in general less than those of recycling materials. Other documents, such as the International

Finance Corporation (IFC)/World Bank Guidelines, use a discourse peppered with expressions like "amelioration," "abatement," "improvement," "optimization," and "minimizing," in the context of a detailed set of recommendations for improving the environmental performance of the industry. The IFC Guidelines admit their applicability is greater in new facilities than in retro-engineered existing plants, and note that their application is always subject to "site specific targets and an appropriate timetable for achieving them," adding that site-specific variables include such factors as "host country context, assimilative capacity of the environment and other project factors."[14] While asserting that the industry should, in case of conflicting guidance, apply the more stringent of the options, these final notes on host countries, their relative weakness in enforcing environmental regulation, and their environmental capacity to somehow digest waste are distressing in their gesture towards a rule that can be bent. They exemplify what John Urry refers to as "a kind of regime-shopping [which also] preclude[s] the slowing down of the rate of growth of CO_2 emissions, which presupposes shared and open global agreements between responsible states, corporations and publics."[15] The IFC Guidelines clearly aspire to that kind of transparency, while at the same time indicating ways it can be ignored.

The sad truth is that the increasing imbrication of the Internet in the operation of daily life from trade to traffic signals, the explosion in mobile media use, and the prospects for an increasingly embedded Internet of things heralded by the move to Internet protocol version 6 with its vastly expanded address space, all suggest that we are stepped too far in to go back. The Semiconductor Industry Association reported "that worldwide semiconductor sales for 2013 reached $305.6 billion."[16] It seems impossible to convert that figure into an estimate of the numbers of chips produced, given the mix of mass and specialist products involved: a unique and secure device created for the military will be priced differently to the one in a cheap watch, an RFID (radio frequency identification) tag or a credit card. The numbers, however, are growing, even as the prices tend to drop in line with Moore's law, despite the years of downturn since the global financial crisis and the increasing costs of key minerals including indium, gold, and the lanthanides. A 2002 report suggested that two hundred billion discrete components (diodes, transistors, rectifiers, etc.) were produced annually, with around another billion units of optoelectronics (LEDs, laser diodes, CCD chips), memory, logic, microprocessing, and other devices.[17] Today we could expect that annual production is at least tenfold. Each chip is tiny, but the collective weight of the metals and chemicals required to make them is great.

This is especially true of the water needed to build chips. According to Global Water Intelligence, "creating an integrated circuit on a 300 mm wafer requires approximately 2,200 gallons of water in total, of which 1,500 gallons is ultrapure water."[18] Ultrapure water (UPW), which typically requires 1,400 gallons of ordinary water to produce 1,000 gallons of UPW, is so pure it is considered an industrial solvent. It not only provides washing and lubrication for the polishing

processes required between steps in manufacture, but unlike normal water does not carry any dissolved minerals that might interfere with the nanometer scale electronics. However, this requires the safe removal of those minerals, while also demanding the removal of the by-products of the polishing processes. Some of the mineral effluent is valuable, and occurs in large enough quantities to be worth rescuing through flocculation, coagulation, centrifuge, and for nanoscale molecules, hollow-fiber membranes. US plants use a series of these processes, plus various chemical reagents to neutralize acids and caustics, but much of what is produced is defined in federal and state legislation, notably that of California, as toxic waste. In other jurisdictions, wastewater ponds are built to allow dangerous materials to sink, but these are vulnerable to flooding and seismic activity and are illegal in the United States and the European Union. Illegality, however, is no guard against illegal behavior, which becomes increasingly attractive as top-end consumers of semiconductors in computer, phone, and games markets pressure their suppliers to cut costs. In fact KPMG auditors report that "Losing [market] share to lower cost producers is perceived as posing the single greatest threat to their business models by global semiconductor manufacturers" (their second greatest fear is "Political/regulatory uncertainty," a reference to environmental regulation among other factors including continuing fallout from the global financial crisis).[19]

On December 9, 2013, Taiwanese company Advanced Semiconductor Engineering (ASE) of Kaohsiung City, a municipality approaching 3 million people, was fined the maximum amount of NT$600,000 (just over US$20,000) for dumping wastewater containing acids and metals into the main river used for irrigation in the area. In June 2014, the Taiwanese Environmental Protection Agency upped to NT$20 million what the maximum fine would be for future infringements. In the same month, ASE announced that despite the partial closure of the plant, the company was planning to increase production in the third quarter of the year, and would be raising up to NT$15 billion to support the expansion.[20] Although water can account for up to 1.5 percent of operating costs, including its reuse and recycling, it is clear that given the scale of operations, fines are routinely written off as part of that cost: ASE was reported to have paid seven fines for ongoing pollution dumps between July 2011 and October 2013. The same report quotes activist assertions that the company had enjoyed tax exemptions of NT$3 billion.[21] Both the strategic importance of the industry—ASE is the world's largest supplier of semiconductors and testing services—and its association with the technocratic dogma in development policy tend to ensure that violations of the law are treated leniently, leading to the assumption that the IFC/World Bank recommendations to conform to host country standards present an opportunity to cut costs in the interests of increasing sales to end-users, in this case manufacturers of consumer electronics. (ASE blamed a one-off employee error and promised an internal investigation).

The water issue is strategic since it involves a common good. In Taiwan as in other countries, companies pay for metered water use, but as in other countries

there appears to be more relaxed metering of outflows from semiconductor fabs. This is particularly worrying in China. Fabs can use up to 30–50 megawatts of peak electrical capacity. In China, this power is most likely to come from hydroelectricity. Growth in the sector, which ran at 24 percent per annum for the decade following 2001, thus competes with itself for consumable water for power or UPW. Competition with agriculture and with other industries as well as human consumption is at its highest where the greatest densities of fabs are found: in the Yangtze River delta (Shanghai and Jiangsu) and in the environs of Beijing, regions that are accounted as "Dry" in the standard UNEP/UNDP measure, having less than a thousand cubic meters of water per person, while Zhejiang to the south of Shanghai is reckoned "At Risk." In total, over 80 percent of the country's fabs are based in Dry or At Risk regions. The industry is making steps towards less profligate use of the resource, including reduction, reuse, and recycling projects and migration from intensive use of UPW. According to research by the nongovernmental organization (NGO) China Water Risk (2013) into the records of the Institute of Public and Environmental Affairs, there were "over 10,000 environmental violations for key semiconductor companies," the major effluents including arsenic, antimony, hydrogen peroxide, and hydrofluoric acid.[22] Of these, arsenic is a major carcinogen in humans and animals;[23] high levels of antimony are especially toxic to aquatic life;[24] hydrogen peroxide, despite being used extensively in wastewater treatment, is classified as a corrosive and in concentrated or aerosol form has a variety of ill effects on humans and animals;[25] and hydrofluoric acid is corrosive and toxic for both humans and animals. The more water is recycled, the more concentrated the remaining toxins become.

Chip fabrication employs a range of technologies besides the chemical. Chip "burning" is a test process subjecting semiconductors to high levels of heat and voltage; ion implantation is used in doping (the practice of introducing tiny quantities of rare earths into silicon crystals to define their electronic qualities); and X-rays are used to check quality. It is unclear whether these processes contributed to a spate of cancers among workers in Samsung fabs in South Korea in the 2010s.[26] Volatile organics like benzene, trichloroethylene, and methylene chloride are also common in "clean rooms" where chips are handled by human operators and may have contributed to the problem. Some three years after Grossman reported on this for *Yale Environment 360*, noting that the Semiconductor Industry Alliance protested that studies of links between fabs and cancer clusters were "scientifically flawed," Samsung apologized and promised compensation to a group of ex-employees who have suffered from cancer, without, however, accepting a link between chemicals or physical processes and their illnesses.[27] Liability may lie with the South Korean government, to whom companies pay a levy from which claims for industrial injury are paid.

These three stories from Taiwan, China, and Korea are, in some sense, typical of the kinds of tales that we discover in any environmental analysis of industries of all kinds. Even the division of high-risk, low-paid labor in manufacture from

low-risk, high-paid labor in research and development parallels similar structures in the garment sector where design is highly paid and respected, unlike the work of sweatshop laborers, or indeed for example automotive, aerospace, and other transport manufacture.[28] These all comprise, in their various ways, aspects of communications; indeed, transport was typically included in the sociology of communications through the 1970s. The case of semiconductors and other electronic components is, by contrast, rather more specific, in that consumption of the end product, by both consumers and businesses, is also a source of high-value innovation, especially when a proportion of that innovation is undertaken by unpaid consumers who pay for their own equipment in order to provide content for corporations like Facebook. We should, however, consider two important distinctions: that between research and development (R&D) or design, on the one side, and content production, on the other; and that between innovation and invention. In the latter, the atmosphere of intense competition over price and new product lines belies the deep standardization of core tools like semiconductors, constrained to work with now entrenched protocols including the use of binary logic, Internet protocol, and shared standards like MPEG, encouraging innovation—new fashions in standard forms—while discouraging real invention. In the former, while both design and content are productive of revenues, only R&D and design are paid. The trend to innovation within standards (as opposed to invention beyond them) and the differential use of paid or unpaid creativity are, however, ultimately linked and equally engaged in answering the question of sustainability.

The developing salience of the produser[29] has become a core feature of consumption in the twenty-first century, offering not merely new ways to innovate[30] but the possibility of a wholesale remaking of the principles of political economy.[31] Produsage blurs the distinction between users and producers in value chains: production is always incomplete, as in the case of computers delivered without software installed, so that the end-user has to participate in the production process. The opportunities for a cashless commons of shared benefits based on principles familiar from open-source software, Wikipedia, and open participation science projects are immense. In the field of semiconductors, however, the entry costs are far higher than those for producing content or code. Contemporary integrated circuit (IC) design faces key challenges in accelerating the performance of processors, now approaching the scale where quantum effects hinder logic design, in improving performance-energy ratios, and ameliorating battery and display designs to reduce power and increase performance. These challenges mean that new chips require US$30–40 million to produce, figures that the peer-to-peer community cannot raise to date. Such sums are even challenging for venture capital seeking start-ups, while large corporations, paradoxically, are reducing their in-house R&D in favor of acquiring start-ups that have passed a threshold of risk (economically a safer bet) or of licensing the intellectual property they require, a sure route towards standardization.[32] Venture capital, since the global financial crisis, has been hard-put to find investors interested in risk, and has become, as a

result, increasingly risk-averse itself. The end product of this has been a diminution of invention, a shift towards investing in applications that have a better risk-to-profit ratio and, even more perversely, a shift in the number of patents being secured away from the United States, which has been traditionally the home of innovation in IC design, towards East Asia, where major corporations are increasingly becoming "fabless," like their US counterparts.[33] A "fabless" corporation typically takes on the lucrative design work, then subcontracts the fabrication of its chips. Keshavarzi and Nicol cite Nicky Lu, CEO of Etron, to the effect that China is investing US$14.2 billion in fabless design companies.[34]

The concentration and mobility of intellectual capital has always been characteristic of capital, but this shift to East Asia is a prime indicator of the hypothesis advanced by Arrighi and others that China is in the process of leading a new era of capital centered in East Asia.[35] The newly diversifying concentrations of R&D and IC design on either side of the Pacific are built on the equally mobile but far more precarious labor in fabs that are increasingly migrated further offshore, especially into South East Asia, Indonesia, and the Philippines. The maquiladoras, sprawling subcontracting factories along the US-Mexican border that have become major economic zones since the introduction of the North American Free Trade Agreement (NAFTA), have been extensively documented for their poor workplace health and safety, exploitation of women, and environmental impacts. Summarizing much of the literature, Schatan and Castilleja argue that lax environmental regulation and enforcement, while giving a cost advantage, ultimately imprisons Mexico in the low-value end of the market, excluding it from the high-value, "clean" product of the fabs north of the border.[36] What they do not note is that this depression of the potential of Mexican fabs is typical of NAFTA's one-sidedness. High-value fabrication remains the preserve of the dominant economy in the partnership; while it suits the US-based corporations that low-value and dirty production, from which they also benefit (albeit at a far lower profit per unit), be kept discrete. In the same way, the employment of young and often uneducated rural women makes competition (or even theft) of intellectual property unlikely, while militating against workplace organization.

Ironically, the export of poverty-level employment and environmental recklessness as a result of NAFTA has had the foreseeable result that pollution is now crossing the border. According to the US Environmental Protection Agency (2013), deforestation has increased runoff in the watershed of the Tijuana River whose estuary lies in San Diego County, California. The runoff from storms carries with it fertilizers, pesticides, metals, and polychlorinated biphenyls (PCBs) from the maquiladoras, as well as sewage from the unplanned expansion of slum housing along the river. Two major sewage spills in April of 2012 totaling four million gallons emphasized the lack of adequate infrastructure for the massive population expansion in the factory zones and for the poverty experienced by their inhabitants. The local San Diego paper reports that one result has been concentrations of drug-resistant genes in bacteria in the estuarine wetlands, which

deliver genetic material traceable to human waste flowing down the river onto a popular surf beach. Meanwhile in the twin cities of Ciudad Juarez and El Paso, on either side of the Chihuahua/Texas border, and Nogales on either side of the Sonora/Arizona border, air pollution travels without regard to boundaries, carrying ozone and particulate matter less than 10 micrometers (PM10, PM2.5)—dust so fine it penetrates deep into the lungs of air-breathing creatures.[37] On the one hand, this has allowed Nogales to claim exemption from federal air quality controls because the dust originates in Mexico, in the tradition of blaming the poor for pollution; while on the other hand promoting in both cities consumer-oriented campaigns to reduce domestic and automotive emissions while continuing to turn a blind eye to industrial pollution, especially that sourced from US-owned or contracted plants. By no means does all of this waterborne or airborne pollution derive from the electronics industry, but it certainly contributes, and its workers are constrained to drink, wash in, and breathe the results.

Even without tracing the sources of minerals and energy used in fabrication, the processes employed are clearly already deeply embroiled not only in human but in nonhuman atmospheric and aquatic cycles, local and regional, up to at least the scale of the Pacific. The responsibility for the ecological fallout from these processes has frequently fallen on citizens and consumers, whose boycotts of sweated and environmentally dangerous goods and campaigns against industrial practices have been significant. It is clear, however, that corporations resist taking responsibility, spending instead vast sums on legal actions blocking charges against them and on public relations campaigns (including the expensive scientists whose reports they commission). Governments from Mexico to Taiwan and South Korea recognize the importance of their electronics industry to GDP and therefore to inward investment, both markers of development that keep them free of the IMF and World Bank structural readjustment that has historically been a tool for exporting capital from countries afflicted by it. To the extent that taking responsibility is a human action, we must infer that the refusal to recognize and take responsibility is not. While, with Latour, we acknowledge the involvement of the nonhuman in the networks of labor, manufacture, and waste involved in semiconductor fabrication, we must also acknowledge the role of inhuman actors, primarily corporations, and beside them the political elites who deny involvement, and ease the operation of corporate irresponsibility.[38]

Workers in the North suffer from the export of jobs to offshore and outsourced subcontractors. They envy the industrial employment of their circum-Pacific neighbors. On the other hand, workers in offshore fabs, typically kept in the dark about the segregation of US society and the existence of a vast African American and Hispanic underclass, envy the levels of consumption available to their North American and European counterparts. The geography of this new division of labor is complex but can be expressed as the increasing spatial divorce of productive and consumptive work. Consumption becomes work when, under conditions of produsage, it is undertaken not for the fulfillment of needs or the

realization of aspirations, but as a disciplined function required by capital to remove the excess product manufactured in the pursuit of expanded accumulation and growth. For capital to continue to grow, the working class of the wealthy nations now has as its chief function not production but the mass consumption of excess product, in cycles that range from overconsumption of junk food and pharmaceuticals, to exercise and diet products to counter the effects of the former.

In the pair, work discipline and consumer discipline, one constant is the passage of responsibility for accidental spillages, toxic waste, and carbon footprints to the productive (laboring) and consumptive classes. This amounts to a migration from political matters—how should we live?—to the ethical level of individual responsibility, a theme frequently on the lips of neoliberal politicians who are otherwise averse to corporate or governmental responsibility. The diminution of global problems like polluted aquifers and airborne toxins to the scale of ethical decisions by citizens, and of ethics to the level of consumer choice (for the constraints on which corporate citizens take no responsibility) is not designed to maximize efficiency in the use of resources. If it were, the problem of waste would not be integral to the financialization response to crises of overproduction, which has been to offer unpayable loans to the poor and open a trade in bad debt. Nor is it a democratic process, since democracy is definitionally concerned with the construction of an "us" capable of acting in consort. It is, rather, a projection of corporate irresponsibility and inhumanity onto the very people who suffer most from it, in the same logic of blaming the poor that drives austerity packages and attacks on public welfare.

A second constant of the division of production from consumption is the migration of aesthetic labor and enjoyment to the elites, and a parallel anaesthesis of the workers. In the productive realm, this is easy to see in the degradation of working and living environments and of the surrounding country; among consumers it is grounded in the depreciation of skills associated with living well, such as home cooking, homemade or crafted clothes and furniture, and vernacular architecture. In their place, "value-added" manufacture provides standardized products with customized additions (T-shirt emblems, a differently colored front door), while comedians vie with one another to deride amateur music or home-knitted garments. This is not to suggest that popular culture has not produced works of great depth and beauty, but that the industrial structure of their production and dissemination scrapes away their intimacy, devalues their capacity for permanence, and, through celebrity cultures and intellectual property regimes, diminishes the possibility of communities taking ownership of the cultural events on offer for themselves. For the producers and consumers of Top 40 radio shows, the object of consumption is not individual works but "music." In this sense, consumption moves to occupy itself no longer purely with use-values but with exchange values. Marx distinguished between living labor, the production of use-values, and objectified labor, its abstract form in which what is produced is not things but exchange value, "undifferentiated, *socially necessary general labour*, utterly

indifferent to any particular content."[39] What he could not predict was that this indifference to particular content would become a characteristic of consumption under conditions of neoliberal disciplined consumerism.

Bifo notes of this abstract form of labor that "it means the distribution of value-producing time regardless of its quality, with no relation to the specific and concrete utility that the produced objects might have," adding that in info-production "labor has lost any residual materiality and concreteness."[40] The irony is that consumption of symbols too has lost its materiality, its specific and concrete utility, and is instead entirely devoted to the production of value, first in various forms of payment for the consumed objects and services, and second in generating more value through paying attention to the advertisements and marketing that are so embedded in the flow of media. Thus, the division of labor between those forced to work and those forced to consume, while unjust and divisive, is at least equitable in divorcing both productive and consumptive classes from meaning and pleasure, while at the same time using that division to minimize the possibilities of a common revolt against their condition of abstraction and anaesthesis.

This anaesthesis extends to the absence of truth in media, specifically truth about themselves and their foundation in toxic conditions of work and both local and global pollution. Metaphorically it might be feasible to speak of certain forms of media message as toxic (violent pornography, race hatred), but metaphorical violence is rarely as directly threatening as actual toxicity. In this instance, the metaphor hides the truth of toxic media, the toxicity of production processes integral to the integrated circuit. The same is true of the digital sweatshop, those call-centers and data-processing centers where the semiotic labor of shifting symbols or converting human conversations into data are undertaken in states of high abstraction. Digital labor, the work of translating into symbols and manipulating those symbols, already has a high degree of abstraction in terms of the relation between the worker and the content, in much the same way as the intense division of labor in the subassembly supply chain deprives workers of a relationship to any finally useful product. But that abstraction is driven to a higher level by the mock-Hegelian logic that Bifo identifies:

> Absolute Knowledge is materialized in the universe of intelligent machines. Totality is not History but the virtual assemblage of the interconnections preprogrammed and predetermined by the universe of intelligent machines. Hegelian logic has thus been made true by computers, since today nothing is true if it is not registered by the universe of intelligent machines . . . When History becomes the development of Absolute Computerized Knowledge difference is not vanquished: it becomes residual, ineffectual, unrecognizable.[41]

The universality of these machines, in which are captured and codified the wisdom and skills of previous generations, is overstated in Bifo's analysis, to the extent

that this universality appears such only from within the universe of intelligent machines. The externalities retain their reality, among them in first place the environment, an economic externality in the sense that it does not enter into the accounts of corporations, and in second place, and with greater intensity with each passing year, the residual difference of populations. Human labor, in production or consumption, is "given," like the environment, in that capital does not pay for its reproduction or education, and is external in the sense that waste product, or indeed junk product, is regularly dumped into populations as into reservoirs, with no account taken of potentially lethal effects. In the cyborg logic of the corporation—a vast network of interlinked computers with human biochips inserted—the human difference is now an externality: a source of creativity to be exploited and a sump of waste to be discounted. That this course is suicidal does not register in the ethos of the cyborg for which profit alone is calculable, and all other effects are simply left out of account.

Nevertheless, Bifo does retain an iota of hope in the form of the residual and unrecognized difference that, I would argue, is not as ineffectual as he says here. The indifference of capital is twofold: the indifferentiation of the objects of labor and consumption under the regime of exchange value, and the indifference to externalities, both human and ecological. This indifference is premised on the universality of neoliberalism, embodied in the claim that there is no alternative, and enacted in the inertia of political classes faced with such tasks as mitigating climate change or enforcing environmental regulations. This universality is, however, premised on its externalities and incapable of functioning without them. To the extent that both workers and environment are now external to capital, they are thrust out of the universal claimed for neoliberalism. At the same time, the IFC/World Bank note on "assimilative capacity of the environment" places a demand on ecological systems that they assimilate the fallout of semiconductor production, a demand equally borne by fab workers, while at the same time requiring individual workers and consumers shoulder responsibility.[42] To the extent that produsers and workers undertake that responsibility, they typically either collapse into inaction before the scale of the task, or move towards that kind of bitter melancholy that can become the basis for political action. When the ideological weight placed on the family became unsustainable in the 1950s and '60s, there was a rush to divorce; when the weight of ideological individualism is crushing, the individual falls apart. Negatively, this appears as mental illness, a frequent accompaniment to sweated labor made frighteningly public in the Foxconn suicides.[43] More positively it can lead to the realization that the self is no longer the source of action, leading to participation in group formation and political activism and a turn towards a new politics of nature. Sustainable media will demand not only a sustainable community of workers but equally a sustainable commons embracing workers and consumers, and beyond that a community of workers, consumers, and their environments. It is in this sphere that the aesthetics of sustainable media may be capable of counteracting and subsuming the

anaesthesis of the contemporary division of labor as well as the division between human and nonhuman environments. It is not only because both economics and politics have failed to create sustainable ways of life, or even to address them, that we need to turn to aesthetics. Traditionally aesthetics has looked towards the organic unity of the artwork. In reality our cultural artifacts are riven by contradiction: to create unity would be a lie. An aesthetic approach must consider both the sustainability of the media themselves as material practices and their role in mediating between phyla and among humans, a movement through communication as a means towards communication as goal.

Marx observed that in the commodity "the relation of the producers to the sum total of their own labor is presented to them as a social relation, existing not between themselves, but between the products of their labour."[44] Eco-critique adds: in the commodity form, the relationship between producers, consumers, and the externalized environment appears in disguise, hiding the true involvement of all three under the sign of exchange value. The commons on which sustainable media might be built involves a migration from the bogus universality of capital to the active integration of the indifferentiated human and nonhuman, declaring their mutual incompletion and need for support, and producing a politics in which the question "how are we to live?" might, at the very least, be posed, and without which it cannot be answered.

Notes

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