# *Towards new materialist circuits*

Our goal of ‘hacking’ hardware involves looking closely at the origins and production processes behind the materials used in our technology. We want to explore and understand the impact of colonial and extractive practices on the mining and manufacturing of these materials. To do so, we use creative storytelling and speculative fiction to examine the entire life cycle of these materials, from mining and transportation to production, consumption and disposal.

Our aim is to create a model for a more equitable and sustainable future, where technology is produced and used in a way that is less harmful to people and the environment. As artists, our goal is to provide a vision of a future that is less extractive, colonial and exploitative. To create minimum standards for feminist hardware production, we took a closer look at hardware commodity chains and embraced the principle of ethical hardware.

# *ICT commodity / supply chains and gender*

'Commodity chain'[21] is a term used to describe the entire process involved in creating a product, from design to manufacturing and marketing. Global commodity chains have long been analysed, but researchers have often overlooked the importance of gender in these chains. One such example is Gereffi and Korzeniewicz (1994), who did not consider the impact of gender on labour strategies and worker households within commodity chains. From 1965 to 1975, the Fairchild Semiconductor plant in New Mexico was the second-largest employer of American Indians. Almost all of the people working on the assembly line creating electronics were women (Precarity Lab, 2019, p. 83). However, today it is clear that women* play a crucial role in global commodity production, especially in the informal sector of developing countries. In fact, women make up a large portion of the global workforce, including one-third of the manufacturing labour force in developing countries and more than half of all industrial workers in Asia. Women are also heavily concentrated in service jobs that support global manufacturing supply chains, and they provide a significant amount of unpaid family labour to sustain household-based farms and enterprises.

21 There have been different approaches to studying commodity chains, with some focusing on the role of large manufacturers in producer-driven chains and others focusing on the role of retailers and advertisers in buyer-driven chains. In producer-driven chains, multinational manufacturers are the key players, and industries such as cars, computers and heavy machinery fall under this category. On the other hand, in buyer-driven chains, large retailers and advertisers play a central role in establishing decentralised manufacturing networks in many exporting countries in the Global South. This type of commodity chain is commonly seen in labour-intensive industries like clothing and consumer electronics. In these chains, the actual processing of the product is separated from the design and marketing stages, and profits are generated through unique research, design, sales, marketing and financial services that connect overseas

Women's contributions, however, are often overlooked and undervalued. Women are less likely to leave the workforce during childbearing years, because of the limited job opportunities for men and their involvement in the informal sector and unpaid contributions. This highlights the need for a more comprehensive understanding of the role of gender in commodity chains and for recognition of the significant contributions of women in this sphere. Women who work in informal conditions, and therefore lack unions, are more vulnerable to market forces and changing prices. We should consider the surplus that capitalism gains from two important contributions made by worker households: reproduction of the labour force; and the provision of low-wage jobs (Dunaway, 2014; Hopkins & Wallerstein, 1977).

Feminist analysis of commodity chains includes examining the gendered nature of globalised production and the ways in which capitalism benefits from externalising the costs of maintaining and reproducing the labour force. This means that the cost of caring for workers and their families shifts to households and communities, which is seen as a crucial aspect of value extraction and capital accumulation in the globalised economy (Bair, 2005; Dunaway, 2014; Bettio & Verashchagina, 2008; Wallerstein, 1995).[22]

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factories with product niches in consumer markets. In simpler terms, there are two types of commodity chain: producer-driven and buyer-driven. The main difference between these two types is the role played by the companies involved. In producer-driven chains, companies that make advanced products such as airplanes and computers play a big part in controlling the entire process, from production to distribution. These companies are usually large multinational corporations. On the other hand, in buyer-driven chains, companies that produce and sell brand-name goods have the power to decide how, when and where products are made and how much profit is made at each stage of the process. These companies are often led by retailers and marketers. The two types of commodity chain are different in terms of the type of company involved, the industries they are in, and how profits are made.

22 It's important to note that the term 'reproductive' goes beyond the biological aspect of reproduction to encompass maintaining and supporting both the labour force and the community. This is because the capitalist system also needs to be reproduced and sustained (Truong, 1996; Dunaway, 2014; Marx, 1976, vol. 1).

The information and communication technology (ICT) supply chain is responsible for numerous human and environmental rights violations, according to the Local Governments for Sustainability, European Secretariat (ICLEI) and Electronics Watch (2020), a watchdog organisation focused on defending the rights of electronics workers. These violations range from long working hours, low pay and temporary contracts to child labour, armed conflict and environmental disasters. The new '*supply chain act* (Lieferkettengesetz) *aims to protect the rights of people who produce goods*' for the European market and '*ensure better human rights protection*' (Bundesregierung Deutschland, 2021). As of February 2024, it had not been implemented by European Union member states.

*In commerce and in production basic human rights are frequently violated within global supply chains, with child labour, exploitation, discrimination and inadequate labour law protection. Environmental destruction is also covered by the bill – illegal logging, inappropriate use of pesticides, the contamination of water resources and air pollution.*

(Bundesregierung Deutschland, 2021, online)

## *Ethical hardware*

The concept of ethical hardware has attracted much attention in recent years because of the increasing awareness of the negative impacts of technology production on workers and the environment. Ethical hardware refers to electronic devices manufactured responsibly and sustainably, with the wellbeing of workers and the environment taken into consideration.
One of the main benefits of ethical hardware is that it can improve working conditions and reduce environmental harm. For example, a study by the International Labour Organization (ILO)

found that the electronics industry was characterised by long working hours, low wages and hazardous working conditions, leading to serious health problems among workers (ILO, 2018). In contrast, ethical hardware production was characterised by decent working conditions, fair wages and environmental sustainability, providing positive impacts for both workers and the environment (Liboiron & Austic, 2025).

Several challenges are associated with promoting ethical hardware. One of the main challenges is the complexity of the electronic supply chain, which spans multiple countries and involves numerous actors (Electronics Watch & ICLEI, 2020). This makes it difficult to monitor and regulate working conditions and environmental practices throughout the entire supply chain. Additionally, the fast pace of technological innovation and the demand for low-cost electronics products puts pressure on manufacturers to cut corners, resulting in labour and environmental abuses (Ho & Jensen, 2018).

Despite these challenges, several initiatives are aimed at promoting ethical hardware production practices. For example, the Electronic Industry Citizenship Coalition (EICC) is a global network of electronics companies that seeks to improve working conditions and environmental sustainability in the electronics industry (EICC, 2020). The Fairphone initiative, launched in 2013, is pioneering ethical hardware production by creating smartphones made with conflict-free minerals under fair working conditions (Fairphone, 2020).

In conclusion, the concept of ethical hardware is increasingly important because of the negative impacts of traditional electronics production on workers and the environment. While challenges exist in promoting ethical hardware, various initiatives are aimed at improving working conditions and environmental

sustainability in the electronics industry. Further research is needed to understand the best practices for promoting ethical hardware production and to assess the impact of these initiatives on workers and the environment.

## *Conflict materials*

In the midst of increasing geo-political and geo-economic tensions between the US and China, the mining industry is expanding. The demand for raw materials to produce decarbonisation technologies (e.g. batteries for e-cars) is propelling new (dirty) investments into mines in Africa, South America and South-East Asia (Hertanti, 2023). So-called transition minerals come with significant social and ecological costs (Hertanti, 2023). At the time of writing this book, Rwanda's M23 attack on DR Congo is causing unthinkable human suffering for the sake of gold and coltan looting (Schwarz-Stiglbauer, 2023; Zane, 2025).

Mines for rare earth are in unique geopolitical positions and do not permit fair-trade alternatives. On the contrary, they actively destroy the existing democratic syntax of nation states (Rodney, 1972). Their monopoly causes modern slavery, child labour and violations against human rights. The only alternative to industrial mining seems to be ASM, namely artisanal and small-scale mining. It is conducted by families, groups or cooperatives on a small scale and with little support from technologies. In many places this comes at a high cost; for example, on the island of Lombok (ID), which neighbours Bali, communities are suffering from severe mercury contamination, because ASM miners use mercury to extract gold (Hidayatin et al., 2009; Paddock, 2016; Ahyadi et al., 2022). They are managing to avoid intermediate purchasers but harming their own land and families.

Another aspect is the viability of ASM. Will the European market be able to meet the demand from ASM mining combined with recycled and upcycled substances? What impact will implementing this law have on global economies?

These questions cannot be answered within the scope of this research. From a new feminist materialist perspective, even the far-reaching and ambitious law proposed by the European Commission will not question the violent concept of extraction, and it will not stop the expanding development of public lands and oceans. Returning to the question of which phenomena could de-escalate mutual transformation, we investigated ancient iterative intra-action, such as transformation based on handicrafts and pre-industrial production. Our arts-based research, therefore, started to engage with different forms of crafting and making.

Applying ancient community-centred crafts enabled us to find enough conductive, resistive or insolating substances to build circuits that comply with the code of conduct for feminist hardware. We propose a new ethical standard for tech development: 'a code of conduct for hardware' that demands the exclusion of conflict materials from tech development to halt colonialist violence and inequalities created through today's tech industry (Hertanti, 2023).