

RESPIRATORY EMERGENCIES IN COAL MINES

Causes of Coal Mine Accidents in the World and Turkey

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Abstract

Occupational accidents and occupational diseases are common in the mining sector in Turkey and throughout the world. The most common causes of accidents in coal mining are firedamp and dust explosions, landslips, mine fires, and technical failures related to transport and mechanization. An analysis of occupational accidents in the consideration of social and economic factors will let understand the real causes behind these accidents, which are said to happen inevitably due to technical deficiencies or failures. Irregular working conditions, based on profit maximization and cost minimization, are related to strategic operational preferences and public policies. Proving that accidents in mines, where occupational health and safety measures are not implemented and inspections are not done properly or at all, are caused by the fact that production is imposed to be carried out in the fastest, cheapest, and most profitable way will allow us to take steps to prevent further mine accidents.

KEYWORDS: Coal mine, occupational accident, occupational health

“Medicine is a social science, and politics is nothing more than medicine on a grand scale”.

R. Virchow

INTRODUCTION

According to the World Health Organization (WHO), health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity. In a world where the number of children that die before reaching the age of 5 years in the African continent is eight times higher than their European counterparts, it is not enough to define health on its own. Inequality in health is defined as the preventable and unacceptable differences that are caused by the economical, political, denominational, occupational, religious, and cultural reasons and by the inadequacies in accessing health services between the individuals and different sections of the society. The prevalence of violence on women by their husbands exceeds 40% in Southeast Asian and African countries; 804,000 deaths occur worldwide because of suicide, and one out of three people cannot work because of an occupational disease or accident. Thus, additional definitions need to be made to the notion of health inequality while discussing health [1]. Social determinants of health (early childhood development, education, employment and working conditions, income and social status, social and physical environments, social support network, life style, personal health practices and coping skills, gender and social gender, culture, and access to qualified health services) create differences in the health of individuals and societies, and the conditions that people live and die in are determined by the political, social, and economical systems [2].

A large number of workers (approximately 2.3 million) die each year worldwide, 350,000 because of occupational accidents and approximately 2 million because of occupational diseases [3]. Occupational health is defined as an area of application in which the effects of work life on health are investigated. A public health approach, using the notion of occupational health represents a partial understanding of health, leads to defining workplace and work life as outside of public health. The reasons for that are that citizens are seen not as workers but as consumers and that work life is moved out of the healthcare field. This causes occupational health to detach from public health when organizing healthcare services [4].

According to the International Labor Organization (ILO) and WHO, occupational accidents are defined as unplanned occurrences, often resulting in personal injuries; damages to machines, tools, and equipment; and halting the production



for a while. In Turkey, an occupational accident happens every 7 min, an employee loses his life every 11 h, and an employee is disabled every 6 h [3,5]. It is often said that accidents are in the nature of the business and they are inevitable. Furthermore, the inevitability of occupational accidents is in the legal opinions in Turkey and in the world. However, even when all precautions are taken and followed, one should not refer to the inevitability of occupational accidents. Insurance, sickness, and disability indemnities should not postpone investigating the causes of occupational accidents and social agony that occurred and taking preventative measures against them.

Currently, coal meets 30% of the world's energy need and accounts for 41% of the world's electricity production and 70% of the world's steel production [6]. According to the 2012 statistics of the Social Security Institution (SGK), most occupational accidents and diseases occur in the coal and lignite extraction business (8,828 occupational accidents, 231 occupational diseases) [7]. It is worth noting that a study conducted by the Turkish Statistical Institute (TÜİK) in 2013 determined that 2.3% of the employees were involved in an occupational accident within the last 12 months and that the ratio of occupational accidents in the mining and quarry sector was 10.4% [8].

The labor in the colliery business consists of the following in chronological order: survey, planning, preparatory studies, reserve estimation, production activities, coal preparation, and sales. The basic area that problems arise in terms of worker's health and safety is the production activities phase. Production activities consist of main activities such as excavation, ground support, and haulage as well as activities such as electricity maintenance, establishing and managing pressurized room networks, communication and signalization systems, and maintenance and repair of various machines and equipment. In particular, accidents in coal mining related to collapses, pit fires, firedamp and coal dust explosions, haulage, and mechanization frequently occur in underground pits [9,10].

Accident Types and Their Causes in the Coal Production Activities in the World and in Turkey

Decent work is safe work (ILO)

i. Accident causes by technical reasons [9-12]:

1. Accidents due to electricity and mechanization systems: Accidents that occur when the rules for safety and usage

are violated regarding the machines and devices that operate on electricity, accumulator, and diesel and when electrical energy is risky, i.e., in presence of pressurized air.

2. Dust and gas explosions, radiation: Firedamp explosion¹, radiation, dust and gas explosions, and discharges Methane, Sulphur dioxide (SO₂), Carbon monoxide (CO), Carbon dioxide (CO₂), Hydrogen sulfide (H₂S), Nitrogen oxides [Nitric oxide (NO), nitrogen dioxide (NO₂), nitrogen trioxide (NO₃), nitrogen tetroxide (N₂O₄)], Nitrogen N₂] see endnotes.
3. Accidents due to explosive materials used in mining.
4. Collapses².
5. Accidents that occur during haulage.
6. Flooding.
7. Pit fires (Coal heating³ is one of the reasons).
8. Sudden inrushes⁴.
9. Accidents that occur during coal preparation.
10. Accidents due to misuse of equipment and not performing their maintenance and repairs.
11. Accidents that occur during transportation, preparation, and usage of materials and tools.
12. Accidents due to environmental factors (heat, moisture, pressure, steam, noise, lighting, sliding surface, etc.).
13. Factors regarding personnel (ability, education, motivation, physical and mental state, personal attention, personal protection, etc.).
14. Unsafe working conditions (Attaching importance to safety, setback in production safety goal, problems in authority-responsibility distribution, not providing education, lack of necessary controls, inadequate warnings, etc.).

ii. Main causes of accidents [13-19]:

In a 2011 report by the Turkish Republic Presidency State Supervisory Council, similarities regarding the causes of coal mine accidents are studied in detail: Lack of risk evaluation, subcontracting⁵, sub-employing, production pressure, not learning lessons from previous accidents, inadequate precautions against the risk of firedamp, inadequate control and inrush borings, irregularities in drilling and blasting, employ-

¹**Firedamp:** Mixture of methane gas and oxygen in the air at a specific concentration and then the explosion of this mixture due to a source of fire. If oxygen is at the rate of 12-20% in the air and methane is at the rate of 7-15%, explosion occurs. If oxygen is less and methane is more, explosion does not occur [24].

²**Collapse:** Collapsing of ceiling as a result of insufficient ground support in underground production or its becoming old and losing its strength.

³**Coal heating:** In coal mines, rising up of coal temperature due to non-spreading heat caused by insufficient ventilation in panels and slow combustion of coal in the stocks or of pyrite in the coal. With increased coal heating, slow combustion can turn into open flame combustion. This is called spontaneous fire.

⁴**Inrush:** Sudden gas discharge (During underground mining, releasing of gases such as methane and CO₂ under pressure with sudden eruption and thus spreading of coal and other layers into the opened space) [24].

⁵**Subcontracting:** It is a sub-contract relationship. The workers of subcontractor company do some works in another company or production area of the company.

ees not having CO masks, inadequacy in gas monitoring and warning systems, inadequacy in ventilation, problems regarding electrical devices and equipment that are fire-damp-safe, inadequacies in vent-escapeways⁶, shortcomings in ground support⁷, problems regarding rescue and first aid services, insufficiency in supervision (internal audit) services in mining businesses, problems regarding internal audit practices such as technical supervisor, etc., ineffective supervision of public agencies, lack of vocational training, and workplace safety culture. The aforementioned report states that there are profound inadequacies in establishing occupational health and safety management systems directed towards taking systematic precautions by evaluating possible risks that may occur in mining businesses and thereby in preventing risks by prior evaluation, and it recommends that Turkey should sign ILO's Safety and Health in Mines Convention No. 176 because of reasons such as employers' not attaching sufficient importance to the precautions that reduce accident costs, inadequate number of skilled and experienced occupational safety specialists, not preparing risk assessments specially for each workplace, the risk assessment method of choice not being suitable for the workplace's conditions, and that occupational health and safety should be conducted by non-governmental organizations such as public service agencies, universities, trade associations, and trade unions [13].

Discussing occupational accidents and worker deaths with the economic, social, and political factors that they develop will make understanding the main causes of accidents easier [14].

Capitalism, which came along after the industrial revolution that began with the invention of the steam engine in the 17th century using coal energy, not only affects economic life but also societal and individual lives. In the early periods of capitalism, a worker entered individual contracts and worked for 15–18 h. During this period, the employee was not required to provide a safe work environment; the mining sector was notorious with such hazards [15].

With the advance of technology in the following century, machines made work easier and worker production increased as the work got easier. In this period, dubbed the Taylorist production process, more than what is required and mandatory was produced. Worker's labor power is bought by the capitalist for a wage that is only enough for the worker to maintain his life, and more than what he can produce with this labor power is seized (the notion of surplus value, Marx). In capitalism, where wages are continuously lowered to increase profits, worker's health becomes a victim of economic calculations. However, the market's volume is set by the wage the capitalist pays to the worker, and the capitalist's motive of profit tolls the death knell of the Taylorist period. Over-accumulation crises ensue when the gradually increasing production cannot be consumed because of the insufficient income of the workers [15,16].

⁶**Vent:** Ventilation shaft and escapeway. In a closed business, air uptake shaft or return airway provides the exit of air in the mine or its absorption with an aspirator

⁷**Ground support:** Reinforcement of a canal in a mineral deposit for preventing its collapse [25].

In capitalist economies, stages of rapid growth are followed by contractions, and these economic cycles also affect the health of the working class. To prevent the bankruptcy of the financier who is in crisis, the state, in an attempt to ensure the continuity of the system, tries to re-increase consumption by providing work, health, education, insurance, retirement assurance, and the right to unionize to consumers (i.e., to workers). This period of resolving the crisis, which lasted until the 1970's in the West after the second world war and until the 1990's in underdeveloped and developing countries, is the Keynesian Fordist production period which is also defined by machines interconnecting with tape. In this period, in addition to the growing capitalist economy, the "modern welfare state," which was forced to be implemented in a bipolar world, provided significant legal improvements in employees' rights, and individual contracts of the previous period are replaced with public contracts [15,16]. To understand the reflection of the period on coal mining in Turkey, it needs to be remembered that a strike that may take place in the Turkish Hardcoal Authority (THA), which could produce five million tonnes annually prior to 1980 when it had 40,000 employees and which could meet the hard coal requirements of Erdemir and Kardemir Iron and Steel Plants, was powerful enough to disrupt the activities of the iron and steel sector. Tens of thousands of colliers and their families joined the Great Mining March of 1990–1991 led by the General Mine Workers Union that took place in Zonguldak Coalfield, and it prevented the privatization of THA, which is a state-owned enterprise and which undertakes the entire hard coal production [17].

The international movement of the capital, which was forced to merge to compete in the free market and thus became centralized, increased from 1990's to today. This process, in which the production is moved to countries where the labor power is the cheapest and in which a single production process is able to take place in different locations simultaneously, is nothing but neoliberalism presented with the name globalization. The necessity of worker rights is eliminated in this period when privatization took place and when workers, just like in the early periods of capitalism, worked with non-standard contracts. Covered work environment is abandoned with flexible production, piecework production, and performance-based salary system to prevent the working class from organizing and disciplining the workers. Uncovered, lawless, and unsafe works cause the deaths and injuries of thousands of workers each year.

Contrary to the popular belief, the world's coal production increased after 1980; this increase occurred because of the production shifting from Europe, where the labor force is expensive, to the Asia-Oceania line, where the labor force is cheap. Today there are five million mine workers in China, the world's biggest coal producer. In Turkey, however, the state paved the way for the privatization of state-owned enterprises while regulating political, economical, and social lives in accordance with the needs of global capital. THA, which could not be privatized because of the mining march

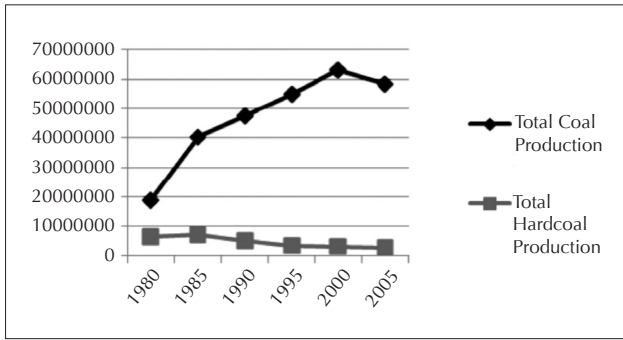


Figure 1. Total coal and hard coal production in Turkey (tonnes) [17]

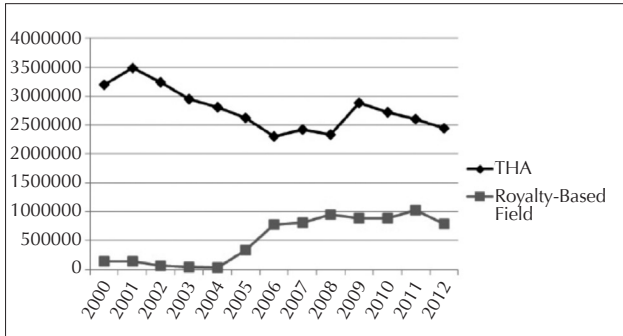


Figure 2. Total coal production in THA and royalty-based fields (tonnes) [17]

of 1990–1991, was privatized with the royalty system as a way for “backdoor privatization” (Figure 1). Today in Zonguldak Hardcoal Coalfield, 32 fields are operated by the royalty system, and the number of workers working in fields with royalty system will soon exceed the number working for THA (Figure 2). The Soma coal mine, where 301 workers died in May of 2014, is also leased with the royalty system by Soma Holding and is operated by sub-employers. In turn, sub-employer companies work through a “gangmaster” who appears as a worker in official records and who puts a group of workers to work with by-the-job contracts⁹. Gangmasters earn their income, which is progress-based and based on work done after progress (performance-based), through workers whom they force for more production and who sometimes cannot even collect their wages. With this work method, collegiality and division of labor, which are very important in mines for workers, cannot be achieved; working hours prolong, temporary part-time flexible jobs arise, layoffs become easier, and therefore work experience disappears [17]. According to a survey conducted among 200 coal mine workers working in two underground businesses, one state-owned and the other privately-owned, 8 out of 10 people in the state-owned company had work experiences of ≥ 15 years, while the same was true for only 2 out of 10 people in the privately-owned company. Minimum wage workers constituted 1.8% of the workers in the state-owned company, whereas they accounted for 25.8% of the workers in the privately-owned company [18]. The important factors contributing to occupational accidents in private sector are the following: sub-employer companies that, to reduce costs, do

Table 1. Deaths due to occupational accidents in Zonguldak Hard Coal Field [17]

	Private and illegal pits	THA pits
Coal production	6.907.576 tonnes	36.029.721 tonnes
Worker deaths	195	86
Deaths per 100,000 tonnes	2.82	0.23
Private and Illegal/THA death rate	12.2	

THA: Turkish Hardcoal Authority

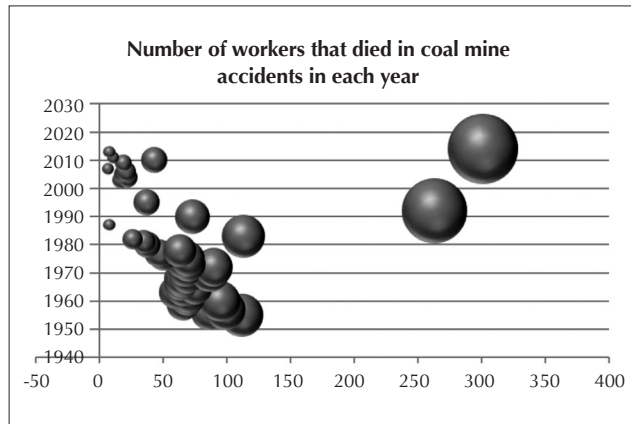


Figure 3. Graphical distribution of the magnitude of the number of workers that died in coal mine accidents in Turkey in each year [12,26]

not even hand out dry food, which was previously done; and do not sufficiently exercise occupational health and safety regulations because of cost considerations; occupational health and safety experts and workplace doctors are earning their salaries from the companies that they work in; occupational health education is no longer the responsibility of trade bodies; and conditions in which workers can receive vocational training are not provided (Figure 1). Furthermore, in the royalty-based fields, to reduce the cost of the production goal that is declared to THA, sub-employer companies allow illegal pits in their fields that operate with 3–5 people (sub-contractor of sub-contractor) and this paves the way for informal economy, non-contractual employment, and child employment, and it leads to a lack of records regarding disease, injury, and accidents in royalty-based fields and illegal businesses and therefore to the loss of collective memory that is required to fight wrongdoings (Figure 3 proportionately demonstrates on a graph the number of workers that died in coal mine accidents in Turkey since 1995). Even though it may appear that the number of workers that died in accidents decreased starting from the 1990’s, unrecorded deaths in illegal companies and two major accidents that caused the deaths of many workers – Kozlu 1992 and Soma 2014 – attract the attention in the upper right corner.

⁸Royalty: Payment to the right holder for copyright transferred to a natural or legal person with license contract.

⁹By-the-job contract: Labor agreement between employee and employer. It can be for a group or a single man. In this contract, the amount of work can be determined according to material use, the number of wagons, length (cm, m), surface (m²), volume (m³), and time measurement or according to the number of wagons and mixed measurement unit [24].

DISCUSSION

"It is unacceptable that people are digging coal at the expense of their lives. Sadly, exaltation of the deceased workers does not provide sufficient protection for possible accidents in the future. It is preposterous to accept mine workers' deaths, instead of doing everything to stop these accidents from happening."

Dr. Ralph Bartel, German Mining, Chemistry, Energy Union; a quotation from Deutsche Welle's Soma Interview

When deaths due to occupational accidents are discussed in a framework of a technical error or a shortcoming, they are restricted to a technical approach that discusses human health as an ordinary input with statistical calculations such as "accident frequency rate." Discussing occupational accidents and worker deaths at the intersection of the social, economical, social, and political factors that they develop in and, as the French sociologist author Mony recommends, placing occupational deaths on a tripod consisting of the strategic choices of the businesses, public policies, and workers' lives will make understanding the causes of accidents easier [14].

In the "Report on the Typhus Epidemic in Upper Silesia," authored by Rudolf Virchow (known as the father of modern pathology) on the basis of multi-agent etiological analysis regarding the typhus epidemic that broke out in the coal mines in 1848, the real cause of the typhus epidemic is identified as the working and living conditions of the working class. In other words, deprivations cause diseases, and one of the long term solutions is the necessity of the health guarantee of the citizens to be under the guarantee of the state to prevent diseases [20]. A century later, in his article titled "ethical problems in the relationship between health and work," Italian public health professor Berlinguer underlines

the deep contradiction between the maximization of profit and the minimization of cost and occupational health and safety [21].

Every year, 350,000 workers in the world and 1,200 workers in Turkey lose their lives because of occupational accidents. Mining, following the construction sector, is one of the fields where deaths related to occupational accidents are most commonly seen in Turkey. In coal mining, most frequent accidents are the ones related to collapses, pit fires, firedamp and coaldust explosions, haulage, and mechanization. Classifying the accidents seen in coal mining with causes such as electrical and mechanization problems, dust and gas explosions, pit fires, sudden discharges, collapses, errors in preparation, transportation and usage of materials, and environmental and personal factors may lead to ignoring the main causes that generate these accidents.

Capitalist production relationships affect the economic life as well as social and individual lives. In capitalism, where more than what is required and mandatory is produced, where worker's wage is continuously lowered to increase profits, and where labor power is bought and sold, people's health, along with their physical, psychological, and moral values become victim to economic calculations. In a capitalist economy, workers' working conditions, wages, and social rights differ as well in growth and contraction periods that succeed each other in a natural cycle; for instance, the state's intervention on determining the working conditions may be necessary to fix the effects of economic crisis.

Even though the English term "precarious," which summarizes the working conditions of the neoliberal period that began after the latest crisis, is mistakenly translated into Turkish as "flexible working," what it really means is unsafe, lawless, and a state of insecurity. Precarious working

Endnote [10, 12]:

Nitrogen (N₂): It is not an explosive or toxic gas but a suffocating gas. Because fires cannot be brought under control if there is pure oxygen in the atmosphere, oxygen level must be decreased by diluting with nitrogen. This can lead to suffocation. Its main sources are organic decomposition, spreading through rock or coal cracks, and explosion. In explosions, 1 kg nitroglycerin and 135 L of nitrogen are released.

Nitrogen oxides: They are toxic gases. Nitric oxide (NO), nitrogen dioxide (NO₂), nitrogen trioxide (NO₃), and nitrogen tetroxide (N₂O₄) are found in nitrogen explosions and in the exhaust gas discharge of diesel engines. It is dangerous to expose to air, including 0.1% nitrous smoke, for more than 30 min. It should not exceed the concentration of 25 ppm in 8-h working time. The presence of nitrogen oxides can be understood by gunpowder odor after explosions.

Hydrogen sulphur (H₂S): It is a toxic and colorless gas. It harms the sense of smell. It smells like rotten egg. It is released as a result of combustion of black gunpowder, explosion of sulphur ores, and drainage of flooded areas. It also emerges because of the decomposition of organic substances, and it causes irritation in the upper respiratory tract and eyes. It is an explosive gas at the rate between 4% and 44.5%.

Carbon dioxide (CO₂): It is a suffocating gas, which is heavier than air. It accumulates in holes and falls. It causes suffocation by reducing the oxygen level in the environment. It generates as a result of burning of wood, coal, and petroleum. It can be detected in the atmosphere by checking the brightness of a safety lamp. Dull and smoky light shows that the level of carbon dioxide in the environment is at least 2%. One of the reliable tests for the detection of CO₂ is passing the air through limewater. The fluid thickens and acquires the color of milk-chalk powder. Another detection method is chemical analyses.

Carbon monoxide (CO): It is released as a result of latent and open mine fires and exhaust gases. It is a toxic gas. Because its affinity to erythrocytes is higher than oxygen, it leads to intoxications. It should not exceed the concentration of 0.005% (50 ppm) in an 8-h working time. Detection techniques for CO include chemical analyses in laboratory, color measurement detector, and thermal and digital detectors. Another method is the use of warm-blooded animals such as linnet, canary, and Mouse.

Sulphur dioxide (SO₂): It is a very toxic gas that is non-flammable. Its main sources are burnt iron pyrite and explosion of sulphuric ores. It irritates the eyes, nose, and throat. High level of sulphur dioxide in the inhaled air damages the lungs.

Methane (CH₄): It is an explosive gas. Methane gas released during the formation of coal can spread with blasts or sudden gas eruptions. In high concentrations, it decreases the level of O₂ in the air. In the presence of methane at the rate of 4%–15% in the mine's atmosphere, explosion occurs and then the temperature in the environment increases up to 1800–2000°C and the pressure increases 9 times. Its concentration can be measured with methane meters, automatic detectors, ringrose alarm, and flame safety lamp. Methane drainage must be performed to prevent firedamp explosion.

includes not only employment insecurity but also functional insecurity, which is the absence of defining which work will be done where, job insecurity, income insecurity, social right insecurity, working hour insecurity, and representation insecurity [22].

With Turkey's process of articulation to neoliberal policies that began in the 1980's, the privatization of the coal mines took place via the royalty system; flexible working, production stress, piecework production, and performance-based salary system are imposed with sub-contracting, gangmaster, and illegal business systems. Thus, safe work environment disappeared. The facts that sub-contractor and illegal companies find occupational health and safety practices and vocational training costly and do not implement them and that internal and public audits are lacking or absent lay the groundwork for occupational accidents and deaths in most companies. Furthermore, the fact that occupational accident records and death statistics are not kept, particularly in illegal businesses, eliminates the collective memory that is effective in fighting wrongdoings [17].

One of the aims of the scientists should be to develop an energy policy that constitutes an alternative to coal mines, where, in addition to the injuries and deaths related to occupational accidents, occupational diseases are also observed. Coal-fired thermal power plants, which are one of the main contributors to carbon emission that causes the climate change, are the source of three times more than the WHO's acceptable limit of particulate matter (PM), SO₂, mercury, arsenic, and cadmium in the air of Turkey's large cities. While currently there are 22 coal-fired thermal power plants in Turkey and 80 more are aimed to be built, Germany increased its electric production related to wind, sun, and geothermal energy from 8% to 22% in the last decade and also employed thousands of people in the renewable energy sector. It appears that renewable energy and energy efficiency policies can reduce the need for fossil fuel [23].

Deaths in coal mines make one think of premeditated murder rather than an accident. Is not the human the obstacle in the way of sharing the joy of working like a human and of producing together? As Seneca said, "Living in necessity is unhappiness, but living in necessity is not a necessity."

De te fabula narratur (The story that is told is yours).

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