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REVIEW ARTICLE



Prospective Ergonomics in the Anthropocene era: reconsidering human needs

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ABSTRACT

This position paper discusses the roles of Prospective Ergonomics to face the challenges of Anthropocene. In particular, we question the nature of human needs to distinguish between fundamental needs essential to human development and artificial needs partly responsible for overconsumption and detrimental effects on Earth system. An overview of theories of human needs across Psychology, Economics and Sociology contributes to clarifying which kind of needs should be supported in the future, and which kind of satisfiers (ways of actualising needs) should be designed in a sustainable perspective. Ethical implications and dilemmas for Prospective Ergonomics are also discussed.

Practitioner Summary: We invite ergonomists to question their practices in satisfying user needs and provide insights to detect artificial needs, in order to limit their expression and development in the design of future products and systems.

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Anthropocene; artificial needs; fundamental needs; transition

1. Introduction

We no longer count the studies (see Forster et al. 2024) warning of the harmful effects of our fossil fuel consumption and industrial activities on the Earth system integrating the lithosphere, hydrosphere, cryosphere, atmosphere, biosphere, pedosphere and anthroposphere (Keller 2024). In this position paper, we propose to question the contribution of Prospective Ergonomics to designing a more sustainable future. We first provide an overview of current systemic crises resulting from a new era called Anthropocene (Federau 2023) and their potential impact on the future of societies worldwide. This leads us to position two kinds of contributions for Prospective Ergonomics to face the Anthropocene: contribute to alleviating its detrimental consequences, or to fighting its root causes. The latter implies to understand human needs that played a role in the emergence and maintenance of overconsumption and acceleration phenomena. The subsequent research questions relate to the fundamental vs. artificial nature of these needs and the extent to which their expression and satisfaction could be controlled or limited in the design of future things. To better inform these questions, we develop three complementary theories of human needs from Psychology, Economics and Sociology perspectives. All these theories

highlight the artificial nature of consumption needs and provide a framework for shaping Prospective Ergonomics' interventions: focus primarily on fundamental needs (e.g. needs for autonomy, competence, relatedness), and contribute to designing synergistic or universal satisfiers covering as much as possible several needs. We also discuss a few ethical implications for the practice of Ergonomics.

2. The Anthropocene era

Anthropocene is a new geological epoch characterised by the negative impact of humans on Earth's ecosystem (Crutzen and Stoermer 2000; Steffen, Crutzen, and McNeill 2007, Steffen et al. 2015; Federau 2023). Anthropocene follows the Holocene, i.e. the interglacial era during which temperature stability enabled human societies to expand. In particular, three major historical milestones can be distinguished in the development of humankind:

1. The rise of the Neolithic age (about 10,000 years ago) and the first agricultural revolution, which marked the transition from a nomadic hunter-gatherer lifestyle to the development of sedentary agricultural communities. This step

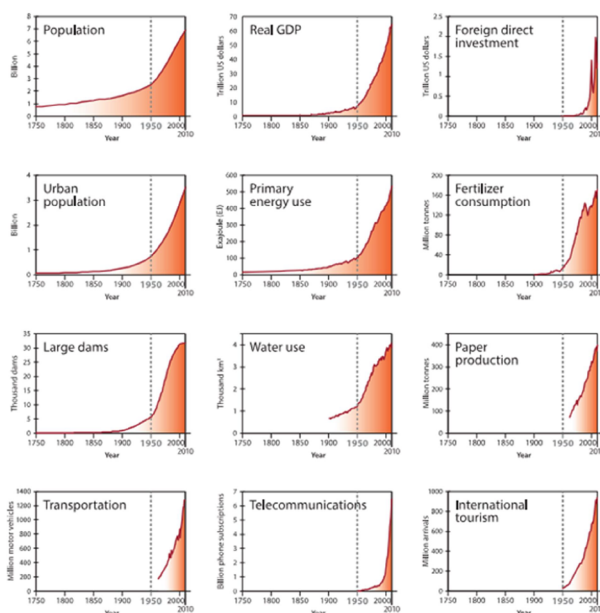
was characterised by the creation of villages and the domestication of plants and animals, and resulted in an increase in population.

2. The First Industrial Revolution (from 1760) then brought many technical, social, political, and economic transformations leading to the creation of modern society. This period was marked by scientific progress and the formalisation of innovation as it is still defined today (an invention that meets a market, OECD, 2019) on the basis of Schumpeter's view on industrialisation and growth. Industrialisation aimed to produce more products at lower costs, leading to the improvement of consumer goods' production (clothing, furniture, food). Aristocrats and bourgeois favoured its expansion by consuming luxury goods, and popular classes imitated them by consuming similar but more affordable products (Désaunay 2021).
3. The 'Great Acceleration' (Steffen et al. 2015) illustrates the fact that over the past seventy years, human activity has altered ecosystems faster and more deeply than in any other comparable period in the history (Figure 1).

Although the beginning of the Anthropocene era is still debated (Lewis and Maslin 2015), the parallel between socio-economic trends (transportation, urban population,...) on the one side and earth's system trends (surface temperature, tropical forest loss,...) on

the other side, highlights the middle of the 20th century as a turning point in both processes (Figure 1). This shift date corroborates the Glorious Thirty defined by a strong growth period from the end of World War II until 1972 first oil shock. Europe being ravaged by war, the United States developed the Foreign Assistance Act (1948, known as the Marshall Plan), which consisted of loans granted to European countries on condition that they import an equivalent amount of American equipment, raw materials, energy, food and products. In 4 years, the United States lent the equivalent of 13 billion old dollars. This period of strong growth marked the explosion of the 'mass consumption society' (Daumas 2018), defined as 'the accumulation and consumption of material goods' (O'Shaughnessy and Jackson O'Shaughnessy 2002; p. 525). This *Western lifestyle* has never stopped growing and spreading due to economic globalisation, even in non-Western countries such as China (Knobloch 2023) and contributed to the explosion of advertising messages, materialistic themes and consumption desires (Burroughs and Rindfleisch 2002). This unprecedented level of consumption in Western societies is a source of job creation and a symbol of success, personal fulfilment, and social distinction (Désaunay 2021). However, overconsumption also generates harmful effects (Boström 2020; Knobloch 2023), such as massive use of non-renewable fossil fuels (Fressoz 2024), resource extraction levels exceeding regeneration capacities, and generation of waste and pollution (Keller 2023).

Socio-economic trends



Earth system trends

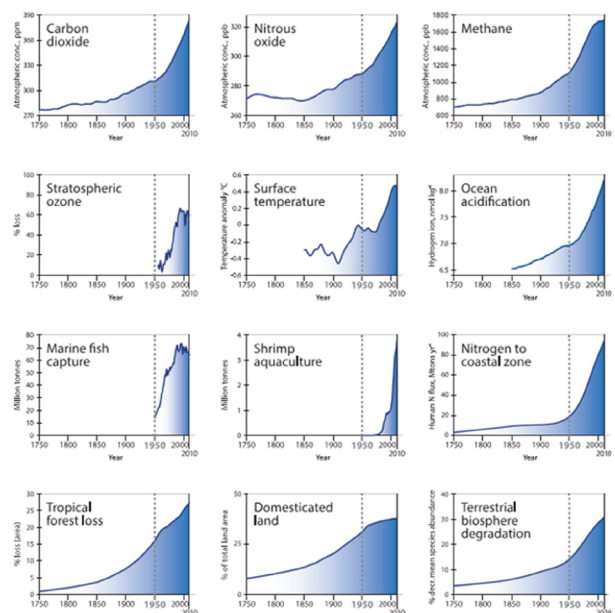


Figure 1. Great Acceleration (Steffen et al. 2015).

The negative consequences of human activities were first highlighted by Meadows et al. (1972; Club of Rome) in their famous report 'The limits to growth', based on mathematical model World 3 to compute the consequences of demographic and industrial growth. Their main recommendation to prevent a collapse of the planetary system was to stabilise population and production (Meadows et al. 1972, Meadows, Randers, and Meadows 2004). Although harshly criticised, this report remains a reference for fighting the environmental crisis and Randers (2012) confirmed their initial results.

More specifically, the Anthropocene puts pressure on planetary boundaries (Rockström et al. 2009), which are biophysical processes regulating the stability and resiliency of the Earth system. Six out of nine boundaries are already exceeded (Figure 2), which in turn challenges Earth's habitability, i.e. the environmental conditions supporting healthy human life, productive livelihoods, and sustainable intergenerational development (Horton et al. 2021). Habitability encompasses basic human survival, livelihood security or resilience,

and societies' capacity to manage environmental risks (Wrathall et al. 2023).

The current and future consequences of the Anthropocene were also formalised into 10 major societal Megatrends affecting the world population and all sectors of activity (Table 1). Megatrends interact with each other and may generate dramatic consequences. For example, according to the World Food Programme (WFP) up to 309 million people do not eat enough in the world in 2024 in 72 countries*¹. Intergovernmental Panel on Climate Change (IPCC; 6th report published from 2021 to 2023) predict, inter alia, that children born in 2020 will experience seven times more extreme heat episodes compared to those born in 1960, twice as many forest fires and droughts, and nearly three times as many floods and poor harvests. These examples highlight that all countries are concerned by these issues but at different levels. Some talk about 'climate justice' (Schlosberg and Collins 2014), as climate change is a source of economic and social inequality (between people, communities, regions and states). It was also shown that the communities most vulnerable

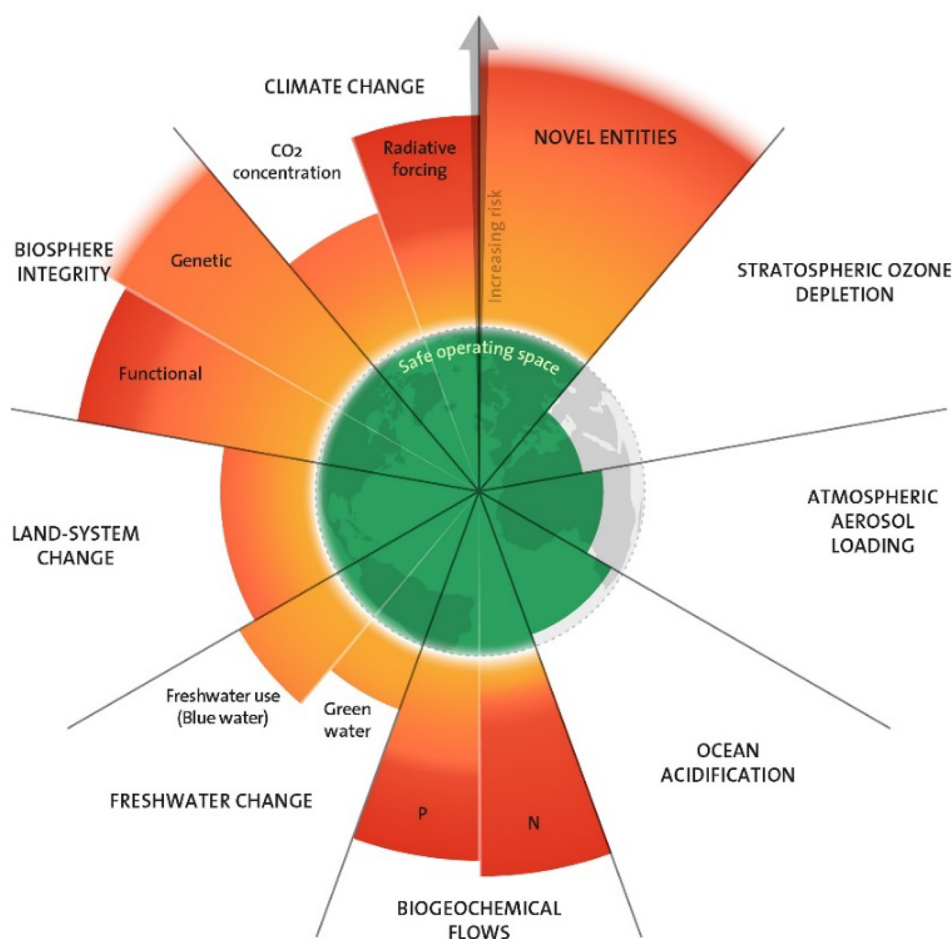


Figure 2. Nine planetary boundaries (this figure was cropped from the original; Credit Azote for Stockholm Resilience Centre, Stockholm University. Based on analysis in (Richardson et al., 2023).

Table 1. Megatrends (Giget 2023).

Megatrends
Climate change
Biodiversity loss
Demographic change
Growing urbanisation
Geopolitical conflicts
Technological revolutions
Depletion of natural resources
Economic rise of Asia
Poverty, inequality
Loss of confidence in progress and future

to climate change are also the least responsible for current levels of greenhouse gas concentrations in the atmosphere (Lavorel and Torre-Schaub 2023).

Megatrends were identified on the basis of 120 prospective studies (see Giget 2018, 2023; first study in 2018 updated annually) as likely to generate transitions (concerted actions related to given geographical areas and economic activities) and risks (events or ruptures in the transition process). These transitions should involve all public and private actors, including governments, industry, and scientists of all disciplines (Barrau 2023; Steffen et al. 2015; Ripple et al. 2020, 2023; Harvey et al. 2023). Our aim is to develop how Prospective Ergonomics can contribute to these transitions, reorient some of its research topics, and question its practices.

3. Fighting the cause or the consequence: two routes for Prospective Ergonomics

Ergonomics' mission being to optimise human well-being and overall system performance, it has accompanied several phases of technological and social development. Ergonomics contributed to industrial development with the emergence of the study of working conditions (Laville 2001); it also participated to the consumer society (1960s) with product ergonomics, and to the digital revolution by studying human-machine interactions and user experience. Nowadays, prospective ergonomics accompanies the generalisation of innovation within organisations by anticipating the needs of tomorrow.

All specialties of Ergonomics may be concerned by contemporary crises (environmental, financial, social and sanitary), as they negatively affect well-being and performance. From the early 90's, Moray (1993) and Helander (1997) invited ergonomists to address issues of global environment and social problems such as water and food shortages, and pollution. Thatcher introduced the term 'Green Ergonomics' in 2012 to designate ergonomic interventions with a pro-nature focus on bi-directional relationships between humans

and the environment. Nevertheless, ten years later, he pointed out that Human Factors and Ergonomics' publications on socio-environmental challenges remain relatively rare (Thatcher 2024).

We believe that Prospective Ergonomics could play a key role in shaping the future of human activities to face the Anthropocene, because its purpose is to prospect and construct future needs and uses in order to create future artefacts adapted to economic, social, and cultural contexts (Brangier and Robert 2014). More specifically, the first two principles of Prospective Ergonomics, prospective and future-oriented cognition, rely on anticipating societal change and supporting strategic decision-making (Bootz 2012; Brangier and Robert 2014; Robert and Brangier 2024). In this respect, Prospective Ergonomics could integrate Transition Design projects (Bisson et al. 2022; Irwin 2015) and bring a unique contribution focusing on the definition of future needs and future uses, thereby contributing to solutions developed with other disciplines (e.g. Design, Engineering, Marketing). While traditional design processes focus on the short-term and the purpose of selling, Transition Design builds on a long-term vision of a preferred future (Bisson et al. 2022) and gives priority to decentralised, distributed and networked solutions (Bisson et al. 2022). Most areas of design research and practice are solution-driven (Cross 2004), which is consistent with the strong emphasis on creativity and the intuitive dimension of design thinking (Kannengiesser and Gero 2019; Thorpert et al. 2024). The solution-driven approach enables designers to overcome 'ill-defined problems' (Kruger and Cross 2006) or 'wicked problems' in Transition Design, which are defined as complex problems involving conflicting interests that cannot be understood within a single discipline (Irwin, Tonkinwise, and Kossoff 2022). This focus on solutions contrasts with the analytical nature of Human Factors and Ergonomics discipline (Karwowski 2006) and its problem-driven orientation. In this respect, a Prospective Ergonomics' approach focusing on human needs and based on scientific knowledge, theoretical considerations and field studies, is likely to bring a valuable contribution to Transition Design. It may provide a problem-driven contribution which is not only complementary to the solution-driven one, but also likely to improve the overall results of the design process in terms of balance between quality and creativity (Kruger and Cross 2006).

To build scenarios for the future, Prospective Ergonomics and Transition Design can rely on the abovementioned Megatrends to feed the anticipation process. They can also build on the scenarios designed

by Ademe (2021). For example, in the Restorative-challenge scenario, mass consumption and economic growth are preserved, and technological innovation is expected to help manage carbon emissions. In such a scenario, society accepts the impacts of climate change and should be prepared to adapt to its consequences: for example, working and living in higher temperatures and developing housing and transportation means to compensate for global warming. In this view, Prospective Ergonomics can contribute to alleviate the impact of climate change through palliative solutions to maintain Earth's habitability. This implies for example, to support basic physical health, and psychological well-being in the context of environmental extremes, variations and permanent changes (Sherwood and Huber 2010; Xu et al. 2020), to support the 'capacity of people across generations to sustain and improve their livelihood opportunities and well-being despite environmental, economic, social and political disturbances' (Tanner et al. 2015, p.23), or to support the collective capacity to adapt to environmental risks (Barnett and Adger 2010).

An alternative scenario in Ademe's (2021) framework recommends strong sobriety and frugality, which involves developing low-tech solutions (Colin and Martin 2023) and decreasing consumption. This scenario is in line with two other principles of Prospective Ergonomics, creativity and ergonomics, which support the creation of desirable, inclusive, sober, and resilient futures (Brangier and Robert 2014; Cheng 2019). The key point in this scenario is to be able to question current ways of living, understand the root causes that led to the Great Acceleration and mass consumption, to overcome the Anthropocene. The emergence of new narratives and myths is crucial (Keller 2024) to make new models of sustainable societies possible. In the following section, we provide an overview of the causes of Anthropocene, in particular those that Prospective Ergonomics can address.

4. Human needs as the root causes of Anthropocene

The influencing factors of the Great Acceleration and the Anthropocene include economic, political, technological, social, cognitive and spatial-temporal factors (Boström 2020), as synthesised in Table 1.

We consider that social-relational factors fall within the scope of Prospective Ergonomics, because they seem to correspond to human needs. To contribute to overcome Anthropocene, Prospective Ergonomics could study in greater details those needs potentially responsible for the emergence and maintenance of

overconsumption, and address the following research questions: Are these needs inherent to human nature or were they artificially created by contextual societal factors? To what extent can they be controlled to limit overconsumption? Can we disregard them when collecting future needs to address in Transition Design?

The key notion here is the nature of need, considering that some needs could be qualified as artificial or superficial and that Prospective Ergonomics could play a role in identifying them, limiting their expression and their satisfaction in order to control (over) consumption. Artificial needs may have been generated by productivism and consumerism (Keucheyan 2019) in a logic of economic growth (Parrique 2022). Consumers may somehow be manipulated by advertisement, design and a renewal frequency 'creating false needs and false consciousness' (Haug 2009, cited by Knobloch 2023, p. 1238). They may not be real needs but rather interpreted as desires (Brulé 2024); a desire to buy, to consume for social distinction or instant pleasure that provide a dopamine shoot.

These artificial needs or desires also refer to hedonic vs. eudaemonic well-being. According to Delle Fave, Massimini, and Bassi (2011), 'the hedonic view equates happiness with pleasure, comfort, and enjoyment, whereas the eudemonic view equates happiness with the human ability to pursue complex goals which are meaningful to the individual and society'. Instant gratification and short-term pleasure correspond to hedonism (O'Shaughnessy and Jackson O'Shaughnessy 2002; p. 525) and subjective well-being relying on positive affects, life satisfaction and low negative affects (Diener et al. 1999). In contrast, eudaemonism corresponds to a long-term perspective, and generates psychological well-being relying on autonomy, purpose in life, personal growth, positive relationships, environmental mastery and self-acceptance (Ryff 1989). A consumer society based on materialistic values may assume that consumption generates well-being. However, research shows on the contrary that materialistic values are negatively correlated with life satisfaction and happiness, and positively correlated with depression and neuroticism (Burroughs and Rindfleisch 2002). This suggests that overconsumption culture may hinder both Earth's system and human well-being (The Royal Society 2012).

Distinguishing artificial vs. fundamental human needs for designing the future could therefore be a valuable contribution from Prospective Ergonomics. With regard to need-seeking strategy (Buisine, Taton, and Boisadan 2021), the aim would be to limit human needs to fundamental ones (i.e. recovery paradigm) instead of searching for new needs (i.e. discovery and

creation paradigms), thereby reducing artificial needs and the resulting overconsumption. To inform these research questions, we develop in the following section scholarly literature on human needs, their types and their fundamental vs. artificial nature.

5. Theories of human needs

Despite its complexity, the study of human needs is central to understand human life (Galtung 1980; Keucheyan 2019). The notion of need was addressed in a diversity of disciplinary fields, which all have their own definition (psychology, sociology, economics, anthropology, and nursing; Hasani 2011, cited by Sohrabi et al. 2021; Pittman and Zeigler 2007; Glasser 1999, cited by Sohrabi et al. 2021). We adopt here the following definition: 'Need, in the broad sense, is a configuration of psychological and physical characteristics that is felt as a lack or tension. It is expressed in the form of motivation to action and its satisfaction is experienced as a tangible experience' (Colin, Barcenilla, and Brangier 2021). Max-Neef, Elizalde, and Hopenhayn (1991) attribute three characteristics to human needs: 1) they are self-evident and universal over space and time across societies and historical periods. They change slowly following an evolutionary rhythm; 2) human needs are satiable, irreducible, and non-substitutable between dimensions; 3) human needs are non-hierarchical. According to Sheldon et al. (2004), satisfying our needs generates well-being and psychological thriving.

The literature highlights three major types of human needs: biological, physiological, and psychological. Regarding biological needs, Bohler (2019) studied the *striatum*, which is one of the oldest deep cerebral structures (from the Paleolithic). Its role is to satisfy five basic needs for the survival of human species: eating, retrieving information about the environment (detecting hazards), having sex, resting, and having a social status (social distinction). The satisfaction of one of these needs instantaneously releases dopamine, which is the main neurotransmitter involved in the reward circuit and in motor control, attention, pleasure, and motivation (Nieoullon and Coquerel 2003).

Physiological needs support immediate survival of the organism (Benjamin 2020): eating, drinking, sleeping, breathing, or protecting oneself from the cold (Keucheyan 2019). Physiological needs are ontologically independent from psychological factors (McLeod, 2014). According to Maslow (1943, 1970), their objective is to maintain the normal and healthy functioning of the body. Physiological needs seem to be the most affected by climate upheavals in poor and rich countries (e.g. mega-fires, difficulties to access drinking water).

Finally, a psychological need is defined as 'an innate psychological nutriment that is essential for ongoing psychological growth, integrity, and well-being' (Deci and Ryan 2000). The study of psychological needs dates back from the early 20th century (McDougall 1908; Freud 1920; Murray 1938 cited by Sheldon et al. 2004). The hierarchy of needs (Maslow 1943) remains a popular theory (Cooke, Mills, and Kelley 2005; McCleskey and Ruddell 2020), although scholars have raised many limitations in its empirical application, its philosophy, and its scientific background (Taormina and Gao 2013). Another major criticism points precisely to its hierarchical nature (Gough 2015) which was ruled out in later theories (Max-Neef, Elizalde, and Hopenhayn 1991).

We may first highlight that social-relational needs behind overconsumption (Table 2) fall into the category of psychological needs. As they are neither basic nor survival needs, they do not relate to biological nor physiological needs, although they may sometimes fool them by stimulating the reward system and thereby our brain's insatiability towards dopamine (Bohler 2019). Regarding psychological needs acknowledged in the fields of Ergonomics and User eXperience, Colin, Barcenilla, and Brangier (2021) proposed a list based on Sheldon et al.'s one (2004):

- Self-fulfilment/purpose: developing its potential and finding meaning in life,
- Autonomy: being responsible for one's actions,
- Competence: being competent and effective,
- Creativity and inventiveness: creating new, inventive, and original things,
- Physical development: feeling healthy,
- Self-esteem: feeling like a valuable person,
- Pleasure: feeling pleasure and being stimulated,
- Popularity: feeling appreciated, respected, and influential,
- Relationships with others: having regular relationships with people who matter to you,
- Security, robustness, reliability: feeling safe and in control.

This list includes needs close to those influencing overconsumption (e.g. pleasure and popularity) but does not enable us to decide on the fundamental vs. artificial nature of each need. To further investigate this point and offer the broadest view on human needs, we present hereafter three theories representing complementary views on human needs. On the basis of Sohrabi et al.'s meta-theory (2021), we selected Self Determination Theory (Deci and Ryan 1985),

Table 2. Influencing factors of the Great Acceleration (Boström 2020).

	Factors	Consequences
Institutional factors	Capitalism	Supports limitless growth and capital accumulation
	Industrial and technological development	Supports productivity and large-scale differentiation
	Urbanisation and standardised mass consumption	Facilitate product accessibility and availability
	Politics	Economic growth as a dogma (the claim that consumption keeps the economy spinning) transcends political divisions
	Neoliberalism	Supports deregulation, globalisation (low-cost production), free trade and privatisation
Social-relational factors	Everyday interaction rituals and social comparison	Consumption serves as a social link (affiliation and exclusion), conveys values and symbolic meanings (e.g. markers of social classes and membership)
	Temporality, including novelty and rapidity	Decreased time to market (e.g. ultra-fast fashion leading some brands to release up to 10,000 new products a day)
	Spatial dimension of consumption	Multiplicity of consumption sites, e.g. home as visible for its exterior (neighbors and passers-by) and its interior (invited visitors or photos on social media), shopping centre.
	Cognitive dimension, normalisation and mass ignorance	Overconsumption perceived as a standard for life, fear of stigmatisation from the endo group, mass ignorance regarding the future impacts of our actions (inability to predict the long-term, difficulties to understand systemic impacts, etc.)

because it is the most acknowledged and applied one in Psychology (Ryan and Deci 2019); Fundamental Human Needs (Max-Neef, Elizalde, and Hopenhayn 1991), which is the most cited one in Economics; and the Theory of Human Need (Doyal and Gough 1991), which is recognised in Sociology.

5.1. Self-determination theory

Deci and Ryan met in 1977 and developed Self-Determination Theory in 1985. The purpose was to inform human motivation, personality and wellness in a dialectical approach. The theory includes several sub-theories (Tang, Wang, and Guerrien 2020), among which the statement that people are motivated by three universal psychological fundamental needs (Deci and Ryan 2000; Ryan and Deci 2000b; Ryan and Deci 2001): the need for autonomy (feeling self-governed and self-endorsed), relatedness (feeling interacted) and competence (feeling efficient). These needs initiate or regulate human behaviour (Guay, Vallerand, and Blanchard 2000) and their satisfaction is considered as essential to optimal functioning and psychological well-being (Ryan and Sapp 2007; Richards et al. 2024) in a eudaemonic perspective.

Sheldon et al. (2004) compared 10 psychological needs (autonomy, competence, relatedness, physical thriving, security, self-esteem, self-actualisation, pleasure-stimulation, lonely-luxury, and popularity-influence) to determine which ones were the most fundamental. Needs were selected from Self-Determination Theory (Deci and Ryan 1985), the theory of personality (Maslow 1954), the cognitive-experiential theory (Epstein 1990), and the American dream theory (Derber 1979). They conducted three

studies with U.S. and South Korean students who had to describe the most satisfying events in their lives and evaluated the salience of each need. The 'big four' needs were autonomy, competence, relatedness, and self-esteem, thereby mainly supporting Self-Determination Theory.

This theory emphasises only three fundamental needs: autonomy, competence and relatedness. We posit that overconsumption may support neither autonomy nor competence, but may sometimes contribute to relatedness, through social identification and social comparison processes. Hence Transition Design and Prospective Ergonomics should focus on finding solutions to enhance citizens' autonomy and competence, as well as satisfying need for relatedness in ways avoiding to stimulate overconsumption.

5.2. Fundamental human needs

Needs are a central notion in Economics and Marx was a pioneer in theorising on the subject. Today, needs are considered from a productivist viewpoint as the major source of socio-environmental crises. This is why some economists are leaving this paradigm to explore degrowth (Laurent 2019; Parrique 2022). Among them, Max-Neef was an 'artist, social justice advocate, and ecological economist' (Doussoulin and Belloy 2022). In 1989, following post-war crisis in Latin America, he formalised the Fundamental Human Needs theory, his most popular and influential work on ecological economics. Brand-Correa and Steinberger (2022) highlight three theoretical contributions: 1) the distinction between needs and satisfiers (ways of actualising needs), 2) satisfiers themselves, which can be market-exchanged goods and services, personal and

collective attitudes, institutions, norms, values, activities and infrastructures (Brand-Correa et al. 2020), and 3) the conceptualisation of energy services as need satisfiers.

Human needs are distinguished into two categories (Max-Neef, Elizalde, and Hopenhayn 1991):

- Existential needs, which include: needs of Being (personal or collective attributes), Having (institutions, norms, mechanisms, tools...), Doing (personal or collective actions) and Interacting (locations and milieus).
- Axiological needs, including need for Subsistence, protection, affection, understanding, participation, idleness, creation, identity, and freedom.

Human needs are viewed as interrelated and inter-active, which means that no need is more important than other ones, except the need for subsistence. Max-Neef, Elizalde, and Hopenhayn (1991) also distinguish positive and negative satisfiers:

- Positive ones include singular satisfiers (satisfy one particular need) and synergic satisfiers (satisfy a need and simultaneously stimulate and contribute to meet other needs).
- Negative satisfiers are destroyers (paradoxical), pseudo-satisfiers (false sense of satisfaction), and inhibiting satisfiers (over-satisfy a need).

The negative and the singular satisfiers are considered as exogenous because they are imposed, induced, ritualised, or institutionalised by society, whereas synergic satisfiers are endogenous (Brand-Correa and Steinberger 2022).

This theory is less parsimonious than Self-Determination Theory regarding the number of fundamental needs. However, among axiological needs, only a few (e.g. participation, identity) are likely to lead to overconsumption because they involve a social dimension. Furthermore, this theory draws our attention on the distinction between needs and satisfiers and suggests that a given need can be fulfilled by several satisfiers. Overconsumption could thus be limited or avoided through the choice of sustainable satisfiers. In particular, this theory emphasises synergistic satisfiers as the most desirable ones, i.e. satisfiers designed to meet several fundamental needs. This is an interesting recommendation for Prospective Ergonomics and Transition Design.

5.3. The theory of human needs

The philosopher Doyal and the political economist Gough formalised this theory to maintain human

well-being facing climate change (Doyal and Gough 1991; Gough 2015). It includes a definition of basic needs as 'universalisable preconditions for non-impaired participation in any form of life' (p.1197; Gough 2015). They identified two needs that seem relevant whatever the cultural background and values: health (physical survival) and autonomy. Health is assimilable to a physiological need, and autonomy is 'the ability to make competent informed choices about what should be done and how to go about doing it' (p.1197, Gough 2015). The lowest levels of autonomy to achieve correspond to: 1) cognitive and emotional capacities, 2) cultural understanding (social skills), and 3) undertaking socially significant activities. The highest level is critical autonomy, i.e. 'the capacity to compare cultural rules, to reflect upon the rules of one's own culture, to work with others to change them and, in extremis, to move to another culture' (p.187, Doyal and Gough 1991).

Gough (2015) rejects Maslow's theory (1954) and the hierarchy of needs and is in line with Self-Determination Theory (Deci and Ryan 1985) and the eudaemonic school of psychology. Furthermore, he distinguishes needs and satisfiers, like Max-Neef (1989). A satisfier is the means to fulfil a human need, for example, the physiological need to eat is universal, but there is a variety of cuisines and diets to satisfy it (Heller 1978; Doyal and Gough 1991; Keucheyan 2019). Gough (2015) characterised universal satisfiers as including goods, services, activities, and relationships that improve physical health and autonomy in all cultures.

With this theory, we go a step further into the notion of satisfiers covering several human needs: here the most desirable satisfiers are not only synergistic, they are universal and encompass response to both physiological and psychological needs.

6. Discussion and conclusion

The Anthropocene challenges Earth's system, planet habitability and human health. Prospective Ergonomics could contribute to both alleviating its detrimental consequences and questioning the social-relational factors partly responsible for its emergence and spreading. The question of human psychological needs, which is central to debates around (over)consumption and Anthropocene, is also a cornerstone in Ergonomics and Prospective Ergonomics. As experts in humans, ergonomists are competent in addressing the fundamental vs. artificial nature of human needs and in informing strategic decisions in the design of more sustainable products and systems.

An overview of the main theories of human needs confirms that social-relational roots of the Anthropocene can be qualified as artificial needs and therefore be disregarded or avoided in the design process. Instead, Prospective Ergonomics should promote primarily the satisfaction of fundamental needs (e.g. autonomy, competence and relatedness as in Self-Determination Theory). Regarding the social nature of the need for relatedness, special care should be taken to design sustainable satisfiers, because we consider this need as the most likely to stimulate (over)consumption. Sustainable satisfiers may be synergistic ones as in Fundamental Human Needs theory, or universal ones as in the Theory of Human Needs. In all cases, satisfiers covering several fundamental needs should be given priority in the design of future products or systems.

The idea of selectively address only certain psychological needs nonetheless raises several ethical dilemmas, as the purpose of Ergonomics has always been to support user comfort and satisfaction (Vink, Overbeeke, et al. 2005). To this end, it has put effort into developing close relationship with the dominant economic and industrial models that have contributed to the discipline's development but have also become destructive for the living. Developing a new paradigm for the future may require taking a distance with technological development.

More fundamentally, ergonomists as specialists of humans are trained to address human needs in a non-judgmental way: they observe, listen and formalise needs in working context and everyday life, design and adjust artefacts and situations to best meet human needs and requirements. This might have somehow contributed to certain technological or energetic excesses, and the current state of Earth's system and habitability makes it essential to revise this approach. To contribute to Transition Design and to a sustainable future, Prospective Ergonomics should implement its expertise in needs management in a slightly different way, and analyse needs more selectively. In this respect, it may be necessary to develop a methodological framework to qualify needs with regard to (over)consumption and compatibility with planetary limits.

An application to comfort in the field of Ergonomics may be interesting to discuss. Comfort is one of the major criteria for a good adaptation of work (Robert 2021) and is defined as the 'pleasant state or relaxed feeling of a human being in reaction to its environment', and discomfort is the 'unpleasant state of the human body in reaction to its physical environment' (Vink and Hallbeck 2012, p.272). Comfort can be

related to emotion (Vink, Overbeeke, et al. 2005). Technological progress continues to increase comfort (with objects, clothing, transportation, interior and exterior spaces; thermal, acoustic, physical, visual comfort; Vink and Hallbeck 2012) with decreasing or even disappearing effort (Boni 2022). For example, comfort in aeroplanes is a great subject of study. As long-distance journeys can generate discomfort, Ergonomics contributed to improve seats and cabins (Vink, Overbeeke, et al. 2005), which illustrates our ethical dilemma: Is participating in projects to improve passengers' comfort in aircraft compatible with socio-ecological issues? In Ademe's (2021) restorative-challenge scenario, the answer is yes; in the sobriety scenario, the answer is no. On the one hand, aviation contributes to climate change with the gases emission; on the other hand, it is a major actor in the global economy and satisfies society's needs for mobility (Grewe et al. 2021). However, this need is satisfied only for the 11% of the population who travel by plane; among these travellers, 1% are responsible for 50% of emissions of CO₂ from commercial aviation (Gössling and Humpe 2020). These data echo the abovementioned notion of climate justice (Schlosberg and Collins 2014).

Many other dilemmas may appear in such an approach of Prospective Ergonomics, because even synergistic or universal satisfiers designed for fundamental needs may require the use of natural resources and energy. The situation is surely complex, stimulating, but also anxiety-provoking. Furthermore, whatever the contribution from Prospective Ergonomics, a radical change may only occur with deep societal transformations, like questioning contemporary political, economic, and institutional factors.

Note

1. <https://www.wfp.org/stories/wfp-glance>.

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