

## **A POST-STRUCTURAL ANALYSIS OF PROGRESS IN ENGINEERING**

L. Stapleton<sup>(1)</sup> and F. Kile<sup>(2)</sup>

<sup>(1)</sup>*Waterford Institute of Technology, Waterford, Republic of Ireland*

<sup>(2)</sup>*Microtrend, Appleton, WI, USA*

This paper examines developments in engineering and their impact on society from a post-structural perspective, focusing on social impact, especially on labor, and on the environmental impact of technology, particularly in terms of global increases in consumption. Displacement of labor is discussed in terms of growing underemployment as machine enhanced productivity evolves from production of tangible goods to skilled and professional work. Ethical questions need to be re-framed to be relevant to reflect the evolution of work structures. Current developments create a positive feedback loop with adverse consequences for socio-political and environmental systems. Some analysts believe our current social system has already become highly unstable.

## **ПОСТСТРУКТУРНЫЙ АНАЛИЗ ПРОГРЕССА В ИНЖЕНЕРНО-ТЕХНИЧЕСКОЙ СФЕРЕ**

Л. Степлтон, Ф. Кайл

Рассмотрена ситуация, сложившаяся в инженерно-технической сфере и ее воздействие на общество в постструктурной перспективе. Особое внимание уделено социальному воздействию техники, в особенности на рабочую силу, а также на окружающую среду, в частности, в терминах глобального роста потребления. Изменение характера труда рассмотрено в плане роста неполной занятости, связанного с увеличением производительности машинного производства и распространением его от выпуска материальных благ на выполнение квалифицированной и профессиональной работы. Отмечено, что этические аспекты должны быть пересмотрены так, чтобы они могли правильно отражать эволюцию трудовых структур. Сегодняшние разработки создают положительную обратную связь с неблагоприятными последствиями для социально-политических и экологических систем. Некоторые аналитики полагают, что наша сегодняшняя социальная система уже стала крайне неустойчивой.

### **INTRODUCTION**

Advances in technology continue to accelerate. However, there is increasing concern at various levels of society, up to the United Nations, that developments in AMAT (Automation and Machine-Assisted Thinking) and ICT (Information and Communications Technology) are creating new sets of problems for our global society. This paper argues that these new problems lie at the heart of ethical analysis of AMAT and

ICT and raise serious questions regarding both current and planned engineering research and development. Specifically, this paper addresses two major issues:

1. Downward pressure on labor forces, in both developed and developing areas, resulting from AMAT. This pressure is felt in an increasing need for advanced training in applications of technology. Labor markets change as skilled persons are replaced by less skilled persons using AMAT to create a man-machine pairing which elevates the functional skill level of the worker. Pressure on labor forces displaces people at skill level

“ $n$ ” with machine-assisted people at skill level “ $n - 1$ ,” and so on through a spectrum of labor expertise”. The final consequence of this downward cascading of pressure on labor results in underemployment among many in both developed and developing economies and total loss of employment opportunities among the least qualified in developing areas, except subsistence farmers, who are not in the labor market.

2. “Markets” are evolving from exchanges of products and goods to markets based on the sale and procurement of “signs” (“simulacra” in the idiom suggested by J. Baudrillard). This evolution of “markets” does not exclude exchange of tangible products and goods; rather, this transformation of markets stems from how tangibles and intangibles are blended in the minds of both sellers and buyers. Increasingly, “market exchanges” are moving from products apart from attributed images in the direction of exchanging “signs” through which both tangibles and intangibles are identified. Thus, one “purchases” status through possession of an expensive, carefully marketed high-end automobile, though this automobile may in no way be superior to a less highly “imaged” machine.

Although, superficially, these two issues may seem unrelated, recent analyses show that this is not the case. However, to date, the literature in engineering ethics, systems engineering development and related work, have not juxtaposed these two issues in one paper. Neither has the post-structural analysis presented here received very much attention, with one or two notable exceptions<sup>1</sup>.

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### 1. PASSIVITY, SIMULACRA, AND IDLENESS

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One interpretation sees simulacra and the consumption of signs as a means by which social action can be derailed structurally within the post-capitalist system (e. g., [1]). Thus, rather than becoming *agent provocateurs*, a healthy opposition to the program of global expansion of Western capitalism, the socially marginalized elements of society are effectively neutered at their source. If people feel uncomfortable by the image of an African child with flies in her eyes, they can change TV channels to “Friends” or an Australian soap opera.

All this may in fact be exacerbated by technology and systems engineering research, which assumes progress through the continuous creation of ever more advanced technology products [2]). This can be presented as a positive feedback loop, which self-perpetuates and increases the problem significantly. A major implication of the positive feedback loop is that, according to current techno-science thinkers, the model of technological “progress” may also contain within it

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<sup>1</sup> Some authors have attempted to tackle these issues in the literature but deep debate remains elusive.

a critical point of over-development at which the system itself reaches an end point<sup>2</sup> and emerges as an entirely new process in which the previous assumptions no longer hold. In the reading of the post-structural analysis presented in this paper, “escape velocity” (a reference to a relationship between societies of humans and machines) is interpreted as a form of runaway system behavior: in control theory the result of an accelerating positive feedback loop. According to the post-structuralist analysis, this “escape velocity” may already have been reached.

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### 2. ENVIRONMENT

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AMAT is leading to high levels of global environmental stress. Globalization of technology appears inevitable, even if protesters against globalization should persuade decision-makers that regional and national markets are preferable to a single global market. Barriers to dissemination of new technology remain ineffective.

Much of the rise in employment during the 1990s was due to increased consumption. It is clear that increased consumption is de-stabilizing the global environment. A continued increase in consumption will, at some point, trigger widespread environmental catastrophes, migrations, ensuing wars, and massive loss of life. These assumptions may seem alarmist. However, note for example that the entire snow cover in the Alps of Switzerland (excepting snow that had fallen on existing glaciers) melted in 2003 for the first time in recorded history. Moreover, Alpine glaciers are receding at rapid rates. Even conservative estimates see the glaciers fully melted by 2020. Some observers estimate that, in terms of providing summer waterflow from glacial melt, no meaningful Alpine glaciers will remain by 2010.

In this view, nature is becoming insignificant and a sort of encumbrance upon technological advance. We continue to create more and more condensed technical systems, functions and models and we transform all the rest into waste – residues. In a sense we have left the earth, we have reached an escape velocity in the west so that we have entered a new reality: hyperreality. This hyperreality transforms the planet itself into a “marginal territory,” a form of waste product. For example, building a freeway (or a toll road) or a shopping center transforms the natural landscape around into wasteland. Even human interaction is subject to this rule. By creating ever-faster communications networks, we reduce human interactions to “txt msgs.” This view of society and environment sees a holistic system of environmental and human waste, (boat people, refugees,

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<sup>2</sup> In this analysis notions like “end” and “beginning” no longer really apply [3].



human trafficking, nuclear waste and so on) all moving around within this meta-system. In this analysis, nature and human society (if that term still has meaning) are reduced to residues within a hypothetically “managed” system, which is, in fact, a new and even more unmanageable entity. In this post-structural analysis the recycling of waste, the control of emissions and so on are signs of the hyperreality of the Western system. As Baudrillard says:

what is worst is not that we are submerged by the waste products of industrial and urban concentration, but that *we ourselves are transformed into residues* [3, p. 78] (italics in the original).

Disconnectivity and Illusion:

The above argument results in a fatal situation in which the Western world, the world, which creates so many of the environmental problems, is deeply disconnected from the real, the material. We recycle our glass bottles but socially unwanted people become “throw away people”.

### 3. LABOR

AMAT is leading to increasing unemployment, underemployment and stressors in full employment positions.

#### Unemployment and Underemployment

Firstly this is a global stressor.

The unemployed are becoming unemployable due to technological advances: for example, ICT literacy is a major issue in Europe.

Underemployment occurs when people work below their skill level or with low pay or less than a desirable number of hours per week. These factors vary by funds needed, job satisfaction cultural expectations, difficulty of travel to work, etc.

Underemployment is a social burden often overlooked in studies of total unemployment. Moreover, underemployment may be part of a continuum leading to complete unemployment.

#### Post-Structuralism and Catastrophe Theory

It should be noted that this post-structuralist scenario, though perhaps societally accurate, and accurate in the description of markets, assumes that this behavior (Western Behavior, if the reader prefers), can continue unchallenged by environmental forces. At some point disease, famine, or mass migrations under the pressure of extreme environmental change, will stress both the “developed world” (or “over-developed” world in the sense of a runaway system which has reached escape velocity) and the “developing world” so powerfully that social upheaval is capable of creating social chaos. This chaos can be viewed in terms of catastrophes, which entirely realign, or eliminate, under-

lying assumptions. Clearly, the attacks on New York and Washington, DC in the USA on September 11, 2001 were a warning sign of more dramatic, analogous future events. Indeed, the escalation of similar (if less extensive attacks) in Turkey, Saudi Arabia and so on emphasize this from the perspective of the “developed” world. It is important to note that the “developing world” exists in large pockets even in the most advanced nations of the West. One need merely refer to poverty and unemployability among people of South Central Los Angeles or the vast “favelas” surrounding the glittering towers of Sao Paulo in Brazil.

#### Displacement and Underemployment

People unemployed because the work for which they are qualified has been displaced by AMAT may elect to accept work below their optimal skill level (underemployment). After a time, this leads to loss of hard-won skills and also to diminished self-esteem.

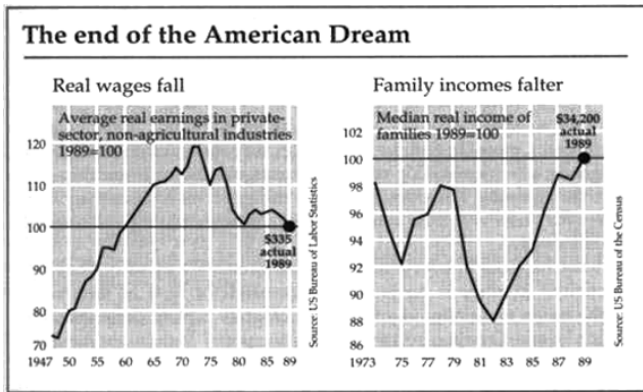
Data regarding underemployment are scanty. It is common knowledge that many people are employed below their skill levels, suggesting that little serious effort has been made to quantify data reflecting the seriousness of this issue. During our travel to the Former Republic of Yugoslavia in May, 2000, highly educated citizens of one of its successor states told the authors that 50% of workers were unemployed. Some of the 50% unemployed were professional people working in a shadow economy, often below a suitable skill-level.

When a person displaced by AMAT accepts work below his/her skill level, another, less skilled person is displaced. The displaced person may accept a position beneath his/her skill level. In this way, underemployment cascades through a chain of skill levels at large costs to many people, each working at a lower level than previously.

An economy, with high productivity through use of AMAT, can create underemployment across many sectors of the economy. Underutilized human capacity increases further as potential customers earn too little to purchase products of the seemingly improved economy. This is a positive feedback loop with negative consequences for the economy.

#### Employment

In this context, effects on the workplace are primarily a “developed” world stressor. The employed are under increasing stress due to technological “advances.” For example, figure shows a decline in real wages in recent years. Furthermore, evidence gathered in modern organizations indicates that people are seeking medical attention for technology-induced stress-related illnesses [4]. By current standards more people in developed societies are overworked than at any time since the post-World War 2 recovery period.



**The Average weekly earnings feel considerably between 1947 and 1990. The rise in family incomes in the 1980s is attributed to the large increase in women workers. Evidence suggests that this trend is continuing into decade [2, p. 81].**

For many in the “developed” world, the nature of work has changed with the increasing pace of technology change. Consequences include invasion of personal space by information and communications technologies [5], increased stress in the workplace as people must adapt more and more to globally constituted integrated information and automation systems [6], sweatshop-call centers and so on [7].

#### 4. DISENFRANCHISEMENT AND DESTABILIZATION

The technology development program, underpinned as it is by the profit motive and the dynamics of a post-structuralist consumer “society”, may exacerbate the systemic problems which leave so many people disenfranchised from global wealth creation systems.

##### The Dislocation of the Disenfranchised — 1

Enormous masses of rural poor in the developing world are never exposed to the products which comprise the globalization of technology. However, they are exposed through mass entertainment media to the supposed benefits of new technology. Most of these same areas are the source of rapid population growth, further increasing pressure for increased consumption and unrest following inability to attain the unrealistic consumption goals set forth in the mass media.

Furthermore, the disjunction between Western goals and methods on the one hand and the processes at work in developing societies are exacerbated by technological developments and systems engineering research based on the idea of progress as the creation of ever more advanced technological products. This acts as a positive feedback loop, which perpetuates and exacerbates the social and technical dissonance between the West and much of the developing world.

##### The Disappearance of the Disenfranchised — 2

One analysis sees simulacra and the consumption of signs as a means by which social action can be derailed structurally within the post-capitalist system. Thus, rather than opposing expansion of Western industrial goals and methods into developing societies incapable of adapting to these goals and methods, the NGOs may actually facilitate change without analysis of its likely effects. Socially (as well as economically and educationally) marginalized sectors of society are thus excluded from changes occurring in their own nations or regions. As we noted earlier, if people feel uncomfortable by the image of an African child with flies in her eyes, they simply change TV channels to a blandly entertaining program.

##### Revolution and Neutralization:

##### The absence of systemic corrective feedback

These stressors would normally lead to revolutionary activity that would destabilize elite power structures. The march of history shows us that these interventions ensure that societies remain stable. So, the peasants’ revolt (an event linked to environmental change as much as anything else) ensured that the feudal system incorporated social impact imperatives. The longer the stressors are allowed to accumulate pressure, the greater the ultimate devastation of the social earthquake that results (witness the collapse of the Roman Empire).

Modern media and consumption structures fill people’s lives to the extent that many have neither the time nor the inclination to agitate. Indeed, where agitation arises, it can be subsumed into a swirl of media fragments, text messages, MMS and the internet, and thus be neutralized. Consequently, the voices of the disenfranchised are reduced to a tiny whisper, and rarely even merit a soundbite on CNN. This is an extremely dangerous situation. To illustrate: in this analysis, the “surprise” of 9/11 (an event predicted by many analysts), and the consequential reverberations through social, financial and political systems, was due to a sudden shock of those outside our hyperreal world suddenly engaging with the West, reminding the West that the tectonics of globalization are part of a positive feedback, rather than negative feedback, loop (the reader is reminded that a “positive” feedback loop is a technical definition of system self-amplification, which finally causes the system to self-destruct. In this sense, positive loop behavior has highly negative consequences). The more subsumed we are into our hyperreality the more disengaged we become with the real, and so on unto infinity.

Globally, this is a highly unstable situation. A comparison with 1920s Germany (when inflation destroyed the economy, destroyed the middle-class, and paved the way for Nazi-ism) illustrates the implications of



massive derailment of major discourse with disenfranchised groups within societies.

To a growing extent technology displaces both manual labor and skilled jobs, including some jobs formerly thought to be “intellectual work.” Increased training is needed with each new generation of technology, dislocating many formerly employable people. Manual work continues to disappear, both in the developed world and in the developing world. Rural workers flock to mega-cities, which are unable to absorb new people at an appropriate rate. As this paper is being written, the political leadership structure of one of the poorest nations in Latin America is collapsing. Political chaos of this sort is so widespread that it can no longer be thought of as a series of collapses. This cascade of political collapse is a phenomenon in its own right. During the 1920s and 1930s similar collapses for largely economic reasons created the conditions for World War 2. The chaos emerging in the early years of the new century are close to triggering global chaos. International events following the September, 2001 attacks on the United States suggest that developed nations lack the will and manpower to contain spreading chaos.

The lessons of Germany in the twenties and thirties lead us to the conclusion that our hyperrealities will become derailed, and come crashing back into the crushing materiality of the poor or the environmental chaos of global climatic change (which may operate according to a step function [8]). In this analysis, technology is a major driver behind 9/11, the terrorist acts of the disenfranchised, or the state behavior of Western powers (which some have interpreted as state terrorism). This raises pointed and disturbing ethical questions for current technology research trajectories.

## 5. RECOMMENDATIONS

The systems discussed in this paper are extremely complex in terms of several key dimensions including power relations, social impact, technological programs of development and so on. This paper calls for corrective and/or adaptive responses to AMAT, ICT, and other technological forces for societal change. The paper is intended more to stimulate debate for ethicists and social impact research, than provide conclusive solutions. Highly complex systems resist prescriptive solutions. Such systems are better dealt with through navigatory aids, and the identification of patterns and traces [9, 10].

### ***AMAT Responses to Environmental and Social Impacts***

With no caps on environmental loading, consequences cannot be predicted. This insight applies to all forms of loading, not merely greenhouse gases. But limiting consumption is very politically charged: Many

people in developed areas believe that they live in a global economy and are thus entitled to consume what they can afford. Additionally, some argue that increased consumption increases employment. These arguments overlook environmental loading. If loading must be capped, consumption must also be capped. Some “consumption” does not increase environmental loading; example: if a TV screen is viewed by five people instead of by four, environmental loading is not affected. “Consumption” of this type is environmentally negligible. However, it is essentially impossible to cap aggregate consumption unless both population and per capita consumption are capped. It is ironic that environmental limits call for capped consumption at the very time that people will have more free time.

It may be that through AMAT the gradual reduction of aggregate worker time needed for routine tasks would release a large pool of available labor to deal with emerging environmental issues. Two alternative scenarios are less promising:

1. Increasing machine-based entertainment, further distracting people from what have until now been considered core dimensions of community life, thus increasing forms of alienation from historically shaped social norms.

2. Increased control of “internet and related learning” by political and/or religious movements, resulting in increasing polarization of society either through social splintering or mass movements resembling group hysteria. The recent phenomenon of “flash mobs” (instant, and very short-lived, i.e., as little as one minute, gatherings of people called together by anonymous email messages) suggests that mobs are easily created. Thus far these flash mobs have been created playfully by people with access to large networks of people in major urban centers. “Mobs” have gathered for minor events such as the opening of a new water fountain. These instant (and highly transitory) crowds (one “mob” dispersed after a planned 20-second duration) have thus far not exhibited classical mob behavior, but a move from playful hysteria to fear-based hysteria is not inconceivable.

Creation of nightmare societal phenomena through new technologies has a long historical pedigree. Clearly, ethicists and social theorists are called to develop new and attractive social theories moving ahead of technological developments. AMAT will undoubtedly migrate rapidly from its present form to new forms as technologies evolve.

This suggests that human behaviors and motivations must change. Motivations can be changed. Many of today’s “wants” would not exist if advertising in mass media had not “created” them. But is a program of “capping” going to deal with the social disconnections described here? Clearly, we are not in a position to answer this question.

## CONCLUSION

This paper explores the implications of recent post-structuralist theory for engineering and technology programs of research and development. It merges certain aspects of post-structuralism with the current debate on ethics within automation and control engineering, indicating that this debate must (re)evaluate at a very deep level the core assumptions which underlie the current research trajectories, both in terms of social and environmental impact. It is self-evident that any discussion of ethics for engineers in the 21st century goes far beyond a "code" and goes to the heart of global engineering research activity.

The analysis reveals that, as has long been the case, development of ethics trails development of technology, often at staggering cost.

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E-mail: [lstapleton@wit.ie](mailto:lstapleton@wit.ie)

[fkile@new.rr.com](mailto:fkile@new.rr.com) □

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# О МОДЕЛЯХ И МЕТОДАХ УПРАВЛЕНИЯ СЛОЖНЫМИ СОЦИАЛЬНО-ЭКОНОМИЧЕСКИМИ ДИНАМИЧЕСКИМИ СИСТЕМАМИ<sup>1</sup>

Л. В. Жуковская

*Институт проблем управления им. В. А. Трапезникова, г. Москва*

Предложены модели, методы и технология исследования и управления динамикой сложных социально-экономических систем применительно к решению некоторых региональных и федеральных проблем выхода из системного кризиса и последующего перехода к устойчивому развитию.

## ВВЕДЕНИЕ

Роль математических средств в решении проблем устойчивого развития сложных социально-экономических систем состоит в обеспечении:

- моделирования и анализа процессов развития при определенных предположениях об экзогенных переменных;
- конструктивного синтеза параметров системы и управляющего воздействия, обеспечивающих в рамках модели желаемый характер развития.

При этом могут оказаться полезными даже грубые модели, если они могут привести к положи-

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