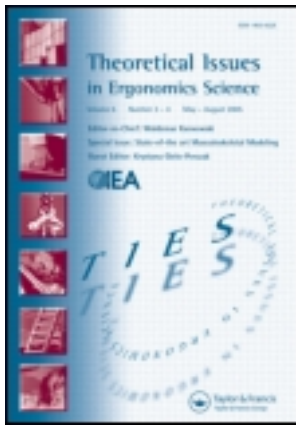


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Does human factors/ergonomics contribute to the quality of life?

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Our study explores the moral bases of human factors/ergonomics (HF/E). Since their inception, these co-evolving facets of the human enterprise have espoused a dedication to the quality of life. We examine whether this principle has been adhered to or transgressed during the history of, the current instantiation of and the future of HF/E. Such deliberations depend upon whether human beings are viewed as the means of production in a capitalist system or as the fundamental ends of that society. This is a political decision that those in HF/E have to partake in as individuals and as professional groups. Such a decision cannot be neglected since: ‘The hottest place in Hell is reserved for those who remain neutral in times of great moral conflict’. Now is a time of great moral conflict and it is upon the outcome of such decisions that the value of HF/E must and will be judged.

Keywords: quality of life; human factors/ergonomics; moral imperatives; political aspirations

1. Preamble: on issues of pure versus applied science

Like Snow’s (1960) differentiation of the ‘two cultures’, the question of pure versus applied research has haunted the pursuit of knowledge since virtually its very inception (Pigliucci 2010). Indeed, the seventeenth century death of Francis Bacon, arguably the instigator of the empirical foundation of science itself, was attributed to his purported first step into the world of practical experimentation. Bacon is reported to have stopped his carriage to explore the possibility that stuffing snow into a chicken to freeze it could act as a preservative. He is recorded as having caught a chill and subsequently dying from its complications. Ever since, this story has been used as a cautionary tale for those who would step from the realms of pure science into its practical, applied examination. Like all such stories, however, it is probably only loosely associated with the truth (Beecroft 2007).

In its seminal form, a large part of the pure versus applied debate has its origins in the class divisions of Europe in the eighteenth and nineteenth centuries. The pure sciences were most closely associated with the upper classes and those ‘amateur’ and ‘gentlemen’ scientists whose involvement was purely on an intellectual and financially disinterested basis. In contrast, the purported ‘applied’ sciences were considered more the domain of the middle and working class artisans, or more colloquially the ‘infra dig’ members of ‘trade’. It is why such scientists as Michael Faraday and also artists such as William Blake were

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considered to be of great talent, indeed genius, but not necessarily acceptable in the upper tiers of society. As with the fundamental nature of the pure versus applied debate itself, these latter class divisions were essentially artificial and now, fortunately, anachronistic. In addition to the wheel of time, the issue of pure versus applied perspectives has largely been laid to rest now almost a decade and a half ago. Stokes (1997) argued that there are two motivations for research: understanding and use. His contribution was to show that these were not opposite ends of a single continuum (pure vs. applied), but effectively two orthogonal dimensions. Thus, the same research can emanate from both sorts of motivation in deepening our understanding while also having inherent utility. Understanding-driven research is quite possible without necessary utility and it is often referred to as curiosity-driven research. Use-driven research is equally possible and is often considered coincident with empiricism itself. Most human factors/ergonomics (HF/E) research appears to inhabit both the understanding and use quadrant of Stokes' two-dimensional continuum, the so-called 'Pasteur's Quadrant'. There is little HF/E research that is not in some way use-inspired, but equally in our still relatively young discipline, most HF/E empirical research should also be contributing to theory development. Neither is this debate about contrasting laboratory studies with field observations; HF/E personnel rightly employ both as the occasion arises. However, as this issue of the Journal attests, the simple contrast of pure versus applied work has never properly been interred within HF/E. As the Eagles so eloquently expressed it: 'They stab it with their steely knives, But they just can't kill the beast'. Here, we do not intend to add any fuel to what we see as a non-productive and already-solved debate, nor add one more stab to this particular beast. Rather, we look to examine what we consider a more meaningful, if not crucial issue for our science and our society. It is one that equally demands us to address the motivations of, and for, our collective scientific work.

2. Introduction

It was the same Francis Bacon whom we have already met who, in perhaps one of the most influential texts of the sixteenth and subsequent centuries (*Novum Organum*), insisted that 'science above all things is for the uses of life' (Bacon 1620). We suspect that Bacon would have very much appreciated a later, companion observation that every new product of technology, and by extension of science itself, is fundamentally an unplanned experiment practiced on the public! Such observations about design and the uses of life very much apply to the various pursuits that are today grouped frequently under the umbrella terms HF/E. Such is the convergent evolution of HF/E that here, we consider the two virtually coincident and refer to this combinatorial effort as HF/E (Dempsey *et al.* 2000, Hancock 2011). HF/E in almost all of its various professional incarnations worldwide has chosen to adopt some form of mission or vision statement. This vision and dedication is not concerned with any dichotomy between the purity and application of its science. Rather, such visions are centrally concerned with its manifest contributions to the Quality of Life (QoL). Rather than belabour this point with repetitions of specific examples from the diverse professional groups, we here point only to the mission statement of the International Ergonomics Association (IEA), the world-wide overarching organisation. IEA proclaims that: '(IEA's) mission is to elaborate and advance ergonomics science and practice, and to expand its scope of application and contribution to society to *improve the quality of life*' [italicised emphasis is ours]. The empirical question is then really quite a simple one. Does HF/E actually add to the quality of human life on this earth or is the net

effect of its actions detrimental to that life quality? Of course, this begs one very big question. Whose life is it that we are considering here? It is big questions like these that must be addressed in our present turbulent times.

Unlike the panellists and pundits who regale the audiences of our popular media, if we are to make progress with this issue we need to define our terms and to take steps towards its rational quantification. Thus, we need to understand QoL to better determine what it is we are trying to improve, or even to optimise, as a profession. From an HF/E perspective, QoL has been studied by Ghylin *et al.* (2008) using a multi-phase approach to determine the words most associated with four aspects of the general concept of quality, i.e. general quality, product quality, service quality and QoL. The first three of these concepts were quite well-aligned, but QoL was somewhat different. The main words used to describe QoL were grouped using a clustering procedure to give those shown in Table 1. Well-being is one component dear to the heart of HF/E researchers and also health professionals in general, but QoL is a much broader issue. It includes affect, the anticipated future, social quality, as well as avoiding feelings of inferiority or failure. Clearly these words bring much wider issues to the forefront of the debate than the technical terms that tend to dominate most debates in HF/E.

In the broader context beyond HF/E, the QoL concept has been extensively studied and has even been proposed as a better measure of national well-being (gross national happiness, or GNH) to replace gross domestic product.¹ GNH is based on indicators of psychological well-being, education, time use, ecology, culture, community vitality, health, living standards and good governance (Alkire and Foster 2007). QoL and well-being are quite closely related concepts. The topic of subjective well-being (SWB) has been reviewed by Diener *et al.* (2009) who give the dimensions of the concept that are shown in Table 2. Note that the concerns of HF/E such as work, stress and health are represented but the list is longer and broader than might usually be considered in HF/E (Hancock *et al.* 2005).

Table 1. QoL definition components.

Concept direction	Concept name	Typical	Words
Positive	Positive affect	Fun	Being able to do what I like
	Positive future	Good future	Living life to its fullest
	Social effect	Socialising	Friends
	Well-being	Physical well-being	Well-being
Negative	Negative affect	Inferior	Failure

Table 2. Components of SWB (after Diener *et al.* (2009)).

Pleasant affect	Unpleasant affect	Life satisfaction	Domain satisfaction
Joy	Guilt/shame	Desire to change life	Work
Elation	Sadness	Satisfaction with current life	Family
Contentment/pride	Anxiety/worry/anger	Satisfaction with past	Leisure
Affection	Stress	Satisfaction with future	Health
Happiness	Depression	Partner's views of one's life	Finances
Ecstasy	Envy		One's group

Table 3. Satisfaction with life scale (Diener *et al.* 1985), 7-point scale for each listed item.

Number	Statement
1	In most ways my life is close to my ideal
2	The conditions of my life are excellent
3	I am satisfied with life
4	So far I have gotten the important things I want in life
5	If I could live my life over, I would change almost nothing

Note also that some of the dimensions found by Ghylin *et al.* (2008) are reflected in Table 2, e.g. positive future and social affect.

Diener *et al.* (1985) have also developed a simple Satisfaction with Life Scale, shown in Table 3, and found interesting results such as the independence of SWB and age and to some extent income beyond meeting basic needs (Diener *et al.* 1999). SWB is also positively affected by marriage and extraversion. Of course, if we are to take a global perspective, we have to establish the degree to which such concepts are culture-specific or whether they actually transcend specific cultures.

As one example of how this broader perspective of QoL and well-being impacts HF/E practice, consider the current issue of work intensity, i.e. how long and hard people work. The length of the work week was projected, and is still been widely expected to decrease with automation (e.g. Wooden *et al.* 2009). However, very often this has not been the case. In an older book, Schor (1991) showed an increase in mean working hours per year for the USA, and this is apparently still the case (Gamtso 2010). However, in other countries there has not been much change in the mean number of hours worked (Drury 2008). What seems to have changed in both developed and developing counties is the variability in work week length. More people are working long weeks (>50 h) and short weeks (<20 h) compared with a 'standard' week of about 35–40 h, although most people express the desire for a more standard week. This latter wish has been labelled the *Goldilocks Hypothesis* by Goldenhar *et al.* (2003). Evans *et al.* (2004) showed that this was happening in the USA, with a 'general consensus' emerging that lower paid workers have difficulty finding jobs while those with higher incomes 'work more hours than ever before' (p. 1). The removal of jobs, by downsizing or other management initiatives, has increased the intensity of work performed by those remaining (Green 2003, Watson *et al.* 2003) leading to potential for performance error and reduction of well-being due to increased work intensity (e.g. Bearden 2003). Wooden *et al.* (2009) found that it was not the working hours *per se* that affected SWB but rather the mismatch between hours worked and hours desired. This should come as no surprise to HF/E practitioners as mismatches between desired and actual levels of variables have been found to drive well-being since at least the National Institute for Occupational Safety and Health studies of the 1970s (e.g. French *et al.* 1974). The idea that stress derives from the mismatch of demand and response capacity is also deeply embedded in HF/E (Hancock and Warm 1989, Hockey 1997). Among others, this observation shows that it is the extrinsic demands of the work system (and the eventual search for profit) which drive the working conditions. This form of demand-based work organisation stands in contrast to alternative work systems that emphasise the importance of the human beings involved. These latter forms of organisation are derived from HF/E and emphasise human-centred design (Billings 1991, Jacobs and Gerson 2004).

What was not asked in the Ghylin *et al.* (2008) study was the identity of the recipient of this QoL. It was assumed to be each respective respondent, although most of the broader studies noted in this section have specifically defined their measures over groups and nations. Moving to this broader view forces us to ask whether we are providing QoL for the whole of the human species or only very selected segments, typically those we happen to encounter in our studies? This theme of the individual as opposed to societal view is a recurrent theme and promises to be an important future dimension of HF/E (Nickerson, 1992, Hancock *et al.* 2009).

No science, or practice of that science, can escape the context in which it is constrained to occur. Similarly, there is a sense in which the pursuit of science is contingent upon and beholden to its respective sponsor(s). Whether that sponsor is a nation state, an individual financier, or a multi-national conglomerate, there remains a sense of inherent obligation to those who support the activity in the first place. This is by no means a recent circumstance. Indeed, from the very inception of science as a formal practice, the notion of a sponsor or patron is fundamentally entrenched into its history. Obviously that history has seen some degree of progressive evolution from the relatively selfish backing of individual private concerns, such as the Medici Princes, through hierarchical and monarchist European nations to the more recent incarnations in which science is seen as part of the public good of the more contemporary democracies. Nevertheless, despite such historical trends, it remains the case that science is a financed endeavour and few and far between are its modern individual practitioners who can afford to be totally self-supporting. The evident indebtedness of modern scientists contrasts starkly with the noted luminaries of science in the eighteenth and nineteenth centuries where persons such as Charles Darwin were of independent means. Thus, despite the very best intentions of those who would protest that science is inherently morally neutral (Moray 1993) the pragmatic fact is that its conceptions and creations are made for hire (Hancock 2009). Can scientists or anyone then, be completely morally neutral when their lives and/or livelihoods are staked on the outcome? This is exactly why it is important to continue to question the motivation which underlies all scientific work.

3. Humans as means or ends?

Although we sought to circumvent further polemics about the pure and applied debate, there can be little doubt that it has haunted the development of all of HF/E over the past half century or more. One of the early luminaries of HF/E science, Donald Broadbent observed that: 'The test of intellectual excellence of a psychological theory, as well as its moral justification, lies in its application to concrete practical considerations' (Editorial 1993). The notion of 'for hire' work is, as we have noted, a contextually embedded statement. Such a conception has not been a ubiquitous truth in human society throughout its existence. However, the 'for hire' notion where work as a service is exchanged for a 'good' is so deeply entrenched in the present global 'zeitgeist' that for some it seems to be a fundamental characteristic of the human condition (Fukuyama 1992). As we consider HF/E, however, we must see this latter perspective for what it is. The way in which we order our modern world is actually only one way through which to organise a co-operative society and we must begin to look now at emergent possibilities for such global organisation (Fraser 2010). Of course, for-hire work is a central component of the current capitalist system and it is a principle that has not been without its vehement critics. The central question of such a system is the distribution of both 'good' and 'goods'. The latter

is relatively easily quantified and represents the sum total of physical resources available to the collective community. The notion of an individual or communal 'good', however, is less easily expressed, especially if the social 'good' e.g. access to mobility, is literally an intangible quality. In this context, individual good can be quite distinct from communal good, as has been argued by philosophers throughout the ages. Communal good (e.g. Mill 1859) means that good is maximised over the whole population, while individual good means that no single individual must come to harm as a result of our actions (e.g. Hobbes 1651). Such elements might refer to qualities such as 'safety', 'security', 'peace of mind' and a whole series of intangibles which are not in themselves physical entities but which are, nevertheless, quintessential elements of a civilised society and, as we have seen here, central elements in what is perceived to be a quality life. Knowledge, as the product of science for example, is a communal 'good'. The quality of any individual life can thus be indexed by the degree to which they share in these communal 'goods' and 'good'.

The curve that can be and is frequently used to describe this distribution is termed the 'Gini' curve or Gini coefficient. In the terms of HF/E this description is actually somewhat analogous to a receiver operating characteristics. In general terms, the principles involved are fundamentally similar. This curve compares the good (i.e. both goods as physical possession and good as intangible benefits) of individuals with the comparable good of the whole society. The illustration shown in Figure 1 focuses on earned income but as we note, in both theory and in practice, the concept can be extended to all forms of possession both tangible and intangible.

The question we can now pose is one that is both social and political in nature and that is the degree to which HF/E supports (or should support?) the notion of egalitarian distribution as represented by the diagonal line in Figure 1. It should be noted immediately that the concept of equal distribution between all human individuals is itself very close to the espousal of a specific political doctrine. However, like a basic foundational philosophy, one possesses a basic political stance whether one explicitly acknowledges it or not. Inherently, and perhaps unfortunately, the central espousal of the idea of QoL in HF/E to date contains perhaps the unwritten caveat that the life so described is largely confined to

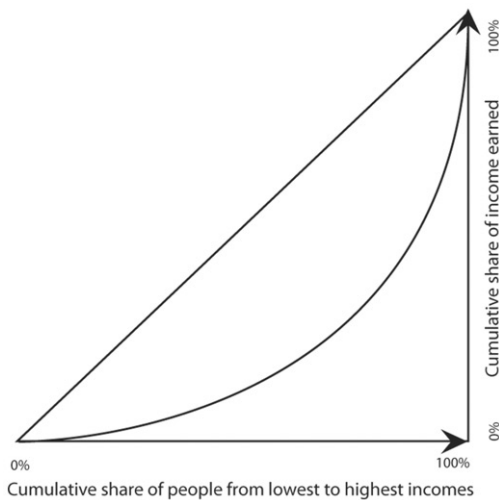


Figure 1. Graphic representation of the Gini curve.

the nation states that compose the respective component members of political organisations such as NATO or even professional organisations such as IEA. Thus, much of the knowledge which is derived as a common ‘good’ in HF/E is actually derived as work for hire from the respective military arms of the nation states so identified. Again the central question re-surfaces. When we espouse the principle of improved QoL, whose QoL are we talking about? Mine, yours, our neighbours?² The question of kinship distance now very much comes to the fore.³ What then is our limit to QoL? Is it just confined to our friends and family or are we committed to enhance global QoL of all people? These are specifications which have rarely, if ever, been made by the explicit vision statements of the various respective HF/E professional societies or, we suspect, by its individual members. In making such an identification we must ourselves avoid the appearance or actuality of self-hypocrisy in that one of us (PAH) has had extensive research funding from military agencies over the past decades. The question which is uppermost in thought at present is whether the organisation of nation states and progressively, the trans-national corporations which exert a disproportional effect on those nation states are themselves supportive of the totality of the quality of human life? We suspect in these cases that QoL is here subordinate to profit which represents momentary benefit but in the end is a species-destructive policy.

The simple answer to the question as to whether there is any sort of parity in the global distribution of QoL appears to be a resounding ‘no’. Even in one of the now foremost bastions of disproportionate distribution, the USA, the degree of that distribution has, over the recent years, radically moved towards the control (especially of physical [financial] resources) by fewer and fewer individuals.⁴ In such circumstances, it is often the case that the distribution of physical ‘goods’ (i.e. monetary resources) eventually also serves to redirect the distribution of putative social ‘good’. When this distribution tends towards the extreme (expressed by a square-wave form of the Gini curve), society itself becomes unstable. To paraphrase a world leader of the past, Winston Churchill, and to quote his words out of context; ‘Never in the course of human history have so many owed so much to so few’. It is our opinion that the present level and trend in distribution are not good. Such an observation impinges directly on an epithet coined by one of the stalwarts and leaders of HF/E. It was Professor Hal Hendrick (one of the few individuals who has been president of both HFES and IEA) who asserted that ‘good ergonomics is good economics’. Using the inherent confusion between the similar terms ergonomics and economics to his benefit, Hendrick sought to show that application of the knowledge derived from HF/E could help improve profit margins by increasing production efficiency whilst simultaneously limiting damaging actions that threatened the health and safety of workers. In and of themselves these protestations seem, at least in part, laudable aims. However, this is to assume that good economics is itself good. That is, in some fashion, to support the idea of increased QoL, this epithet made the assumption that all individuals would benefit from the outcome of the increasing levels of safe and efficient production. However, as current events bear witness, this aspiration is clearly not realised. Viral capitalism treats human individuals as a means to an end. That end is profit for the few. The true ethic of HF/E, as an agent seeking to improve the quality of human life, is in the treatment of human individuals as the end of the process simply not a means of it. The process might well seek profit, but that profit in support of the general good is not the overwhelming enrichment of the very few. In essence, our global society is out of balance.

Now we can return to the example given earlier on the length of the working week, or working year, which we saw was connected to QoL. Some three to four decades ago, the idea of technological automation of work was paired with the general notion of reduced

hours at work. Confident assertions were made about reducing the working week to 30 and even 20 h. These estimates may not have been so wild or even as inaccurate as they now may be perceived to be. The fundamental assumption was based upon the notion of employment for all, i.e. take all the work required and divide it among all those wishing (and able) to perform that work. However, this is not what has happened in contemporary capitalist economies. For, in pursuit of profit, the adaptation has been for the extra hours of work to be placed upon one individual while others remain simply unemployed. That is, the automation supported work task may have reduced the necessary human work hours from 120 to 90 (Sheridan 2002) but instead of reducing the 40-h work week for three individuals to a 30-h work week for each person, the profit-only driven economy has tossed one of those individuals into unemployment and massively increased the work of the remaining individuals by 50%, i.e. two 45-h weeks. (Alternatively, in some countries (e.g. USA) it is actually cheaper to employ part-time personnel so that benefits do not have to be paid, so that six part-timers could be employed, none on a living wage!) Further, in the name of profit, those remaining employed are not paid proportionately better but rather the unemployment of his or her now out of work peers is used to drive down the pay of those who remain employed. While this strategy certainly sub-serves the goal of increased profit, it does not move towards increased QoL of the population (Smith 1776). Thus, in this case, technology has indeed served to reduce the necessity for human work. However, the step towards the Arcadia (Sidney 1590) of short individual working weeks has been very much perverted by the overarching theme of profit. Here again we see humans being used as the means of production not the ends of that production.

4. Summary and conclusions

The coefficient provided by the Gini curve is not simply a descriptive representation of the distribution of wealth within a society. In part it also acts as a surrogate representation for the collective QoL and thus a potential index for social stability. When the distribution gets to such a disproportionate level that few have little left to lose, then social unrest can burgeon into social revolution as was evident in France in the late 1700s. At such junctures, epithets such as 'let them eat cake' and 'today's pork is tomorrow's bacon', signify a level of incipient social unrest that promises an explosive resolution as we have recently seen in some areas of the middle East. Thus, QoL is not merely an interesting academic exercise nor is its espousal by professional HF/E groups or the rest of the behavioural sciences to be taken lightly. Our times also represent an emerging and radical change from the relatively isolated Nation states of the previous centuries. The world is now instantly inter-connected and the form of collective, global organisation which is now emerging promises to be quite fundamentally different from anything humans have previously experienced. Unlike Fukiyama (1992), we do not see the end of history but the beginning of a very new sort of history. Within such a new emergent social structure, technology must and will exert its overwhelming influence (Hancock 2009). The greatest challenge will remain how humans conceive of, design, fabricate, maintain and operate such technology, and to what end. If the darker visions of Malthus (1798) are not to be vindicated, some form of social stability must persist and for this to be sustained, an acceptable level of QoL must be defined and collectively maintained for all human beings. The challenge is before us. As we necessarily embrace this challenge, we must each individually and together collectively in our professional organisations, debate and resolve

the issue of QoL for whom? It is a question that promises to define us not simply as HF/E professionals but as a very species.

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Notes

1. www.grossnationalhappiness.com.
2. In this situation, we might pose the question 'who is my neighbour?' but perhaps that is a polemic too far.
3. During the first Gulf War, local news reports would indicate the number of people killed in a specific encounter of the day. The reporter would then announce the number of American dead, often to be followed by a statement such as: 'fortunately no Minnesotans were injured'. This made very obvious where the kinship threshold was set, firmly at the boundaries of the North Star State.
4. Recently, the Congressional Budget Office has reported that the income gap between the top 1% of individuals in the U.S.A and the rest of the population has more than tripled between 1979 and 2007 in which the top 1% saw its income increase 281%, compared to just 25% for the middle fifth of the population.

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