Jeremy Pitt, John Henry Clippinger, Carsten Sørensen

Values, axial currencies, and computational axiology: digital currencies can do more than buy stuff

Article (Accepted version) (Refereed)

Values, Axial Currencies and Computational Axiology

Digital Currencies can do better than buying stuff

Jeremy Pitt
Dept. of Electrical & Electronic Engineering, Imperial College London, London, UK
John Henry Clippinger
City Sciences, MIT Media Lab., Cambridge, MA, USA
Carsten Sørensen
Dept. of Management, London School of Economics and Political Science, London, UK

11-12 thousand years ago, early humans lived in small communities with no discernible hierarchy. The result of the 'agrarian revolution' resulted in communities growing on such a scale that mechanisms of self-organisation -- e.g. for monitoring, keeping order, and ensuring a 'satisfactory' allocation of resources -- were no longer efficient or effective. However, the concurrent 'cognitive' revolution resulted in the faculty of imagination, in particular, the imagination of rules, to solve such problems [1].

However, agriculture created dependency (for example, on the success of a particular crop), dependency created the conditions for crisis, and crisis created the opportunity for power (i.e. it was simply more efficient for a small group to impose order and distribute resources using the imagined rules). The passing of crisis did not result in the relinquishing of this power: indeed, once acquired and although abstract, it became as much an object of desire, accumulation and retention as any physical resource.

The accumulation and retention of power in a community that was increasing in scale resulted in other (growing) communities being perceived as either a threat, or an opportunity, or both. This accelerated the replacement of non-hierarchical decentralised organisation with hierarchical centralised organisation as a more efficient means of mastering scale, and managing ever higher degrees of scale as communities were 'unified'.

The consequence is that the experience of most humans to have ever lived is to have been part of an empire run by an autocratic form of governance. In this respect, the approximately 200 years of democratic rule in the city state of classical Athens, and the constitutional democracies from the Age of Enlightenment to the post-Second World War 'Western' democracies [2], are an aberration in the historical record of governance models.

However, the establishment of vertically integrated industries [3] presented a relatively stable industrial structure. Since the 1970s the modularisation of industries and organisations [4] has resulted in flexible global supply chains within manufacturing allowing for highly distributed innovation [5]. This prepared the ground for the advent of the digital platform implementing multi-sided markets, challenging the established order through the rapid formation of 'Internet Giants'. These are, through automated self-service arrangements and the monetisation of social behaviour, becoming de facto monopolies in each their own sphere of influence and commanding unprecedented control over both global digital infrastructures, and having direct influence over social affairs [6].

Therefore, the main issue facing the 'Digital Society' is that the growth in scale and complexity, as a corollary of social, cognitive and technological change, has made the 'original' (pre-agriculture) order of local self-governing communities even harder to achieve. Even if it is achieved, it is also much harder to sustain; and liberal democracy at a national scale itself appears to be under threat globally [7]. Indeed, the notion of individual liberalism itself will be challenged once algorithms controlled by commercial interests will know us better than we know ourselves, and therefore give rise to technological collectivism [2].

Moreover, the scope of the Internet has facilitated the emergence of what has been called the 'World Empire' [1], but could also reasonably be called the 'Global Digital Empire', with trans-national corporations beyond the scale, and tax laws, of nation states. But the unprecedented and unregulated growth and (mis)use of social media has fuelled both factionalism, polarisation and the distortion/manipulation of information and knowledge, while the potential of IoT and data analytics could enable surveillance and monitoring on a, literally, global scale.

To summarise, by facilitating planetary-scale communication, data processing and statistical analysis, the information revolution (as the latest stage in a series of social, cognitive and technological developments, including the renaissance, enlightenment and industrial revolution which produced 21st century liberal democracies) has effectively enabled, or imposed, the highest possible scale of society, in both the physical and intellectual spheres. This can have two possible outcomes: either, it can support the decentralised communication processes essential to a democratic self-governance from the local to the global; or it can implement the largest-scale, and most robust, autocracy ever seen.

To retain the 'good' eventualities, to limit the 'bad', and to avoid the 'ugly' altogether, we claim that the developers of socio-technical systems underpinning the digital transformation need to: firstly, imbue these systems with the capacity for self-organisation, generativity and continuous re-invention; secondly, need to supply robust and resilient mechanisms for collective self-governance, knowledge management, and coordination that are both resistant to entropic tendencies to tyranny but are also attuned to context, e.g. the type and scale of problem being addressed (cf. [8]); and thirdly requires significantly more complex approaches to design, in particular design that is not just sensitive to 'supra-functional requirements' like qualitative human values (cf. [9]), but is capable of understanding, representing and reasoning with these values.

The aim of this article is to examine this third claim in some more detail. We argue that in a socio-technical system, design *for* the 'socio' part needs to recognise two premises. The first premise is that the people impacted by the system have values, both individual values derived from a sense of self, and collective values derived from a sense of belonging to a community. The second premise is that it is communities which stimulate cooperation and incentivise collective action to provide the foundations for these values to thrive. Based on these two premises, design *of* the 'techno' part needs to provide support for promotion and empowerment of both values and communities in order to realise the full benefits of digital technologies. One promising approach is the use of distributed consensus technologies, but we argue that, deployed inappropriately, such technologies can actually *devalue* values and communities. Instead, we advocate the use of *axial currencies* (monetary systems in which tokens can have more than purely transactional value) based on the theoretical foundations of *computational axiology* (the study of value and valuation in digital or algorithmic form).

Values

The idea that values are an intrinsic part of socially-constructed 'reality' is justified by numerous sources in economics, political science, legal anthropology and sociology, including:

- Shalom Schwartz's Theory of Basic Human Values [10], which identified ten basic values that have been recognised throughout all major human cultures;
- David Graeber, who shows how, in the Axial Age, fundamental philosophical questions, and major religions in Europe, India and China, emerged as a reaction to what he called the military-coinage-slavery complex, and elevated moral and ethical values over basic monetary value [11];

- the Nobel-prize winning research of political scientist Elinor Ostrom, whose empirical fieldwork showed how individuals throughout history and geography place value on conventional rules, and voluntarily comply with and organize themselves with respect to those rules in order to realise the benefits of trade, mutual protection against risk, and sustainability of natural resources [12];
- the pioneering studies of legal anthropologist Bronislaw Malinowski, and his analysis of gift economies in the Trobriand islands, which showed that value resided in the social context and process of exchange, establishing both political authority and mutual obligations for protection and assistance, and did not reside (necessarily, just, or even in) the object of exchange itself [13];
- Peter Kropotkin, whose ideas about mutualism, voluntary associations and artisan currencies [14] are (deliberately or not) observable in contemporary maker movements, crowdfunding and freecycling; and
- Josiah Ober's analysis of democracy in classical Athens [15], which showed how government by the people could enable a large and socially diverse citizenship – but with a commitment to shared values – to find effective collective action solutions to seemingly intractable social problems; while only later did liberal democracy conflate democratic processes with concern for values like justice, morality and rights.

Given the prevalence and significance of values in 'analogue' social situations, the question is how do such values become part of the socio-technical fabric (cf. [16]) of the 'digital society', or digital communities? In the absence of a centralised controller, command structure, or other form of orchestration, a community instead relies on self-organisation to achieve the necessary agreement on, or synchronisation of, collective action. However, 'larger' communities often require other incentives to encourage participation, contribution, or action selection which maximises the collective, rather than individual, utility, and discourages free-riding (cf. [17]). One type of incentive is *social capital*.

Social capital has been defined as attributes of a community that assist its individual members with resolving collective action situations [18]. These attributes come in many forms, such as trustworthiness, social networks, and institutions. However, it is more important not to focus so much on what social capital *is*, but on what social capital *does*; and what it can do is coordinate expectations in social contexts [19], provide a basis for community governance [20], or shortcut the complexity of risk management (e.g. the codification of reputation in the StackOverflow developer community (https://stackoverflow.com/), and in e-commerce applications). Therefore, any framework for *electronic* social capital which can be used to support successful collective action in self-organising systems will need not just to define, in computational form, the *attributes* that the system needs to represent and reason with, but also the *processes* by which those involved can coordinate their expectations and govern their communities [21].

Given such a (high-level) specification of a framework for electronic social capital as a means of representing and reasoning with qualitative human values in a decentralised system, one approach to implementing such a framework would be to use a correspondingly decentralised technology, for example distributed consensus technology.

Distributed Consensus Technology

An increasingly dominant approach to developing open systems requiring distributed consensus is based on *blockchain* technology, which is essentially a protocol for building a reliable, verifiable distributed ledger. The ledger records transactions between any two parties, although more generally it in effect records anonymous multi-party transactions where each party's share is recorded. The integrity of the ledger is usually maintained by a peer-to-peer network of 'miners', who validate and timestamp those transactions. This avoids

the need for a trusted third party, and ensures that any one block in the chain cannot be altered without altering subsequent blocks. The transaction is based on the exchange of tokens. Although the idea of a tradeable, traceable digital token was originally intended for an electronic currency (i.e. a cryptocurrency, for example BitCoin), the token could represent an asset of any kind, e.g. a share, an identity, a contract – indeed a *value* of any kind.

In one sense, blockchain is arguably just a realisation of earlier protocols developed to solve similar problems, e.g. Paxos to maintain consistency in distributed databases [22], or logical inference with inconsistent distributed knowledge bases [23], or interoperability in multi agent systems. It is just that computing power to implement the processor-intensive validation procedures in a 'reasonable' time has only recently become available (and has coincided with a number of pressing economic and financial drivers). However, the potential to represent a value of any kind is fundamentally transformative: it is arguably equivalent to the stored-program concept (where sequences of 0 and 1 could be interpreted by the computer to mean anything the programmer wants it to mean, i.e. data, or an instruction). The corresponding intuition could be the *stored value concept*: the token can be interpreted to mean (can be imbued with meaning) anything a community wants it to mean.

Therefore, blockchain technology would be a prime candidate for implementing electronic forms of social capital. However, in addition to some criticisms concerned with financial irregularity, there are risks, downsides, and caveats of blockchain technology that need to be considered purely in its relation to values.

The Devaluation of Values

It is unfortunate that the term 'social capital' is potentially misleading, or open to a reductionist, literal misinterpretation, as it suggests something that can be owned, traded or (even worse) 'spent'. For this reason, socially-sensitive systems design [24] prefers the term 'social potential', more in keeping with the definition offered earlier. However, digitalisation of social capital using blockchain technology exposes it to a number of processes which might serve to diminish values: these are metrication, commodification, dissolution, indirection, and extraction (neo-colonialism). We examine each in turn.

Metrication of values: in all walks of life, performance measurement is increasingly common, whether by ranking systems, numeric feedback, league tables, likes/dislikes, and other quantitative indices. However, many social interactions, for example in education and health, are not a unidirectional one from service provider to service consumer, but a co-production. For example, someone with a back problem can visit a physiotherapist and be recommended a course of exercises, but might then complain that the physiotherapist did not cure them, even though they did not do the exercises. Such relationships, for example between a patient and health practitioner, or a teacher and student, cannot be evaluated in a single, one way, one size fits all, numerical dimension.

Commodification of values: an unexpected consequence of social media is the way that social values are denuded of their original content and replaced instead with a purely monetary value. Social values such as trust, friendship and loyalty are being turned into commodities, reducing their leverage as social capital and undermining people's capability and opportunities for successful collective action [25]. The pursuit of 'likes', 'kudos' or 'followers' becomes an end in itself, irrespective of the actual purpose.

Dissolution of values: values generated by interactions and pro-social behaviours in one context do not translate, or are not transferable, to values in another.

Indirection: sometimes, a set of rules or policies may be only indirectly related to the value(s) that it is intended to support. For example, there is question for jurisprudence, which system

is better: a system which convicts all of the guilty but some of the innocent; or a system which only convicts some of the guilty, but none of the innocent? In the UK, the legal system has developed a set of procedures, protocols, requirements and indeed rituals for trying court cases to ensure the latter. These appear to be time-consuming and ostensibly otiose, and are relatively costly in financial terms. Accordingly, there are proposals for 'fast-track justice' to obviate these processes. However, it is arguably these 'slow' mechanisms that help ensure the desired property of the judicial system. Fast track justice prioritises 'value' in purely base financial terms based on the assumption that a cheaper system is more preferable to one that derives its value from principles of jurisprudence. Truly, its proponents are people who know "the price of everything, and the value of nothing".

Neo-colonialism [26]: platform owners are "in the place and ruling it, but not of it", and are indifferent to the primary sources and targets of their wealth extraction [6], i.e. the local population of the 'place'. There is also lack of awareness of the indirect effects of expenditure and economic choices. For example, spending on a cheaper service offered over the Internet but operated by a global corporation may result in the direct, immediate benefit of cost-effectiveness, but this is outweighed in the long-term by the indirect effects of removing monetary value from the local economy. Money is a force multiplier, i.e. a unit of a currency can be spent more than once (there is a reason why it is referred to as 'currency' or 'being in circulation'). Like the gift economies studied by Malinowski [13], this series of transactions creates a local economy on which other values can be created and sustained: it is much easier to be a 'good citizen' when not oneself in 'survival mode'.

By contrast, the persistent extraction of wealth can lead to the collapse of entire communities in rural areas [27] and even within cities [28]. Given the extent of overseas property ownership in wealthier areas, London could be described as "a reserve currency with better restaurants". However, most of these properties are largely unoccupied, leading to a decline in population density, and so leading to the *closure* of those restaurants. Wealth extraction without re-investment can undermine organisations too: there are many examples of unrestricted self-enrichment by company directors while the company itself goes bankrupt.

Moreover, there are some reservations with the way that blockchain technology has developed and been deployed. Firstly, the Proof of Work cryptographic puzzle race applied by Bitcoin can be very wasteful, given that the cost of electricity to compute the solution to the puzzle can exceed the benefit of the reward for winning the race. As in many security applications, the cost of security should be proportional to the 'worth' of the asset being protected. Secondly, the permanence and near-immutability of the ledger may be a cause for concern in some applications, for example, not just 'data retirement' or 'forgetting' [29] but the inability to change one's mind, to rectify mistakes, or to re-tell the narrative [30].

Thirdly, smart contracts and the "code is law and law is code" mantra has its potential benefits (for example, design contractualism [31]), but it can also be used to create a locked-in form of algorithmic governance: the computer decides the space of legal actions and users only have a choice within this narrow space of possibilities according to the terms and conditions of the contract. The argument for smart contracts is that it will lead to more data portability and better choices that fit people's personal situations. The counter-argument by proponents of consumer data rights is that it increases scrutiny and data-mining, thereby offering greater opportunity for 'customer lock in', all under the guise of 'loyalty' and 'security'. Arguably, left to the 'technocratic' rule of algorithmic governance, the blockchain may well be a mechanism for a self-fulfilling prophecy, and a highly undesirable one: it can diminish both flexibility in common-sense decision making and the bi-directionality of co-productive relationships, while letting an algorithm make all the decisions can also diminish the faculty of critical thinking [32].

Finally, and perhaps critically, there is a displacement of trust from norms and institutions to code, and so to the programmers, and so to people telling the programmers what to do [33]. However, for example, with a blockchain-enabled voting system it can be proved that a vote was not tampered with, but it cannot be proved that every vote was cast by a legitimately enfranchised voter. There are still questions concerning transparency with blockchain technology that are unresolved, i.e. ensuring that any disinterested third party could verify both the inputs *and* the provenance of those inputs, and also validate the outcomes from a specification of the process, given the inputs.

It is our contention that to avoid the diminution of values and to overcome these reservations, we need a new currency model based *axial currencies*, and critically, developed in a principled way.

Axial Currencies

Axial currencies are systems of exchange in which the tokens represent more than transactional information – for example, it can also include relational or reputational information in economies of esteem or gift economies. Furthermore, as the technology is developed and tokens become "smart" and represent different sets or systems of value, then a group of diverse tokens can help provide civic homeostasis or dynamic balance.

To define the principles of axial currencies, in the first instance we turn to two of the theories of value identified previously, those of Graeber and Kropotkin. Graeber [11] observed that the great Axial Age civilizations (800–200 BC) began to use coins to quantify the economic values of portions of what he calls "human economies". Graeber says these civilizations held a radically different conception of debt and social relations. These were based on the radical incalculability of human life and the constant creation and recreation of social bonds through gifts, marriages, and general sociability.

Similarly, Kropotkin argued that "it was an evolutionary emphasis on cooperation instead of competition in the Darwinian sense that made for the success of species, including the human" [14]. Kropotkin explored the widespread use of cooperation as a survival mechanism in human societies – through their many stages – and amongst animals. He used many real-life examples in an attempt to show that the main factor in facilitating evolution is cooperation between individuals in free-associated societies and groups, without central control, authority, or compulsion.

Based on these, we propose the following principles of axial (crypto)currency design for digital communities:

1. Identify purpose of Currency: Incentivize generation of social capital and liquidity through minting of currency to encourage creation of communally preferred assets and actions. Non-speculative; non-hoarding; no interest rates or debt. Enable all members to set up an account. Received assets in equity and accumulate assets through socially valued (pro-social) actions;
2. Closed Loop Currency: axial currency is not convertible into fiat currency;
3. Gratitude Gift Currency: rewards and acknowledgement for pro-social acts and "good works" [34];
4. Complementary Currency: combine with fiat for purchases of all goods and services. Vary proportions to reflect social incentives;
5. Issuance of Currencies: All members of network (nodes) have accounts and receive seed issuance of currency. Upper limit of initial issuance is determined by total nodes in social network;

6. Right to mint additional types of Axial "Asset Accounts": determined by public square vote with visualization (determines total reserves and the allocation to specific accounts;
7. Determination of allocation of specific accounts determined by "guilds": associations in sectors (art, mobility, well-being - etc.);
8. No Debt, No Credit, No Interest: An axial currency is not a currency of scarcity, but rather of increasing returns: the more the information/currency is spread, the greater the social value, in shared learning, empathy and reduced coordination costs. There are no arbitrage opportunities through variable access to "capital" and hence, interest and credit. One does not have to repay a loan because it is granted - or minted for a social act that is valued and hence, itself creates social economic value. One can see the "reputation" of individual and groups through their accounts and how they accumulate and spend their Axials.
9. Delimit what is purchasable with axials: it should be determined by the community what liquidity and convertibility should be. For example, how much axials+fiats can be used for rent, public transportation, purchase of some goods and services. Making some exclusive services, goods or privileges purchasable only through axials, creating "scarcity" for axials versus fiat currencies.

Computational Axiology

In summary, starting from a theoretical foundation in literature from the social sciences, deriving a set of principles for informing design and development, and using these to operationalise a cryptocurrency, is an example of *computational axiology*, which we define as the study of how qualitative human values should be understood, represented, reasoned with, preserved and generated by digital technology (cf. [35]).

We would agree that capitalism works best when it has a social or moral purpose, and the currency that serves that purpose should use blockchain technology in a genuine peer-to-peer network so that all personal data, incentives (in the form of social capital) and governance are all distributed. This leads to an economy in which transactional information is no longer queen bee but just another worker in the economic value-creation hive, which includes relational, reputational and institutional information. Therefore, as the digital transformation gathers pace and the role of cryptocurrencies becomes increasingly central to that process, then the theory and technologies provided by computational axiology will be in increasingly critical to both create and protect viable, sustainable and non-exploitative digital communities.

Computational axiology acknowledges on the one hand, the importance of design methodologies like value-sensitive design [9], initiatives like ethically-aligned design (IEEE's global initiative on the ethics of autonomous and intelligent systems (https://ethicsinaction.ieee.org/), and educational programmes which produce more ethically-aware designers and engineers; and on the other, the importance of foundational reasoning about the fundamental form, nature and use of values, the operationalisation of value systems in algorithmic form, and visualisation and evaluation of values in socio-technical applications. However, this relies on a systems view of governance that recognises knowledge management, self-determination and meaningful currency as the three pillars of its support.

Summary

The aim of this article has been to identify, and to some extent evaluate, the factors involved the recognition, creation, representation, integration and visualisation of values in the 'digital transformation' and the 'digital society'. It began with a (limited) historical account of 'governance' which has led to the emergence of the 'World Empire'/'Global Digital Empire', although there may be a complex non-linear relationship between the issues (of scale, culture,

governance, polycentrism, economics, cognition, technology, accumulation of wealth and power, etc.) they are nonetheless related, and the exact linear causality may not be the essential characteristic.

We then considered the role of socio-technical systems in this context, and argued that these systems need new design methodologies and technologies for continuous (self) re-invention, collective and democratic self-governance, and respect for qualitative human values. Focusing on the third aspect, we considered how distributed consensus technology could be used as for what we termed the *stored value concept*, which is potentially as radical an innovation as the stored program concept – or, as we discussed, a route to the complete devaluation of values. To avoid this, we proposed nine principles for the design of *axial currencies*, cryptocurrencies which are imbued with more than just transactional information, and the deeper study of *computational axiology*, the study of qualitative human values with respect to digital technology and algorithm design.

In essence, there are three core questions of computational axiology (assuming devaluation by blockchain can be avoided). These are, given that we need human and social norms, institutions and relations, firstly: to what extent can these are governed by algorithmic discretion and to what extent by human discretion; secondly: what affairs are they expected to engage with – contract law? morality? justice? and thirdly: in digital systems, what is the relative value of work versus the value of capital, what actions actually create value, and what affordances make this possible, cf. [36]?

Finally, it is recognised that answering these questions this is a highly complex, nuanced and inter-disciplinary matter, and, as perhaps exemplified by this article, depending on background and discipline some arguments will look too complex, and some too simplistic, and some arguments will be seen as black-boxing what has constituted decades of intense debate in other disciplines. But the underpinning purpose of this work is to further an academic debate across fields, with the hope that the debate itself might cause a re-consideration of the headlong rush to – and forgive the demotic rather than academic expression – blockchain the [deleted] out of everything.

Acknowledgements

Many of the ideas discussed in this paper were developed during conversations with participants of the ID3 Windhover Retreats in 2013 and 2014, and participants in the consortium developing the VIDE project proposal in 2016, and thanks is due to all those who participated in these activities. Particular thanks also to the Special Issue Editors and anonymous reviewers for their many helpful and insightful comments.

References

[1] Y. Harari. Sapiens, A Brief History of Humankind. Harvill Secker, 2014.
[2] Y. Harari. Homo Deus: A Brief History of Tomorrow. Random House. 2016.
[3] A. Chandler. The Visible Hand. The Managerial Revolution in American Business. The Belknap Press, 1977.
[4] C. Baldwin and K. Clark. Design Rules, Vol. 1: The Power of Modularity. MIT Press. 2000.
[5] B. Eaton, S. Elaluf-Calderwood, C. Sørensen and Y. Yoo. Distributed Tuning of Boundary Resources: The Case of Apple's iOS Service System. MIS Quarterly: Special Issue on Service Innovation in a Digital Age, vol. 39, no. 1, pp. 217-243, 2015.
[6] S. Zuboff. Big other: surveillance capitalism and the prospects of an information civilization. Journal of Information Technology, vol. 30, no. 1, pp. 75-89, 2015.
[7] Y. Mounk. The People vs. Democracy: Why Our Freedom is in Danger and How to Save It. Harvard University Press, 2018.

[8] J. Ober. Demopolis; Democracy Before Liberalism in Theory and Practice. Cambridge University Press, 2017.
[9] B. Friedman, P. Kahn, and A. Borning. Value sensitive design and information systems. In K. Himma and H. Tavani, editors, The Handbook of Information and Computer Ethics, pages 69–101. Wiley, 2008.
[10] Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries. Advances in Experimental Psychology, 25:1–65, 1992.
[11] D. Graeber. Debt: The First 5,000 Years. Melville House Publishing, 2011.
[12] E. Ostrom. Governing the Commons. Cambridge University Press, 1990.
[13] B. Malinowski. Kula: the circulating exchange of valuables in the archipelagoes of Eastern New Guinea. Man, 20:97–105, 1920.
[14] P. Kropotkin. Mutual Aid: A Factor of Evolution. Heinemann, 1902.
[15] J. Ober, Democracy and Knowledge. Princeton Univ. Press, 2008.
[16] A. Ferscha, N. Davies, A. Schmidt and N. Streitz. Pervasive socio-technical fabric. Procedia CS 7 (2011), 88--91.
[17] M. Olson. The Logic of Collective Action. Harvard University Press, 1965.
[18] E. Ostrom and T. K. Ahn. Introduction. In E. Ostrom and T. K. Ahn, editors, Foundations of Social Capital, pp xi–xxxix. Edward Elgar Publishing, 2003.
[19] H. Peyton Young. Social norms. In S. Durlauf and L. Blume., editors, The New Palgrave Dictionary of Economics (2nd Edition). Palgrave Macmillan, 2008.
[20] S. Bowles and H. Gintis. Social capital and community governance. The Economic Journal, 112(483):F419–F436, 2002.
[21] P. Petruzzi, J. Pitt and D. Busquets. Electronic Social Capital for Self-Organising Multi-Agent Systems. TAAS 12(3): 13:1-13:25, 2017.
[22] L. Lamport. The part-time parliament. ACM Trans. Comput. Syst., 16(2):133–169, 1998.
[23] R. Kowalski. Logic-based open systems. In Representation and Reasoning, pages 125–134, 1988.
[24] K. Bellman, J. Botev, H. Hildmann, P. Lewis, S. Marsh, J. Pitt, I. Scholtes and S. Tomforde. Socially-Sensitive Systems Design: Exploring Social Potential. IEEE Technol. Soc. Mag. 36(3):72-80, 2017.
[25] J. Pitt and A. Nowak. The reinvention of social capital for socio-technical systems. IEEE Technology & Society Magazine, 33(1):27–33, 2014.
[26] M. Lofgren, "The revolt of the rich," The American Conservative, August 27, 2012. http://www.theamericanconservative.com/articles/revolt-of-the-rich/
[27] D. Glaister. In St Ives, we're facing the financial cleansing of the town's people. The Guardian, 3rd April, 2016. https://www.theguardian.com/uk-news/2016/apr/03/st-ives-second-home-referendum-financial-cleansing
[28] R. Moore. London: The City that Ate Itself. The Observer, 28th June 2015. https://www.theguardian.com/uk-news/2015/jun/28/london-the-city-that-ate-itself-rowan-moore
[29] V. Mayer-Schönberger. The Virtue of Forgetting in the Digital Age. Princeton University Press, 2011.
[30] C. Perakslis, J. Pitt and K. Michael. Drones Humanus, IEEE Technology and Society Magazine 33(2):38-39, 2014.
[31] J. Pitt. Design Contractualism for Pervasive/Affective Computing, IEEE Technology and Society Magazine, 31(4):22-29, 2012.
[32] A. Diaconescu and J. Pitt: Technological Impacts in Socio-Technical Communities: Values and Pathologies. IEEE Technol. Soc. Mag. 36(3):63-71, 2017.
[33] K. Stinchcombe. Blockchain is not only crappy technology but a bad vision for the future. https://medium.com/@kaistinchcombe/decentralized-and-trustless-crypto-paradise-is-actually-a-medieval-hellhole-c1ca122efdec
[34] M. Sandel. What Money Can't Buy: The Moral Limits of Markets. Penguin, 2014.
[35] W. Newsome. What is Computational Axiology. https://willnewsome.wordpress.com/2010/12/16/what-is-computational-axiology/
[36] D. Graeber. Bullshit Work: A Theory. London: Penguin. 2018.