

Institutional Literacy and New Institutions and Rules for Integrated Systems of Production

Tom Snow
agence designContext EURL

Abstract

Orthodox micro-economics provides systemic designers (SD), working within systems of production, with little insight into how current economic systems developed, what is actually going on now, and how SD may be able to intervene in the future. Just as it is proposed that an 'ecoliteracy' (understanding of ecological and living-systems) is the first logical step prior to designing systems of production, that attempt to work with and within natural systems (Capra, 2014); it is arguably as important, that this is supported with an 'institutional literacy' (understanding socio-economic relationships and rules within systems of production), as these more 'regenerative' systems of production may require new institutional forms (that are also more equitable) allowing them to emerge and thrive. Living-systems can be sources of inspiration, and as such, are discussed along with new institutional designs already existing on the margins, that may support the transitions. The prevalent economic arrangements of production, living systems, and potential new arrangements of production, are all looked at through macro, meso and micro nested wholes, and within five interdependent themes: Telos, Factors, Coordination, Distribution and Operations.

Introduction

Keywords:

Systemic Design, Ecological Design, Blue Economy, Circular Economy, Ecological Economics, Institutional Economics

Systemic design (SD) is shifting *upstream* (Ryan, 2014) into the 'means' of production – the processes and institutions *behind* products or services (Bistagnino, 2017). Consequently, SD practitioners are being challenged to develop deeper and broader technical skills to support these different forms of activity (e.g. ecological, biological, physical and chemical literacy).

At the same time, SD practitioners are being asked, in light of a range of inter-related issues, from climate-change to ecosystem degradation (or are simply motivated), to support the design of the means of production that generate zero-waste (Bistagnino, 2011), and mimic and work regeneratively with and within local ecosystems and communities (Mang et al., 2012). This can bring along with it, both new opportunities and challenges, that go beyond a pure focus on flows of energy, and cycling and transformation of materials; as these new activities can also require direct interactions with various forms of stakeholder groups (Ryan, 2014; Mang et al., 2012), and can require the development (or co-development) of new types of *institutional* forms and relationships.

Systems of production essentially involve how *people* within organisations (e.g. private firms, clusters, coops, or associations), communities, or regions:

“...organise a system to assure the production of enough goods and services for its own survival,” and to “...arrange the distribution of the fruits of its production so that more production can take place” (Heilbroner et al., 2012).

As systems of production (e.g. agricultural, industrial, and waste management) are also embedded within larger socio-economic systems, this necessitates that SD practitioners develop a broad and deep micro and macro '*institutional literacy*' (e.g. understanding of organisational design, value distribution strategies, policy, history and economics).

New forms of institutional design may be a necessity, as the predominant forms of organisational design and business models, built around economies-of-scale, centralisation of control and profits, hyper-specialisation, large and dispersed global supply chains, and a focus on exports, for instance, may essentially be incompatible with the practicalities and economics of zero-waste, low-carbon, and regenerative systems of production. Combined with the fact that there is a growing number of people, that want to work, and are working, within more inclusive, healthy and autonomous organisations (Laloux, 2014), which bring value to all their stakeholders, and improve the health and value of the greater system (Sanford, 2011); SD's literacy of institutional design within upstream activities is, therefore, of increasing importance.

This paper, therefore, attempts to support SD 'institutional literacy' through three main sections. The first section explores some of the key elements of production institutions, within *traditional* (orthodox) organisations and predominantly micro-economics. Following in the philosophy of *Regenerative Development* (du Pressis, 2012; Mang, 2012); this work is also inspired and rooted in living-systems – and therefore, *living system* design. Inspired by physicist Fritjof Capra, and evolution biologist Elisabet Sahtouris, and regenerative thinkers, such as members of Regenesis Group Inc. and Carol Sanford, the second section looks to living-systems as inspiration for direct ideas and transferable analogies. And the third section explores some of the newer, more *regenerative* forms of institutional design that are evolving on the margins. The paper finishes with a conclusion.

Within this working paper, not all topics in the three main visual frameworks are discussed, due to an attempt for some brevity.

Telos, Factors, Coordination, Distribution, and Operations

Aristotle proposed the importance of '*telos*', from the Greek τέλος for "end," "purpose," or "goal," which attempts to "...identify the norms appropriate to social practices by trying to grasp the characteristic end, or purpose, of those practices." (Sandel, 2010)

Simply stated the '*factors of production*' are the necessary (or minimal) 'inputs' required to obtain an 'output' within production activities (Encyclopædia Britannica, n.d.). They are typically classified into three groups: *land*, *labour* and *capital*.

Coordination in economics has evolved in its usage, however, here it used to describe a set of relationships - with corresponding rules to frame them - that are created to determine certain pre-determined outcomes, such as promoting efficiency. The main examples that are discussed here, are *money*, *markets* and *organisational forms*.

The term '*distribution*' in economics, should not be confused with the retail and logistics of goods. In orthodox economics, distribution is looked at through '*distribution theory*' which

“...is concerned with the basic question of for whom economic goods are to be produced. In examining how the different factors of production—land, labor, and capital—get priced in the market, distribution theory considers how supplies and demands for these factors are linked and how they determine all kinds of wages, rents, interest rates, and profits” (Samuelson et al., 2010).

Operations principally includes concepts around *social division of labour*, and *division of labour* within systems of production, and the division of production systems around the planet (globalisation).

Prevalent Rules of Production

This first section looks at some of the prevalent (orthodox) institutional rules that frame how groups and individuals work together and are managed by others; which has a great effect on how things are perceived, and how power and value is created, extracted and distributed.

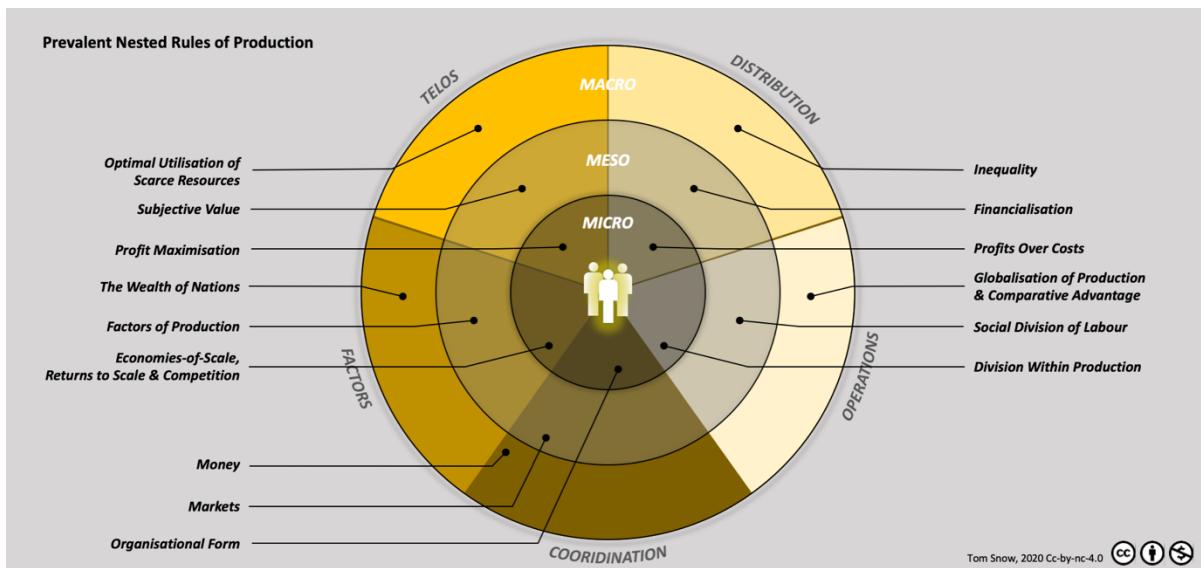


Figure 1. Prevalent (orthodox) Rules of Production (Author, 2020)

Telos

Macro: The ‘economic problem’ – sometimes called the basic or central economic problem, has various definitions and has changed over time. Economics, as a field, made a substantial change in what was defined as the ‘economic problem,’ during the so-called ‘marginalist revolution’ (commonly cited 1871-1874) (Roncaglia, 2005; Mazzucato, 2018). *Classical economics* (the predominant school of economics prior to the marginalist schools) defined economics as the study of the “...functioning of an economic system based on the division of labour, and hence analysis of production, distribution, accumulation and circulation of the product” (Roncaglia, 2005). Classical economics considered an *objective* (fact-based, measurable, observable...) view of economic value based on the difficulties and costs of production (principally labour), and prices attained the role of indicator for the relative difficulties in production.

The economic problem from the *marginalist approach*, can be said to be the:

"...optimal utilisation of scarce available resources to satisfy the needs and desires of economic agents." (Roncaglia, 2005)

Meso: In marginalist economics, the 'marginal' utility and scarcity defines the *price* and the size of the market (Mazzucato, 2018). The supply and demand of scarce resources adjusts 'value,' which is conveyed in monetary terms. In the market, this becomes 'prices,' which become the indicators for relative scarcity and consumer preferences. Prices are kept in check through competition, and simultaneously indicate the level of demand, and the required quantities for supply: greater demand raises prices, which raises (willingness to generate more) supply; and a fall in demand, visa-versa (Heilbroner, 1999).

Roncaglia (2005), proposes that the discipline of economics grew around two different meanings of value: the *moral* issues – the rules of conduct (thus related to *values*), and the *economic scientific* issues – how to organise a society, based on the division-of-labour, to keep the process going (thus related to *value*). Up until the mid-nineteenth century, economists believed that a clear *objective* theory of value (also known as intrinsic theory of value) was a prerequisite to having a clear appreciation of the prices of services and goods in the economy. Objective value means that an object's value can be estimated using objective measures, such as the conditions of production, the amount and quality of the labour required to produce goods or services, the technological and organisational form, or the relationships between capital and labour for instance (Mazzucato, 2018). However, after the mid-nineteenth century, the understanding of what economic value was, shifted towards one of '*subjectivity*'; where the price which is paid by the consumer (who is said to have subjective 'preferences') in the 'market,' determines the value of the goods or service, which are now regularly conceptualised as being 'scarce' (Mazzucato, 2018).

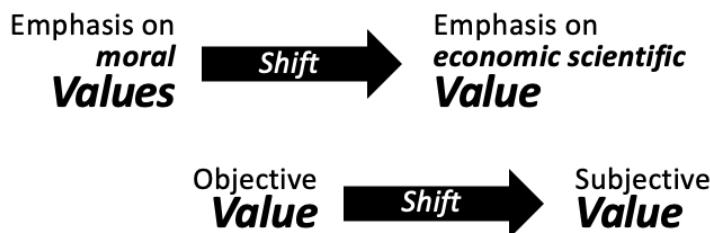


Figure 2. Shifting Value (Author, 2019)

Micro: With the rise of the *utilitarian philosophy* in the early nineteenth century, it was asserted that whatever served the individual served society, and so by "...logical analogy, whatever created a profit (and thereby served the individual capitalist) also served society," and so in effect, whatever passed the profit-and-loss test of the market place, automatically is positive for society (Heilbroner, 1985).

Alfred P. Sloan Jr., the CEO of General Motors from 1923 to 1946, is one of the first from industry, noted to proclaim that the goal of the company was to "...make money, not just to make motor car." (Sloan, 1990). This statement framed the now conventional wisdom for the purpose of business. The goal therefore of companies became '*profit-maximisation*', which was underlined by economist Milton Friedman (1970), in an article published in the New York Times Magazine, titled '*The Social Responsibility of Business Is to Increase its Profit's*' and profit maximisation along with cost reduction was the modus operandi of all managers within the organisation (Mazzucato, 2018).

Factors

Macro: The transition of most western European societies from feudalism into the first 'soft proto-market-economies,' was made through a mixed dynamic of different (and rivalrous) productive organisation forms (Heilbroner et al, 2012). Slowly developing outside of the reach of feudal manorial estates, small urban dwellings began to arise, with a small number of specialised *guilds*,

providing specialised goods that the manorial estates could not provide for themselves (Heilbroner et al, 2012). Later, *merchants* searching ways to circumvent the 'monopoly' of the guilds, went to private households (often in the countryside) and began supplying this cheaper labour (as they often had the means to feed themselves) with materials, and subsequently some specialised machines, whilst specifying the product details and selling to the final customer (Heilbroner et al, 2012; Rifkin 2012). Later, but also in parallel, small factories began to harness relatively large power sources of wind and water, to power large numbers of machines – which required *economies of scale* (bringing many looms under one roof) to make the relatively energy abundant system economically viable (Collier, 2015); putting into motion the dynamics of economies of scale in production (describe in more detail in the 'micro section').

Through these three briefly described dynamics (guilds, merchants with households, and factories), *power* - where the 'wealth of nations' was most intensely being created - was shifting from the land (and therefore land owners), to merchants (the holder of the input capital, and clientele), and to the industrial capitalists (the holders of 'capital'). The mechanist's lending or even renting of specialised machines began the separation of labour from the 'means of production' (Rifkin, 2012), which the factory extended further through private ownership. And so, householders began selling their labour in exchange for money to the merchant and the factory owners. Within these often-conflicting institutional collective forms of production, labour, land, and capital – the once integrated and largely non-distinguishable elements started to become divided as distinguishable 'economic' concepts, which could be bought and sold within markets.

At the level of the state, factors can be viewed at the level of 'sectors' – land – being *agriculture*, capital - being *industry*, and labour remaining as it is, the *labour force* (perhaps labour unions if they were more pervasive, would create a labour sector) for example. According to economist Kenneth Galbraith (1985), until around 200 years ago, power rested with those who owned land and could till it. The wealth of a country was assured by the production of food and fibres, which made up the majority (up to 80%) of production of a nation. During the industrial revolution, power relatively rapidly shifted to those who owned capital, and those with the skills of engineering. And so, in countries like France, during the early 1700's, where power and wealth resided with land owners, 'Les Économistes' (later known as the 'Physiocrats') viewed the base of the wealth of nations as the land ('produits de la terre'), as humans could *merely* transform it (Mazzucato, 2018). Whilst across the channel, Adam Smith, wishing to counter the continuation of the mercantilists, and seeing the growth and potential of industry, saw and promoted industrial capitalism and its division of labour, as the *real* wealth of nations (ref).

Meso: The term 'land' includes natural resources such as water, air, soil, minerals, flora and fauna. The term 'labour' (or 'labour force'), includes all members of working age, of a population, who are either employed or unemployed (but officially seeking or awaiting formal employment), however, it does not include the underemployed, the marginally employed, the would-be employed, and particularly, it does not include those that work in the informal sector, or work as housewives – the work of *reproduction* (Waring, 1988). Owners of land can charge rents for their use, whilst labour can charge a wage or salary for the use of labour power. The price of all factors depends on its *relative* scarcity – the most difficult to obtain or the hardest to replace (Galbraith, 1985). And therefore, if a factor becomes *relatively* abundant or redundant, then the power it yields collapses.

This is a very simplified introduction to factors of production, however, as one looks more closely, definitions abound around what *capital* actually is, due in part, to its chameleon - like nature – and perhaps the 'enigma of capital' benefits those that have access to it (ref). According to law expert Katharina Pistor (2019), within market economies "...capital is not a thing, but a quality." What is

still predominantly seen and described as capital, are the *physical* assets - those 'capital goods' which are used to produce other goods; such as plant equipment and machines. However, Pistor points out that capital has 'enclosed' many different elements from the other factors, such as *land enclosure* (as private property), *labour* (in the case of slavery in the past – or even forced-labour today), and many modern '*intangibles*', such as financial asset, and 'intellectual property rights' such as patents, copyrights and trademarks and brands – which is more recently *IP enclosures* expanding into personal data and structure for life, such as DNA (Belloc et al, 2012). According to Pistor, it is thanks to a slowly fought and more recently (around 1970s) accelerated change in the 'codes' (laws) that 'package' a resource and transform it into an "asset." Essentially, once a resource becomes an 'asset,' it can be turned into *financial* capital, and it is ready to generate wealth. Owners of 'capital' can earn profits, interest and charge rents for example.

These codes – particularly those enforcing contracts, property collateral, the law of trust and corporations and bankruptcy law, for example, are importantly backed and *enforced by the state*. And this bestows important *attributes* on assets, and therefore privileges to the holder, including: "*Priority*, which ranks competing claims to the same assets; *durability*, which extends priority claims in time; *universality*, which extends them in space; and *convertibility*, which operates as an insurance device that allows holders to convert their private credit claims into state money on demand..." (Pistor, 2019).

Some economists also name a 'fourth factor,' which for some is 'entrepreneurs' (see J.B. Clark), for others it is 'intellectual capital' (ref.); and for others it is the 'technostructure'- basically a management elite that services its own needs, to the potential detriment of the organisation (Galbraith, 1985) for example. This fourth factor, like capital, also seems to have a chameleon-like form overtime, during different periods of developments – however perhaps the common theme is '*information*' – who has it or has access to it. Particularly with the rise of internet-based service companies, during the last 20 years, this 'technostructure' has arguably shifted power from management within companies to the technology companies, primarily based in Silicon Valley (Morozov, 2015a and 2015b; Foroohar, 2019).

Micro: Micro economists (or managers) attempt to optimise the ratio - or '*allocation*' - of factor inputs in production to maximise profits – often focusing on the ratio of labour (L) to capital (K), which can lead to an optimised 'production function' and an economy of scale of the activity (ref). However, as has been already described, economists show that land and capital are different things in a legal and often (but not always) physical sense, and therefore, they have differences in returns and forms of competition (Reinert, 2008).

For land, *diminishing returns* is said to be a predominant trend, as there is a point in which adding more 'units' of capital and/or labour will generate a smaller return on investment (Reinert, 2008). There can be *extensive* diminishing returns (when marginal land is brought into use – natural resources differ in qualities – from an anthropomorphic perspective), or *intensive* diminishing returns (when more capital or labour is added to the same land) – increasing costs over time. Land also is said to have *perfect competition*, as it is said to have a low ability to differentiate, meaning that the producer has very little influence over the price that they can sell the final good in the market. And innovation in production tends to lead to lower prices for customers, but not higher profits for the farmers (Reinert, 2008). This is also related to the fact that agricultural activities can have low-income elasticity of demand – when customers get richer, they cannot eat more food (but they can buy more shoes).

For capital, *increasing returns* is said to be a predominant trend, as the means of production expands, the cost of production per unit reduces (even without technical change) (Reinert, 2008). Capital is said to be able to have *imperfect competition*, as increasing returns tend to create a form of market power, which makes it possible for the producer to influence their selling price (Reinert, 2008). Process innovations will tend to increase profits.

And finally, *economies-of-scale*, according to Collier (2015) in *industrial* production was first truly developed as an idea (and as a strategy within productive activities) with the harnessing of water (and wind) power to drive machines. He proposes that the original spinning jennies for textile production didn't *need* scale, they could (and where) predominantly distributed between individual cottages and were powered by the workers themselves. However, by running large numbers together by waterpower, meant that they needed to be brought together under one roof (water is not like coal or electricity – production needs to happen where the energy is being transformed). *Therefore, the large source of available energy required large scale production to harness it economically.* A typical water mill, in the late eleventh century, could generate two to three horsepower for approximately 50% of the operating time of the mill (Rifken, 2104); and could replace the labour of 10-20 people for the equivalent level of output (Rifken, 2014).

Distribution

Macro: In the 1980's, a surge of economic and legal reform in developed and emerging markets shifted the priority of allocating economic resources, from governments to markets (Pistor, 2019). The idea was principally made to protect the initiative of the individual, through clear property rights and credible contracts, that would make sure that the 'most efficient owner' would be allocated the scarce resources, and this would result in a larger pie for the greater society (Pistor, 2019). Thirty years later this 'trickle-down economics' is not celebrating prosperity for all, instead economists are debating whether we have already reached levels of inequality that were last seen before the French Revolution (Pistor, 2019).

The reasons for this, from various schools of thought, have been pointed at the exploitation of labour by capitalists (Meiksins Wood, 1999); excessive globalisation depriving regions the power (and control) to tax international organisations appropriately (Stiglitz, 2002; Rodrik, 2011); or that in mature economies, capital grows faster than the 'real' economy ($r > g$), therefore whoever amassed wealth in the past, has the ability to multiply it at a greater rate relative to others (Piketty, 2014). However, according to Pistor, although these may all be parts of the story, she suggests that the (or another) key ingredient goes back to the legal codes placed around assets – creating capital, and who has access to it, and can create wealth with it, and who cannot (Pistor, 2019).

Meso: This subsection looks at 'financialization.' The *traditional* role of finance within an economy, is to take savings from households and turn them into investment (Foroohar, 2016). However today, the financial sector attempts to separate itself from the 'real economy' and use new '*financial products*' and issue massive amounts of debt, in attempts to create money from money – a kind of 'closed-loop' industry (Foroohar, 2016). In simple terms, rather than funding new ideas and projects, that may create jobs and raise wages, finance has shifted its focus towards *securitising* existing assets (again, wrapping assets up in new legal codes) such as homes, stocks, bonds and so on, and turning them into tradable products; and products that can be virtually divided up many times, in attempts to create 'mixed portfolios' of theoretical low risk debts (Turner, 2015) (2007 proved that this 'innovation' was toxic).

The trend has been for financial institutions to funnel money towards debt and speculation, as it can make quick and big rewards (if one is on the upside), whilst investments on productive activities can be longer term (Foroohar, 2016). This means that industries, such as advanced manufacturing for example, find it more difficult to find investors than those in real estate and construction, which can produce quick, and reliable *short-term* gains (Cecchetti et al., 2015). Today, between 70-80% of all trading is done by computer, with much of it based on 'fractional price changes' over split-second intervals (Foroohar, 2016); where instead of a stock holder investing in a company for the long-term, or even an average of eight years (like back in the 1960s), this has slipped to a just a few months in 2012 (Foroohar, 2016), with many purchases only lasting around 10 minutes (ref) (This is hardly an informed investment).

Micro: Traditionally, the way to increase profits over costs, is to (1) reduce input costs, (2) increase productivity (or, therefore, reduce marginal cost), and (3) increase margins (ref). From this relatively simple concept, comes a range of strategies, and a vast breadth of consequences to distribution and on the operations – and therefore people.

For example, with a focus to drive down input costs, companies have focused on *off-shoring* – moving their own production facilities to geographic location that have cheaper factors of production (usually linked to lower standards for the environment or workers), and/or lower taxation for instance (Milberg et. al, 2013); or *out-sourcing* – taking the activity off the books (often freeing up capital) and paying a specialised provider for a service. It also encourages monopolies or oligopolies up the supply chain, to squeeze the prices of suppliers (Milberg et al., 2013).

Industrial systems, in particular, have the ability to increase productivity over comparatively long periods of time, thanks to production innovations – in comparison to non-industrial activities. There is, therefore, a prolonged '*multiplier effect*' between raw materials and final goods (Reinhart, 2008). However, an insistent drive for productivity can have consequences on workers – as productivity growth is often defined by increased mechanisation; whilst *efficiency* can seem a 'win-win' strategy (similar to 'picking the low-hanging fruit'), however, what comes next is often not discussed. And that is the improvement in efficiency of a factor, is equivalent to creating a larger supply, therefore the price of the factor will fall (Daly, 2019). As prices fall, more uses will now be found for it, and it is possible systems of production end up using *more* of the resource, though more efficiently (Daly, 2019). This is sometime called the "Jevons effect." And so, to bear in mind in policy or management strategy: "A policy of "frugality first" ... induces efficiency as a secondary consequence; "efficiency first" does not induce frugality – it makes frugality less necessary..." (Daly, 2019)

And third, which focuses on increasing margins, attempts with tools, such as monopoly of supply, access to customers via distribution, innovative functions that people value far beyond their real cost (e.g. aesthetic design – particularly elaborate packaging, status symbols, brands, exclusivity, limited editions).

Financialisation has had an effect on all of three of these areas. For example, in input costs, companies or even states, can attempt to gain comparative advantage over limited raw materials such as world copper supplies, lithium for batteries, milk for yogurts, or water for soft-drink manufacturers, which can reduce citizens of these regions access to basic resources (ref).

'*Derivatives*' are a financial tool, that has been used for centuries as an insurance policy on risk of owning things, or for inputs (Foroohar, 2016). Airlines or trucking companies for instance, can "hedge" oil to reduce risk of price fluctuations. However, by the 1900s and into the 2000s, finance

expanded the form of use, until it became “financial weapons of mass destruction” (Buffet, 2002) as ‘interest rate swaps,’ ‘foreign exchange bets,’ and ‘grain futures’ for example.

Financialisation has also had a direct effect on productivity, as companies have reduced the amount they invest in R&D (Foroohar, 2016; Mazzucato, 2018). The fall in reinvestment in the US, between 2000 and 2010, is estimated to have reduced by more than 21% - and in certain industries, such as motor vehicles, by 40% (Foroohar, 2016).

Instead of investing profits in R&D, companies have increased a double strategy, of reducing *declared* profits (profits before tax (PBT)) – and therefore increasing margins – via a range of strategies, such as offshoring profits (e.g. shifting payments to offshore tax havens in Holland or Ireland for example), deprecating value of capital (owners of restate for example can use the depreciation of capital to effectively pay no taxes, whilst labour workers that earn money from wages have - virtually - no such ability). Management of companies can also change how they are remunerated; for example, many ‘super-managers’ in the US, can have anywhere between 30-80% of their income given to them, not via salaries, but via stock options and shares (Foroohar, 2016). The income part via these channels is taxed much lower than on wages, feeding inequality. Finance institutions have also helped (or encouraged) companies to make moves that increase ‘shareholder value’ (which is set by the market – not by the company), again to the detriment in reinvestment in factories, infrastructure or worker training for instance (which in the short-term can seem be less profitable). Actions that ‘shareholders’ (or those managing these fluid financial pools) prefer mergers and acquisitions, and shareholder buybacks and dividends – which boost share prices – and therefore profits (Foroohar, 2016).

And finally, personal debt and business debt has grown at a rate of 2-2.5 times that of total income during the past forty years (Madrick, 2012). For business, this can be traced to the fact that they are able to deduct payments of interest on debt (a form of rent on money), whilst paying full taxes on (declared or on shored) profits. What this means is that it can make corporate debt up to 42% cheaper than corporate equity (Foroohar, 2016). And more commonly known is household debt as a share of disposable income has risen from 54% in 1970 to 95% today (in the US) (Foroohar, 2016); as flattening wages have become the norm.

Coordination

Macro: Money will be discussed in more detail in this subsection – particularly what it is, and how it is created; as well as some detail on alternative currencies and the gold standard. Particularly since the *Great Recession* (the economic downturn from 2007 to 2009), and the rise (and public awareness) of ‘financialization,’ there has been a vast array of books and debate – academic and public - around money (ref). Money is multi-faceted, with arguably its ‘darker-side’ creating a long shadow when its focus becomes the ‘ends’ instead of a ‘means.’ This potential shift arguably developed hand-in-hand with the change up to Feudal times, from power (e.g. previously given by blood and/or by divine right) creating the ability for those who held it to extract wealth; to the inverse slowly growing within the soft-proto capitalist societies up to today, where wealth creates power (Heilbroner et al, 2012).

Meso: In modern prevalent economics, markets are taken to be the ‘natural’ (and only) coordination mechanism (ref). According to Adam Smith, the history of civilisation developed, followed a four-stage model: the first stage, being the age of Hunters; the second, the age of Shepherds; the third, the age of Agriculture, and the fourth, the age of Commerce (Brewer, 2008). This theory was shared

by other Scottish and French writers of the time (Brewer, 2008). In lectures, Smith expressed this framework through a *story* of an island; a report dated 1766 of one such lecture goes like this:

"The four stages of society are hunting, pasturage, farming, and commerce. If a number of persons were shipwrecked on a desert island their first sustenance would be from the fruits which the soil naturally produced, and the wild beasts which they could kill. As these could not at all times be sufficient, they come at last to tame some of the wild-beasts... In process of time even these would not be sufficient, and as they saw the earth naturally produce considerable quantities of vegetables of its own accord, they would think of cultivating it so that it might produce more of them. Hence agriculture... The age of commerce naturally succeeds that of agriculture. As men could now confine themselves to one species of labour, they would naturally exchange the surplus of their own commodity for that of another of which they stood in need." (Smith, 1978)

Through this view of different forms of development, came different ways for communities to coordinate themselves. However, these concepts, also developed further by Adam Smith, that the age of commerce began with *barter, truck and exchange*, prior to the 'natural' transition to (and more efficient form of exchange within) markets. Polanyi, in his book, *The Great Transition*, goes to great lengths to study and describe that this is not the case, calling it "*the economicistic fallacy*." Why is this so important? Firstly, if one believes that markets are a 'natural' transition from these potentially 'inferior' ways of managing exchange, then markets can be seen as the best and most evolved option we have. Second, for those that may think that markets are not working, they might look to these previous systems for inspiration.

Within an organisation, the work is not coordinated via markets, in accordance to the purchase and sale of goods, and the constant exchange of contracts. Instead, an operations plan is made, defining workers, their roles and the machinery and workflow design (stock and flows placed in time and space), in the required proportions (Pagano, 1985). Outside the boundaries of the organisation the market coordinates the supply and demand. Although this may seem obvious, it wasn't to Adam Smith (Pagano, 1985), and it took Marx to actually point it out (Pagano, 1985). The efficiency of organisations vs. markets has been a prolonged debate, with Chicago School Economist and Nobel laureate Ronald Coase saying that "...Firms are islands of central planning in a sea of market relationships." Whilst raising the point that market interactions can be inefficient. And on the other extreme Hayek proposed the most efficient system was the firm of 'one' and all interactions being market interactions (and therefore no central planning at all (Pagano, 1985). In some ways, the so called 'sharing economy' has in-effect made Hayek's dream come true - '*we are all capitalists now*' (Milanovic, 2019). Whilst at the same time, via the internet and big data, it does seem possible that all these market transactions and assets can be efficiently allocated – which brings it closer to concepts of *central planning* – which Hayek (and others) said would be impossible. So perhaps the sharing economy has proved Hayek right and wrong! (At least in certain capital markets)

Micro: Traditional hierarchical and patriarchal organisational forms will be discussed more here.

Operations

Macro: Globalisation of production has been on an increasing march since the 1990's (Milberg et al., 2013). Value chains often start with primary producers, such as farmers and miners, then go to secondary producers, such as chemical or industrial production companies, and tertiary producers, such as finance and distribution and retail. Innovation here is not individual but *structural*.

Vertical integration includes the integration of primary production into the same operation as the secondary production; and/or secondary production also integrating sales for example. This is a trend that has been in reverse since out-sourcing, off-shoring, and specialisation has created ever-longer value chains (Milberg et al., 2013); however, new technologies, and innovative economics of entire businesses, have shown that different forms of vertical integration (as was the strategy of Ford motors) is coming back into the fore (e.g. Tesla, Apple and Regenerative Agriculture).

Promotion of a shift ‘up’ the value chain – from limestone, to bricks for example. In many cases, individual firms cannot internalise all the costs involved, such as in human capital (new knowledge – education, and skills), improved infrastructure, capital goods investments, increasingly complex technologies, and the potential need for co-ordination of many different firms to achieve the changes, for example. Governments can help bridge this gap.

Another strategy is to focus on high-value goods (and services), and in this case, goods that have a high-value per kilo. This can potentially reduce the physical quantities of inputs, and the physical space required to manipulate it – per (\$) value generated (Stahel, 2006).

Allyn Young (1928) and Nicholas Kaldor (1996), explained that the ever-increasing specialisation of tasks, decomposed production into a sequential group of *different* firms; with each producing an intermediate product - becoming a ‘layer’ within the entire process – an input for the next stage. The end of the process (moving ‘upstream’) finishes with final assembly of the final good or capital good which is then sold to final customers directly or via a retailer ('downstream'). This network of firms, all developing commodity parts for one related final good assembler, is known as “vertically integrated industry” (Pasinetti, 1981); and each supplier to that network is therefore engaged in vertical specialisation.

This trend has meant that... “about 50 percent of the value of international trade in goods and services is in intermediate rather than in final goods and services” (Milberg et al, 2013). In principle the process follows the same logic of the Babbage principle – discussed in the ‘micro’ subsection below. The only difference is that Babbage looked at individuals within one organisation, and this uses the same process to organise individual companies in ‘value chains’ (ref).

More about Comparative Advantage (Daly, 2019) will be discussed here.

Meso: The *social division* of labour, is the term used here, to describe the various ‘niches’ particular people may have performed within *social groups and communities*, which, depending on the culture, and can be linked to their *comparative* differences in abilities, skills and knowledge, or gender and age (ref).

Foragers can be defined as small groups, that move around a lot, hunting wild animals and gathering wild plants, without domesticating either (except dogs) (Daly et al., 1999). For possibly 90% of human history, all humans were foragers (Morris, 2015). In most cases it is actually gathering- such as digging for roots, picking berries, and collecting materials such as wood, horn and flint for tools, as well as ‘gathering’ knowledge about the surroundings (Harari, 2014). It is estimated that it requires around 260 to 2600 hectares (depending on the carrying capacity of the region), to support a single foraging individual (Daly et al., 1999; Montgomery, 2017). Different carrying capacities and geographies of different regions, therefore, influence significantly the size and the amount of sedentary possibilities of groups (Morris, 2015); however, average group-size is thought to be between 2-8 people, which are part of larger groups of perhaps 500 (providing a viable breeding population) (Morris, 2015). These small groups are principally families (or organised

like families), and the social division of labour is generally made by age and gender (the small size of the groups also limits more complex division of labour). Women are generally thought to be the main gatherers of plants, preparers of food, and responsible for some handicrafts; whilst men hunt, and also do some preparation of food and handicrafts (Morris, 2015). Girls and boys help in their gender-specific roles. It is also understood that small population sizes are maintained by boom-and-bust cycles of population growth and starvation (Diamond, 2012).

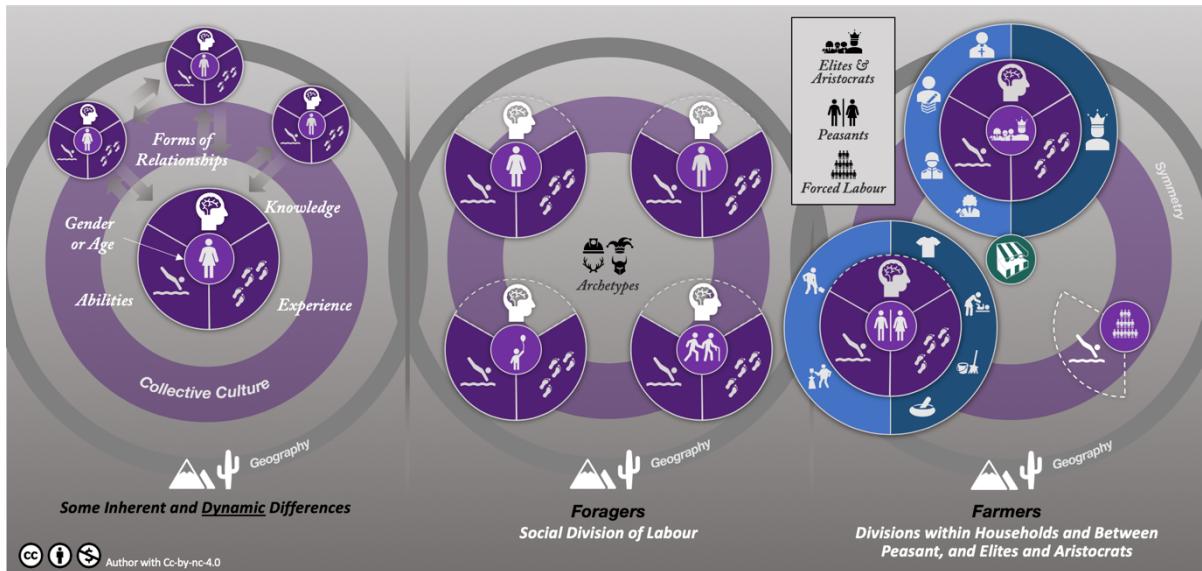


Figure 3. Social Division of Labour with Early Societies (Author, 2019)

According to Polanyi (1944), the bounty of a hunter-gathering group (rarely an individual) is given as a *gift* to the community. In many cases the gift is *redistributed* via a tribal leader (a head man), who often keeps it in storage. The important function of collection, tracking of gifts, storage, redistribution, and the managing of redistribution over-time, helps to reduce irregularities in productive outputs, which Polanyi (1944) calls *centricity* (as it describes the movements of products of land and labour into and out of a centre). Here, the form of redistribution may be fair – or not (from a fair chief, to a stingy temple, despot or lord...); nevertheless, the food is shared through social activities, including feasts, and dances – so that the gifts are seen by the community, to provoke honour and *social prestige* (status) to the provider (one's skills and generosity will be seen by all), and emulation in others.

It seems that although the hierarchies are relatively flat, all forager groups seem to be weakly male-dominated (patriarchal). These communities are not passively egalitarian however, but actively so; using strategies such as ‘reverse dominance’ – forms of mockery to those who’s egos swell too large (Boehm, 1999) to help diminish individual hunter’s success for instance. Beyond mockery, other forms, such as ostracism and blunt criticism are also used (Morris, 2015). And in many cases, violence within groups is relatively high (nearly always by men) – although highly contested, some anthropologists suggest a 10% likelihood of death by violence in these small forager communities (Pinker, 2011).

Farmers can be defined as those, often large sedentary groups, that intentionally modify their local gene pool of plants and animals (domestication) (Morris, 2015). This is thought to have begun around 10,000 years ago (Harari, 2014), independently in various areas, including Central America, Western Iran, East Asia, and Africa for example. The reason that agriculture started in these places (collectively known as the ‘Lucky Latitudes’) is simply believed to be because these particular

plants (an estimated 56 varieties worldwide, with large edible grains (Diamond, 1997)), and animals (14 large meaty mammals worldwide), were available in high enough densities in these places (Harari, 2014): 50 of the 56 plant varieties, and 10 of the 14 animal species, that have been domesticated worldwide, were from these regions (Morris, 2015). Harari (2014) also proposes that premodern humans may have been motivated to develop agriculture, so as to be able to remain sedentary long-enough, to build religious monuments.

One major transformation that followed was the division of labour within the *household*. Agricultural intensity slowly increased with the development of techniques such as the irrigation, manuring and ploughing, which led to a greater need for upper body strength (Morris, 2015). The agricultural products, such as cereals also necessitated secondary processing, such as threshing, sifting, grinding and so forth. Sedentary agricultural groups also had far more children; meaning women spent far more time being pregnant, and the time required to care for small children, therefore, also increased. At the same time, even the simplest of permanent dwellings needed more time in cleaning and maintenance (than forager's temporary structures). It is believed that these various factors contributed to a new gender division of labour, where men generally spent more time outside the home managing heavier agricultural techniques, whilst women spent more time inside, combining the tasks of secondary processing, cleaning and childcare. Farming households also made most things that they needed, with women often weaving cloth, and men making and mending agricultural machinery (outside of the harvest season).

In farming societies property hierarchies, became far more distinct. It is suggested by Morris (2015), that due to differences in land qualities, and the built structures, such as water wells and terraces, which took time and resources to build, gave far greater importance to specific geographic locations. This, Morris suggests, is foundational for the increased importance given to marriage and on legitimacy of kin - for inheritance, and the burial and rituals for dead ancestors.

Larger populations in larger settlements, afforded greater possibilities for division of labour between households, (specialisation), including such activities as weaponry, black-smith, and pottery for example (this will be discussed in more depth in the next section). In perhaps the world's first true 'city,' Uruk in southern Mesopotamia (3500BC), the city began employing some citizens in specialised service tasks, involving the running of civic administration (Steel, 2009).

For large farming societies to be able to build the large monuments, roads and other infrastructures, institutions larger than the household, it seems that three main forms evolved in response: kin groups, labour markets and forced labour. Kin groups - groups of households related by blood or marriage - were able to organise the construction of certain structures (perhaps like and including Stonehenge), but was not appropriate for the scales of large public works. For this, labour markets evolved, at least from the time of Uruk as previously mentioned, and through to three thousand years later in Rome, where soldiers, monument builders, and grain harbour workers for instance, were all mostly paid labour (Morris, 2015).

Forced labour whether (chattel) slavery or serfdom (many peasants under feudalism were serfs), became the cornerstone for many of these societies. It is estimated that (in a perhaps extreme case) 1 in 3 people were chattel slaves in Classical Athens (Morris, 2015). At the other end of a steeper hierachal spectrum, aristocrats were ordained by a ruling elite to lesson potential competition, creating a distinct richer and powerful governing class. These aristocrats, overtime, often developed specialised skills, such as military, law, writing, and religion, helping to make themselves necessary components, for the elite, and for the functioning of these increasingly complex societies; helping to govern the collection of taxes, fight wars, quash revolutions, and enforce the law for

example. It is estimated that the more developed societies, such as Roman Rome, the elite, which made-up around ten percent of the population, were extracting around eighty percent of what was theoretically possible from the rest of the population (Scheidel et al., 2009).

Aristotle believed that we are ‘naturally’ ‘designed’ to live in cultures – in the ‘polis’ (from the Greek for city, or as a body of citizens); and that it has two natural pairs of association – one is man and woman for procreation, the second is of master and slave for the purposes of natural preservation (Roncaglia, 2006). This creates a household group, which together with others create villages, and villages together with other villages make the polis – the polis then becomes the ‘natural’ ends of these two natural associations. Nature and the gods made some people leaders (and therefore godlike or even gods) and others to obey them.

The changes in the social division of labour during the industrial revolution are important, but due to brevity, the focus will now go to the operations within the industrial systems themselves, and some of social divisions will be discussed in relation to industry.

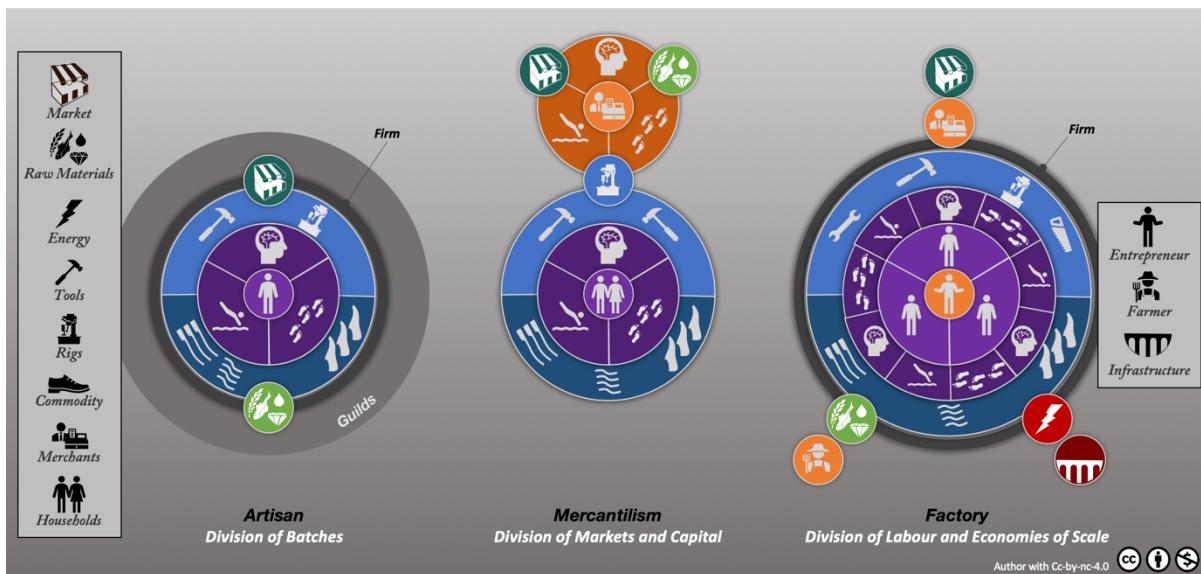


Figure 4. Division of Labour in Production (Author, 2019)

Micro: The division of labour, here is focused on how operations within production of goods and services – and particularly commodities, those goods made for exchange, not for personal use (Polanyi, ref). **Error! Reference source not found.** describes the early sequential and concurrent forms of productive operations.

Initially, it is thought that early independent *artisans*, within relatively simple designed spaces (outside or inside buildings), began to *divide the process* into batches (Braverman, 1998). In this way, the artisan breaks the process of making a shoe, for example, into batches of different components - a batch of soles, a batch of laces, and a batch of uppers. This allows for overlaps of processes that do not require direct labour, such as drying time for glues, to be integrated into a more dynamic process. Also, the invention of simple jigs and rigs – made by the worker, increased productivity. According to Pagano (1985), the benefit of this process, is that “...specialization increases job-specific skills, which in turn results in an improved performance in production.” Today, within an ‘artisan’ bakery, or within (small-scale) producers of ceramics, textiles, or certain forms of reproduction art (such as prints, or even tourist sculptures), many of the same concepts

still apply. Artisans, worked for local clientele, which were a small, but fairly stable group, that were bound to them personally (Landes, 2003).

Later and concurrently with artisans, individuals or grouped of artisans formed *guilds*, which formed in the small villages or towns, that were developing outside of the reign of the feudal manors. It was the guilds that utilised new forms of water and wind energies to produce economies of scale production systems (Rifkin, 2014), and provided services and products, such as glaziers, masons, expert armorers and metalworkers, fine weavers and dyers, often for the manors (Heilbroner et al., 2012). The guilds were a form of union, not of workers, but of guildmasters made up of independent artisans (craftsman), which still worked in their home, but where the rules of wages, working conditions, training process, specifications of output, and civic duties were all discussed (Heilbroner et al., date). The purpose of the guild was not to make money, rather to maintain a certain market, reducing monopoly and competition, and risk in a society where money was rare (Heilbroner et al., 2012). Guildsmen also sought to exclude goods, previously produced in the household, from the market, which pushed many women out of productive work (Meagher, 2011). By the late seventeenth century, in urban Europe, women's productive work became confined to mainly textile, clothes trades, retailing and domestic services; whilst the privileges (and trappings) of artisan work, became the exclusive domain of skilled makes (Meagher, 2011).

Subsequently and concurrently - and in competition to - independent artisans and guilds, was the development of soft-proto beginnings of capitalism, in the form of *mercantilism*. Merchants began to bypass the guilds in the urban areas and give work to the cheaper labour force in the rural countryside – the so-called ‘putting-out’ system (Rifkin, 2014). Here, peasants, keen to add to the meagre income from the land, worked in the off-season, and engaged the women and children in the tasks (Landes, 2003). In this relationship, the merchants began to supply the ‘means of production’ – often the looms, either by sale or by leasing, and by which changed the course of history for ever (Rifkin, 2014). Merchants also often supplied the raw materials, and understood the volume and quality, demanded by his customers (Polanyi, 1944). If supplies failed, it was the cottager that suffered, as the merchant could spread his risk across different suppliers (Polanyi, 1944); and cottagers usually had to borrow from the merchant after lean times, which if persistent could end in a treadmill of debt, with his finished work already mortgaged to advance his creditor

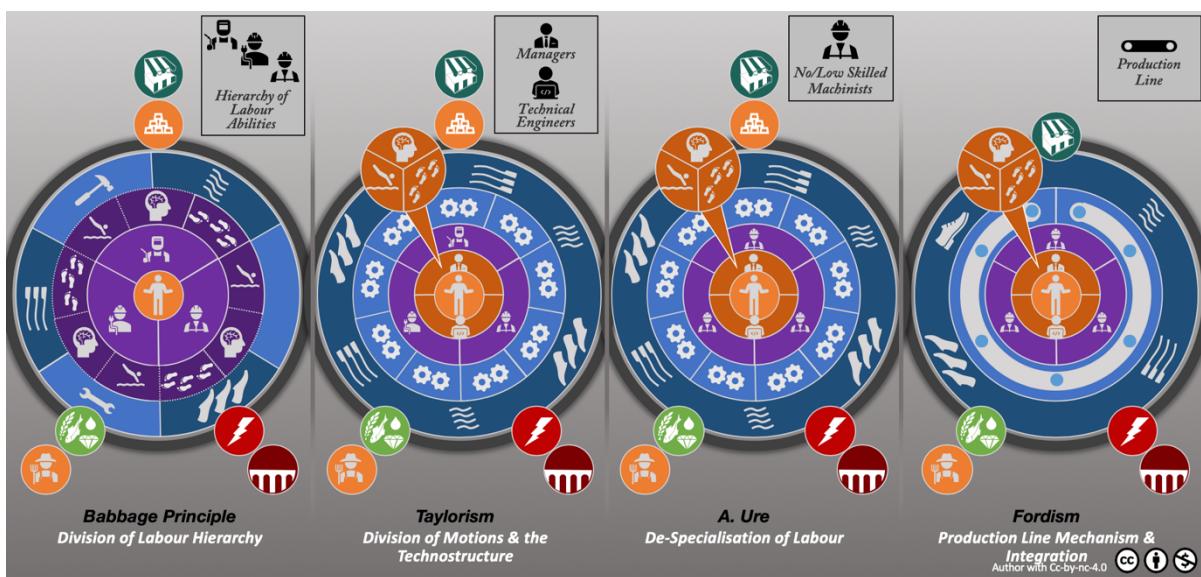


Figure 5. The Economic Study and Application of the Division of Labour (Author, 2019)

(Landes, 2003). His work was no longer sufficient to support the family, he was now in fact a 'proletarian' – selling not a commodity, but his labour (Landes, 2003).

Following on, and also concurrently, and often in competition to the artisans (or cottages), guilds and merchants, in the late 16th century came a new generation of small factories (Rifkin, 2014). In contrast to putting out, where the mercantilist was primarily a seller – within markets or *dispersed* small-scale producers, looking for arbitrage opportunities, the factory owner (or 'capitalist') placed the focus on making things (Landes, 2003), and controlling the operations at will. The factory, which built on the relative power of water and wind to bring many powered machines under one roof, the processes of 'mass production' and 'standardisation' increased in intensity. The factory owner owned the means of production, and the workers become the 'hand' (the term is significant as the 'head' becomes the capitalist); and a relationship of wages, creates a new relationship of supervision and discipline (Landes, 2003). However, the 'hands' still were highly skilled, at these early stages (ref).

Now to Figure 5. And Adam Smith's famous pin factory:

"One man draws out the wire, another straightens it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head; to make the head requires two or three distinct operations; to put it on, is a peculiar business, to whiten the pins is another; it is even a trade by itself to put them into the paper; and the important business of making a pin is, in this manner, divided into about eighteen distinct operations, which, in some manufactories, are all performed by distinct hands, though in others the same man will sometimes perform two or three of them."
(Smith, 1976)

Adam Smith, although he missed the concept of managerial planning, he described in this famous passage, the initial and most known application of the division of labour. However, it goes on to develop far more than this. As can be seen in the first image in Figure 5 (to the left), it was in his book '*On the Economy of Machinery and Manufacturers*' (1832), that Charles Babbage, in his book built on this observation for Gioia (described in the next section) and identified the key benefits of his evolved form of the division of labour:

"That the master manufacturer, by dividing the work to be performed into different processes each requires different degrees of skill and force, can purchase exactly that precise quantity necessary for each process; whereas, if the entire work is executed by one workman, that person must possess sufficient skill to perform the most difficult, and sufficient strength to carry out the most laborious of the operations into which art is divided." (Babbage, 1832)

To underline the concept, Babbage used this simple example of the famous pin factory:

Drawing Wire	Man	3s. 3d. per day
Straightening wire	Woman	1s. 0d.
	Girl	0s. 6d
Pointing	Man	5s. 3d.
Twisting and cutting heads	Boy	0s. 4 1/2 d.
	Man	5s. 4 1/2 d.
Heading	Women	1s. 3d.
Tinning or whitening	Man	6s. 0d.

Papering	Woman	3s. 0d.
	Woman	1s. 6d.

As can be seen in the previous table, if a single craftsman is able to do all the operations listed above and was payed exactly the highest wage of the highest paid worker, they would earn 5s. 4 .5d. per day. The labour cost would be, therefore be more than double. And importantly, this is the case, even if the single craftsman could produce the *same output* (pins per unit time) as the group of workers above.

And so now, we have a *hierarchy of skills and a hierarchy of pay*. Therefore, whereas Smith highlighted the importance of the division of labour favouring the development of job-specific skills, here we see that jobs at the bottom of the hierarchy actually favour the opposite: low training, low or no skills, or training required, and easy replacement becoming the key proponent. This concept of *non-specialisation*, therefore, can start to be recognised as a further driving principle (Pagano, 1995).

In the second image from the left in Figure 5, A. Ure, in his book 'The Philosophy of Manufactures.' written in 1835 also took Smith's analysis to task in the case of mechanisation, as another part of the story. Ure proposed that work that required 'skills' where actually a burden to the process:

"On the contrary, wherever a process requires particular dexterity and steadiness of hand, it is withdrawn as soon as possible from the 'cunning' workman who is prone to many kinds of irregularities, and it is placed in charge of a particular mechanism, so self-regulating that a child could supervise it." (Ure, 1835, p.19)

And Ure went on to highlight that potentially, the higher the skill of the worker, the:

"...more self-willed and intractable he is apt to become and, of course, the less fit for being a component of a mechanical system where, by occasional irregularities, he can do great damage to the whole." (Ure, 1835, p.20)

And so, with these different dynamics involved, the upward trend of *non-specialism* up the hierarchy of skilled workers, moves up until in some manufacturing facilities there is no hierarchy except for a minimal number of shop floor managers, and all jobs have become the same *non-skill level*. This makes it possible for all worker to rotate workers around the shop-floor. Rotation helps reduce boredom (and therefore mistakes) and too much repeat actions (down-time in injuries). And it is here, perhaps that Smith foresaw beyond the others, potential negative effects on workers, in his fifth book of the Wealth of Nations:

"The man whose life is spent in performing a few simple operations of which the effects upon one are, perhaps always the same, or at least very nearly the same, has no occasion to exert his understanding or exercise his inventiveness for discovering expedients for removing difficulties which never occur. Therefore, he naturally loses the habit of such exertion, and generally becomes as stupid and ignorant as it is possible for a human creature to become. The torpor of his mind renders him not only incapable of relishing or bearing a point in any rational conversation, but also of conceiving any generous, noble or tender sentiments, and consequently of forming any just judgement concerning many of even the most ordinary duties of private life." (Smith, 1976)

The following part of this section will go on to discuss Taylorism, and Fordism – including some of the trends for reintegration by companies like Tesla. And then onto the rise of the gig economy, the sharing economy (which is related to the gig economy).

Inspiration from Living Systems

This second section looks at some different structures, process and patterns (Capra, 1996) within living through the same five themes as in human made institutional systems of production. Within this working paper only *operations* are discussed, again for brevity, and as an example, of how the other themes can be addressed.

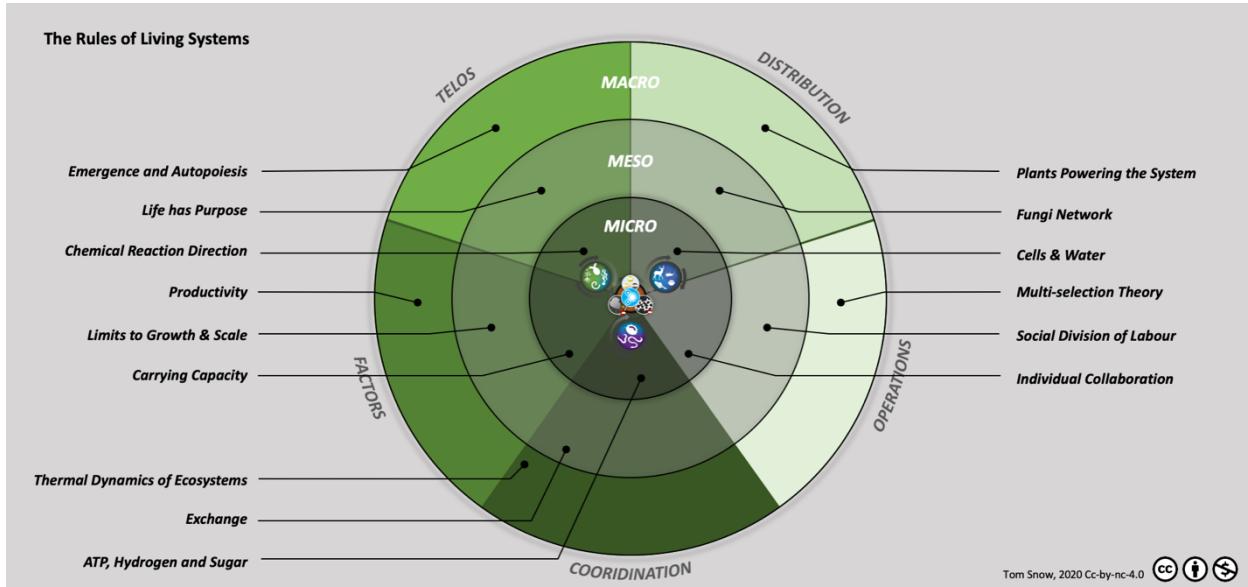


Figure 6. Nested Rules of Living Systems (Author, 2020)

Operations

This section briefly looks at some of the ways in which living organisms organise and divide up the task required for their own survival. How do organisms and groups operate with each other? Is it all about competition and survival of the ‘fittest’ individual? Or cheaters win?

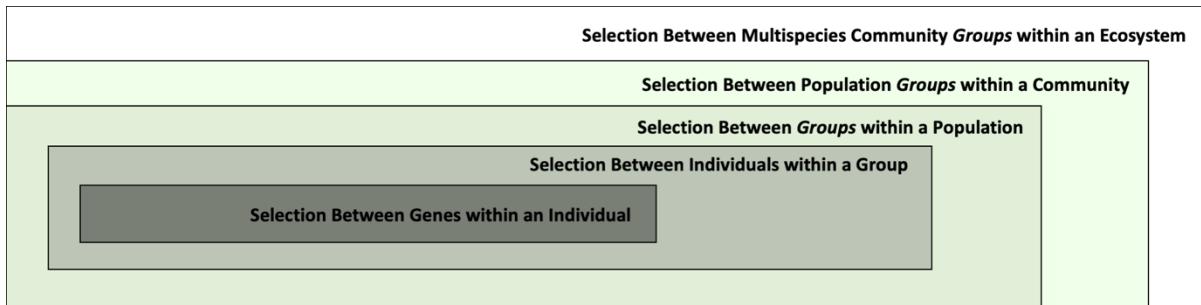


Figure 7. Multilevel Selection Theory. Adapted from Wilson et al., (2008)

Macro:

“Competing is intense among humans, and within a group, selfish individuals always win. But in contests between groups, groups of altruists always beat groups of selfish individuals.” (Wilson, 2012)

The Multilevel Selection Theory describes a hierarchy of evolutionary processes which are organised within nested wholes (Sloan Wilson et al., 2008). At the centre, is a single organism, where there is selection between genes within an individual; at the next level there is selection that acts upon the relative fitness of the individual; and at the higher level, there is selection that acts upon groups within a population, so on. It is important to underline that between-group selection is occasionally a weak evolutionary force – and sometimes a very strong evolutionary force – depending on the case being looked at (Sloan Wilson et al., 2008); and that adaptation at any level tends to be destabilised by selection at a lower level.

Group level selection can be best explained through the chicken and egg laboratory experiment (Sloan Wilson et al., 2008). Here hens were kept in groups within cages, and two kinds of selection for egg productivity was made. In the first experiment, the individual with the highest production of eggs, within each group (cage) was selected to breed the next generation. In this case, the most productive hen achieved her productivity essentially by bullying the other hens. After repeating the selection process over six generations, a hyper-aggressive strain had emerged, which resulted in a nosedive in total productivity. In the second experiment, the *group* with the highest *collective* production of eggs were all selected to breed the next generation of chickens. This was done repeatedly over six generations. The result was a docile strain of chickens with egg productivity increase of 160% over the six generations. This is an example of ‘between-group selection.’

A third, and unintentional version of this experiment seems to show that ‘ecosystem-level selection’ is also possible. This is where a selection of strains of yeasts and bacteria that are used to produce *kefir* (a yogurt-like drink) is selected for its taste and health benefits over other (Sloan Wilson et al., 2008). Not only does the process select a multi-species microbial community, but the community has evolved to aggregate into clusters, all held together by a sugary matrix – which makes it possible to move it across batches as one single ‘unit.’

These insights can have vast insights for human organisations. Some more obvious ones can be direct analogies – such as ‘picking for winners’ (e.g. see ‘stack ranking’) – when we do this, do we create groups of dysfunctional socio-paths? Is it better to nurture collaborative groups over time – with individuals learning over time?

Also, looking back to the foragers example in the previous human section – these groups were fiercely egalitarian, and succeeded, primarily through teamwork.

And the important point that productivity as a time element which is often not taken into account. For example, an operations design might design for optimum process for the lowest unit cost. But then over time, the system might not be able to be upgraded (as technology changes over time) and outputs and inputs can change over time. How does the production system adapt and be dynamically productive?



Figure 8. Cooperation between individuals of equal kind (left: ladymacbeth, date; right: reginal, date)

The latter example of group level selection is a key principle of eco-engineer John Todd, that often fills toxic degrading systems with a vast array of different microorganisms and leaves the system to select for the most effective composition (Todd, 2019).

Meso: At the meso level, there can be patterns of collaboration between individuals (of similar types) within a group.

According to Pagano (1985), Adam Smith "...confines the division of labour to human beings, because he believes that animals never engage in exchange" (Pagano, 1985). Pagano suggests that Smith believed this, as he alleged that the division-of-labour is only coordinated by the *means of exchange* (Pagano, 1985). And as he saw no form of exchange anywhere in nature, then Smith believed that the division of labour was a purely human attribute. Mechiorre Gioia (Gioja), however, reasoned in his book '*Nuovo Prospetto delle scienze Economiche*' (1815), that both of these assumptions were wrong, and that the division of labour does exist in the *animal* world (and in all other Kingdoms of life), and it doesn't rely on exchange - and neither does it (solely) in human societies.

In nature Gioia brings attention to cranes flying in a 'V' formation. Here, it is believed that the vee-form helps to equally distribute the drag across the group (not necessarily making the lead bird position the most strenuous) and can increase the range of a single bird by around 70% (Lissaman et al., 1970). Gioia also highlights another advantage of association for cranes, who are able to group together tightly in high winds, helping them to maintain a steady course. This second example is different to the first, in that a single crane may not be able to achieve this objective on their own (association makes it possible), whereas in the first example they are able to fly alone (need source). And so, these forms of divisions of labour can be looked at (at least in these cases) as *advantages of association*.

From this, and other insights into nature and human production activities, Gioia developed a statistical concept, that stated that when labour of *qualitatively equal types*, work together, there is an increase in efficiency: synthesised by Pagano (1985):

"...each person who cooperates in production with $n-1$ people would obtain much less than $1/n$ of the desired effect if he decided to work alone; alternatively, he would have to put in much more than n times the same effort if he wanted to obtain the same result alone."

For anyone that has moved to a new house, helped by a group of friends or family for instance, knows this instinctively. This is more spontaneous and instinctive, and is less planned, and more about iterative change whilst in the action.

At the *meso level*, *patterns of social division of labour* between organisms within a group can also be used as inspiration.

Eusocial animals, such as wasps, bees, ants and termites, have '*strength in numbers*,' in which larger groups often defeat smaller armies for instance (Claessen et al., 2016); or a large pride of lions can overpower larger prey, or a larger group of starlings can allude the hawk.

And so, it can also be seen, that the division of labour also compels "...confederations or union of various energies, intelligences, and powers on behalf of common production." (List, 1909). Another benefit of association (making larger groups) is the ability of groups to segregate tasks, which

allows the diversification of coordinated individuals or sub-groups, that specialise in different activities (Claessen et al., 2016). The Eusocial insects, previously mentioned, epitomise this, which in the case of leaf cutter ants, where there can be a populations into the millions, have ‘farmers’ tending to the fungal crops, ‘child carers’ that rear the progeny, ‘defenders’ that protect the nest, and ‘foragers’ that gather biomass, such as leaves (Wilson, 1980).

A honeybee colony has evolved to evaluate potential nest site during the swarming phase of its live cycle, with the higher-quality nest sites attracting more scouts, which leads to a decision to select one nest site over another. This is compared to an example within a rhesus monkey. (Sloan Wilson et al., 2008)

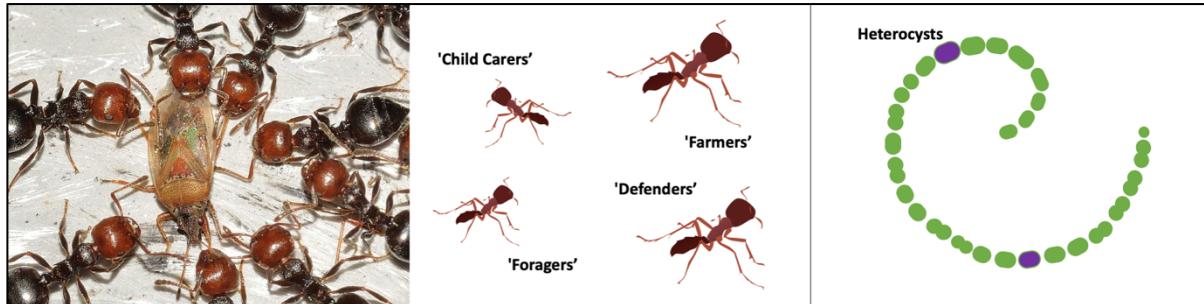


Figure 9. Strength in Numbers (left); Social Division of Labour (centre & right)

In *filamentous* (single cells, connecting as threads) species of cyanobacteria (such as *Anabaena* spp), which are both photosynthetic and able to fix atmospheric nitrogen, have segregated the two tasks between different cells in the chain (the specialised nitrogen fixing cells are called *heterocysts* and are unable to reproduce), due to their chemical incompatibility (Claessen et al., 2016).

Many bacteria (single cell organisms) also divide tasks within colonies (Claessen et al., 2016); this can include the collective development of biofilms ('*cities for the microbes*'), and as is the case with Myxobacteria (*Myxococcus xanthus*) hunt in groups and coordinate their secretions of metabolic enzymes (Claessen et al., 2016).

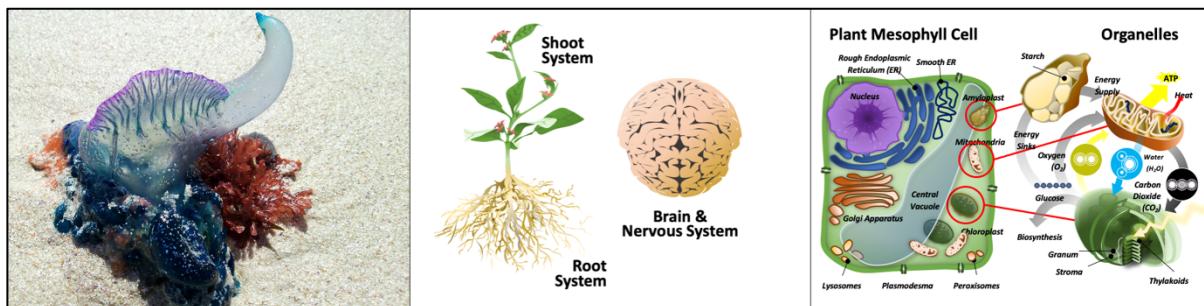


Figure 10. Portuguese man-of-war (photo: leeshypooh, 2013); organs and organelles (Author, 2019)

Micro: At the micro level, collaboration between ‘polyps’, organs and organelles within individuals can be used as inspiration. How can there be collaboration *within* an individual – it seems an oxymoron? Nature is full of individuals made up of assemblages of other individuals (see holobiont).

For example, a *siphonophore*, is a ‘colony’ made up of individuals with specialised forms and/or functions (Sloan Wilson et al., 2008). One well known example is the Portuguese man-of-war – which is not a jellyfish, it is not even an ‘it’ – it is a ‘they.’ An *animal* that is made up of a colony of

different individual members. Comprising four different ‘polyps’: one is a gas-filled bladder (which makes a sail); one forms the tentacles that sting (protect and kill prey); one forms the digestive organs; and the fourth contains the reproductive organisms. In this way, organisms become *organs*, and in this case, the division of labour and functional attributes (or traits) of these siphonophore colonies “evolve by virtue of between colony selection.”

Multicellular organisms such as plants, fungi, and animals have developed distinct cells, tissues, and organs that have specific (and often multiple) functions within the *same* organism. In plants, this can include shoot and root systems in plants, leaves and stems as component organs with their distinct (and often multiple) functions.

In short, what started out as cooperation between separate bacteria ended in the creation of *one indivisible cell*, illustrating a general principle made by theoretical biologist David Sloan Wilson, that: “Sometimes, social groups become so functionally integrated that they become higher-level organisms in their own right.” (cited in Brown, 2003)

Certain animals (particularly eusocial insects) have indeed evolved complex forms of division of labour; however, the division of labour has a ‘mirror image’ (in nature and human society): which can be termed the ‘*aggregation of complimentary functions*.’ And through this lens, nature has also evolved these complementary dynamics at the cellular level with endosymbiosis, at the level of ecological communities through symbiosis between different species, and at the level of ecosystems through the integration of ecological functional groups.

However, these now classical examples of ants, are far from the only examples of segregation of tasks and functions in nature.

New Rules for Production

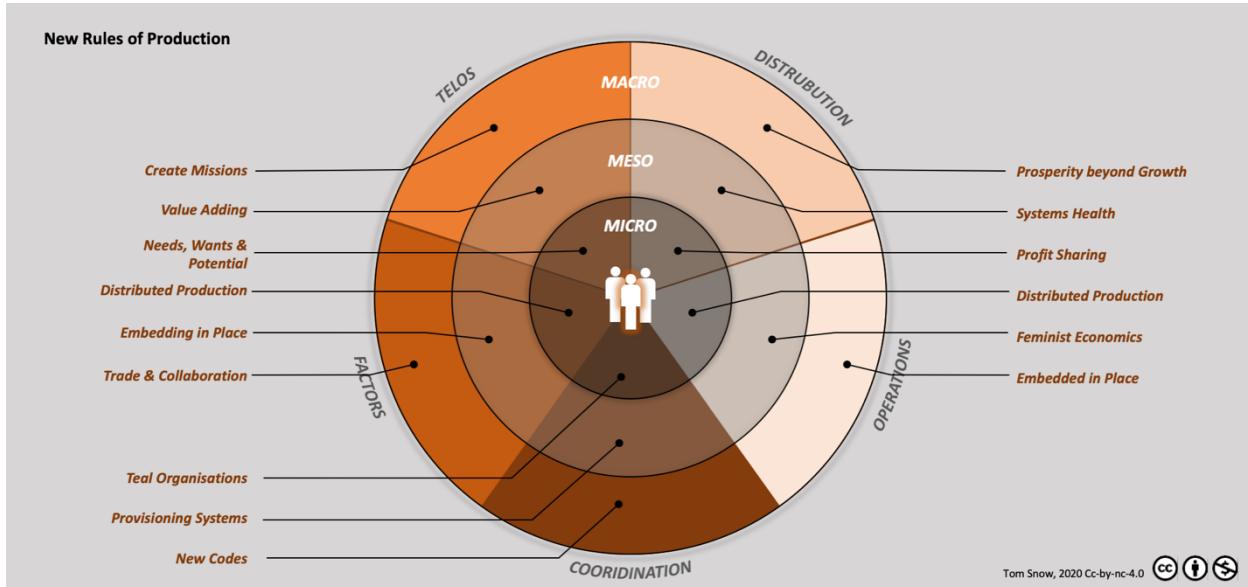


Figure 11. New Institutional Rules for Production (Author, 2020)

This third and final section looks at some of the ‘new rules’, inspired both by the living systems discussed in the previous section, and by new and innovative intuitions and rules that exist around the world on the margins.

Telos

Macro: According to Nicolas Georgescu-Roegen, the originator of '*bioeconomics*,' the ultimate goal of the economy is *not* to produce and consume goods and services, but instead, to reproduce and improve – regenerate – the system of processes that are required to produce and to consume goods and services (Giampietro et al., 2014). This shifts the focus away from the mainstream economic focus on the '*flow elements*' (Georgescu-Roegen) – similar to Aristotle's concept of '*chrematistics*,' where the focus is on inputs consumed, and outputs produced (e.g. goods, food, energy, minerals, biomass, water or wastes), which are measured in monetary values or prices (gain); to a focus on the production factors, such as human beings, rules and institutions, which is closer to Aristotle's '*oeconomia*' – or '*fund elements*' in the parlance of Georgescu-Roegen. This focus on *oeconomia* or fund elements is also seen within '*substantive economics*' (in substance and in the concrete), which "...centres on how human beings organize and allocate the pursuit of the things needed to sustain human life" (Block et al., 2014); popularized, on the margins, by political economists such as Karl W. Kapp (1910-1976) and Karl Polanyi (1886-1964).

The economist Mariana Mazzucato (2013) argues that governments should help define a goal (a telos) such as that boldly announced in a speech by President John Kennedy in 1962:

"We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organise and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win, and the others, too."

In this case, the goal was announced, the means of the government (e.g. legislations, institutions, budgets, and strategies) were made available, with the prospect that the state and its people would respond and reach the ends; whilst also serving those *implicit* ends (or hidden ends) – such as the importance of rocket research to military dominance, and the Cold War between the US (and capitalism) and the Soviet Union (and communism) (Kolbe, 2017).

This example underlines the point, that there can be multiple 'ends,' which may or may not be explicit, and having clear ends does not mean that this makes actions morally right, and without direct or indirect consequences locally or abroad. And it does not guarantee that anything will be achieved - the moon-shot example is often used because it was deemed a success (explicitly and implicitly) in reaching the ends set out seven years earlier; however, one can find many such speeches defining goals, which were not achieved.

With this in mind, clear goals do have risks; however, '*lesser-faire*,' which seems to be the business-as-usual alternative, appears to be decidedly inadequate for the social, environmental and economic realities of our time (or probably of any time).

It is important to underline that when a state defines a 'mission,' it is really creating a story – a vision for a potential future: it is not a dictatorship. As economist Ha-Joon Chang (2009) underlines, this does not mean that governments are 'all-knowing' or smarter than private firms (or markets) – the point is that the state (should) have the benefit of the national and long-term view, as opposed to a sector-based and shorter-term view of organisations; and therefore can be better placed to support the definition of a state level regional strategy.

Meso: Carol Sanford (2011) also brings the topic of value back down to the scale of an organisation, with her *differentiation* between ‘value added’ and ‘value adding.’ To her, value added, is focused on narrow financial objectives, such as increasing profit margin, and refinement of the material processes (and inherently *extractive*); and value adding, is derived from the use of a material and process (not from the making of it) – and she highlights that a craftsman, inherently understands, thanks to direct contact with their customers, the values that they are adding to their customers lives.

Micro: Thorstein Veblen (1857-1929) the American economist asserted that ‘wants’ are manifested in unnecessary things, such as symbols – giving examples of cats, dogs, and sports. With this “conspicuous consumption” Veblen (1994) suggested that the purpose of these ‘symbols’ was to impress or intimidate; with his particular concern on the use of *material* means for psychological ends – particularly if those ends are thought to be related to social status.

‘Needs,’ on the other hand can be described as the universal preconditions for effective participation in any form of social life (Pettifor, 2019). Economist Ian Gough (2017), has developed a list of (basic or fundamental) human needs, which he proposes are not morally neutral, and imply ethical obligations (at the individual and state level), as: adequate, nutritious food and water; protective housing; non-hazardous physical and work environments; security in childhood; physical security; economic security; safe birth control and child-bearing; and basic education. He further argues that for a society to be able to provide for these needs, societies need freedoms to satisfy needs, from oppression, and of political expression. (Also see Neef, 1989 for another example of a human need frameworks).

Mahatma Gandhi said that “...Earth provides enough to satisfy every man’s need, but not for every man’s greed.” (cited in Schumacher, 1973). And Kenneth Galbraith put much of the responsibility for the perpetual growth in wants to *industry* – which he purported, created the desires along with the goods and services to satisfy them (Galbraith, 1985).

Economist Gunter Pauli (2010), proposes that the ‘Blue Economy’ is an economy that focuses on innovations that build social capital that “...meet our basic needs with what we have.” He also proposes that all life is able to satisfy its “...basic needs for water, food, shelter, health and energy...” and that, these same basic needs can be the starting point for developing new local systems of production – with the ‘end’ is answering to these needs.

The benefit with starting with local needs, from an economic perspective, is that it identifies *existing* markets (and therefore proven and measurable in size); if this is currently being supplied by external regions, then this existing market can become a potential market for a new local production system to take root. Local systems of production can have a number of benefits, including developing local jobs, lower transport kilometres, they can create local connections and bonding, and a local ‘economic multiplier effect,’ whereby local activities require and promote the creation of new local services, increasing local activities and flows of financial capital and tax revenues.

Economist Kate Raworth (2019) has developed a range of models, one being the ‘*Doughnut Diagram*’ which places the ‘social foundations’ (needs) at the base, and an ‘ecological ceiling’ (based on ‘planetary boundaries,’ see Rockström, 2009) at the top. A form of telos is stated, by defining that the goal of our economy, is to provide for our needs within these *system boundaries*. In this case the telos is large, and highly flexible (it doesn’t say ‘how’) whilst being clear; and it highlights the importance of setting boundaries when defining goals.

Is the goal of people and society, therefore, to focus on needs, set boundaries, *and* cast-off all wants? Just as Henry David Thoreau (1817-1862), who practiced a rigid rejection to 'wants' - which he claimed can lead to the road of enlightenment (Thoreau, 2009).

However compelling this may seem, 'not so fast' - suggests, economist David Fleming (2016). Artefacts have a significance which extends beyond their functions as instruments for a practical purpose. And arguably our modern *disposable* society is less materialistic than those of traditional societies (Fleming, 2016). The *implicit* functions of goods (some of those abhorred by Veblen) - the symbolism of particular loyalties, obligations, tastes, character and belonging, can all be important parts of a nonverbal medium for human communication of nuance and meaning and expression (Douglas et al., 1979). Furthermore, Fleming argues that it is often our *wants* that are sacrificed - time for play, festival, joy, to relax, read novels, decoration, make artefacts; which is replaced by our personal needs to work long hours (putting-aside our wants), and societies needs for larger and larger complex infrastructures to support our reduced community/region -resilient lifestyles and large police forces for example (Fleming, 2016) - that we may not actually *want*.

Carol Sanford (2016) goes further and suggests that when developing goods or services (for example), we should also avert our gaze away from wants. By performing surveys and asking people what they want (for example) risks to stay within the existing paradigm, searching for improvements without changing any of the underlining causes. It also stays within the context of what isn't working, and what isn't sufficient - which all other companies will already or similarly be focusing on. Instead, she suggests, that we should focus on what social groups are trying to *achieve* and why. She underlines that the focus should be squarely on the 'highest' *intentions* of the social (living) system.

Conclusions



Figure 12. Positioning this paper within the context of other views of the systems of production (human material and energy production systems in the middle, and living systems at the base)

This work has evolved through a progression of research and development of frameworks looking at living systems, and how human systems of production can potentially integrate (work with and within) living systems. The limits of only focusing on material and energy flows, is one can forget (or ignore) that these are fundamental systems, managed and made by *people*, and are central to supplying peoples material needs, whilst often creating purpose and meaning; and are often at the heart of modern economic life, and politics.

Within previous papers, discussions around ecosystems and production systems, and biology, chemistry and physics, has meant that to a large extent, the political or ideological concepts have been (to some extent) avoided - although even here, world views also often frame our way of viewing nature – from anthropocentrism, and life like machines. Conversely, very quickly, when researching this work, and in discussion with teachers and practitioners, this is obviously not the case within social economic systems – economics *is* politics (hence its early name ‘political economy’) and why it *is* a social science (not a ‘natural science’). However, as a small point here, although there is much valid criticism from heterodox economists that orthodox economists suffer from ‘physics envy,’ often attempting to display economics as if it was Newtonian physics (ref); some integration of physics – particularly the understanding of *thermal dynamics* (as is the case in ecological economics), and ecology, would seem clearly beneficial (if not a necessity).

After taking a micro-economics ‘101’ course in the London School of Economics (LSE), this paper grew out of a frustration of what *wasn’t* taught – rather than what was (nearly nothing learnt within the course is in this paper). For example, the ‘black-box’ of *production* – one of the central ‘means’ of the micro-economy, was virtually not discussed; whilst the ‘ends’ – the markets - were the primary focus.

Additionally, due to much ideological skewing of economics during the cold war of capitalism vs. communism, industrial development, and governments role in it, was also pushed out of fashion, as it sat too close to concepts of central planning (ref). As such, it has been the work of many heterodox (often institutional) economists that have retained the long history of economic knowledge around production and economic policy (ref).

Whilst researching and supporting start-ups, and progressively approaching regions, in their development of regenerative systems of production, it has been clear that ‘institutional literacy’ is a fundamental part of the work of systems design. On the one side, those financing projects want to know the economic benefits of the project – which may not be so simply as existing linear systems to calculate, to organise, and explain. Whilst start-ups need to understand and figure out how to operate (with or without investors) often in new ways, to be able to survive economically in traditional market economies, where competition is the ‘modus operandi’ and a bias towards economies of scale, make their potential alternatives difficult to match in price.

Equally some may berate low levels of entrepreneurship in Europe (ref), or for spending too much time making business plans, and researching (ref) – and not (therefore) ‘*doing*'; however, when the European economy (or other, so-called ‘developed’ countries) require such high levels of minimum income to makes ends-meet, these are not actions that can be made lightly. And therefore, building up new, and often *unproven* business models from scratch, whilst working part-time or full-time and/or with family commitments (or having to put off family commitments), can be too much for some (again, one’s own experience with some entrepreneurs).

The hope with this paper, is to continue to support the deepening of knowledge and debate around these topics and increase the speed and potential for change to take place.

Bibliography

- Babbage C. (1832) *On the Economics of Machines and Manufactures*. London, UK: Charles Knight.
- Belloc, F and Pagano, U (2012) *Knowledge Enclosures, Forced Specialization and Investment Crisis*. European Journal of Comparative Economics, vol. 9, no. 3, 445–83
- Bistagnino, Luigi (2011) *Systemic Design: Designing the Productive and Environmental Sustainability*. Italy: Slow Food® Editore srl.
- Bistagnino, Luigi (2017) 2.3 Systemic Design: Methodology and Principles. Barbero, Silvia (eds). *Systemic Design Method Guide for Policymaking: A Circular Europe on the Way*. Volume 1. Retrace, Interreg Europe. Turin, Italy: Umberto Allemandi
- Block, Fred and Somers, Margaret R. (2014) *The Powers of Market Fundamentalism: Karl Polanyi's Critique*. USA: Harvard University Press
- Boehm, Christopher (2001 revised edition) *Hierarchy in the Forest: The Evolution of Egalitarian Behavior*. USA: Harvard University Press.
- Braverman H. (1998) *Labor and Monopoly Capital*. New York, USA: Monthly Review Press.
- Brewer, Anthony (March 2008) *Adam Smith's Stages of History*. Discussion Paper No.08/601. Bristol UK: Department of Economics, University of Bristol.
- Brown, Andrew (July 24, 2003) *Interview: I wanted to Show How Niceness Evolves*. The Guardian. Retrieved 19 January 2020:
<https://www.theguardian.com/science/2003/jul/24/scienceinterviews.research>
- Cecchetti, Stephen G and Kharroubi, Enisse (February 12, 2015) *Why Does Financial Sector Growth Crowd Out Real Economic Growth?* BIS Working Papers. No 490.
<https://www.bis.org/publ/work490.htm>
- Chang, Ha-Joon. (22-24 June 2009) *Industrial Policy: Can We Go Beyond an Unproductive Confrontation?* A Plenary Paper for ABCDE (Annual World Bank Conference on Development Economics) Seoul, South Korea.
- Claessen, Dennis., Rozen, Daniel E. and Zhang, Zheren. (2016 December 21) *Understanding Microbial Divisions of Labor*. *Frontiers in Microbiology*. Review, Volume 7, Article 2070. doi: 10.3389/fmicb.2016.02070
- Collier, Sir Paul (22 June 2015) *Understanding Economic Development*. Public Lectures and Events: podcasts and videos, LSE, London. Retrieved 19 January 2020: <http://www.lse.ac.uk/lse-player?id=3144>
- Daly, Herman (2019) *Growthism: Its Ecological, Economic and Ethical Limits*. Real-World Economics Review, issue no. 87, 19 March, pp. 9-22,
<http://www.paecon.net/PAEReview/issue87/Daly87.pdf>
- Diamond, Jared (1997) *Guns, Germs, and Steel: The Fates of Human Societies*. New York. USA: Norton.
- du Plessis, C. (2012) *Towards a Regenerative Paradigm for the Built Environment*. Building Research & Information, 40(1), 7-22.
- Douglas, Mary and Isherwood, Baron (1979) *The World of Goods*. New York, USA: Basic Books Inc.
- Encyclopædia Britannica (n.d.) *Factors of Production*. Economics. Retrieved 19 January 2020 from <https://www.britannica.com/topic/factors-of-production>
- Fleming, David (2016) *Surviving the Future: Culture, Carnival and Capital in the Aftermath of the Market Economy*. Selected and Edited by Shaun Chamberlin. White River Junction, Vermont, USA: Chelsea Green Publishing
- Foroohar, Rana (2016) *Makers and Takers: How Wall Street Destroyed Main Street*. New York, USA: Currency
- Foroohar, Rana (2019) *Don't be Evil: How Big Tech Betrayed its Founding Principles – and All of Us*. New York, USA: Currency
- Galbraith, John, Kenneth. (1985 Edition) *The New Industrial State*. 41 William Street, Princeton, New Jersey 08540 USA: Princeton University Press

- Gerber, Julien-Francois (07 June 2016) The Legacy of K. William Kapp.' Development and Change, 47(4), pages 902–917. <https://doi.org/10.1111/dech.12238> The Hague: 2016 International Institute of Social Studies.
- Giampietro, Mario., Aspinall, Richard J., Ramos-Martin, Jesus., and Bikkens, Sandra G. F. (2014) *Resource Accounting for Sustainability Assessment: The Nexus between Energy, Food, Water and Land Use*. Oxon, UK, and New York USA: Earthscan from Routledge
- Gioia (Gioja), Mechiorre (1815-1817) 'Nuovo Prospetto delle scienze Economiche' Milano, Italy: Presso Gio. Pirotta
- Gough, Ian (2017) *Heat, Greed and Human Need: Climate Change, Capitalism and Sustainable Wellbeing*. Cheltenham, UK: Edward Elgar Publishing Ltd
- Harari, Yuval Noah (2014 [2011]) *Sapiens: A Brief History of Humankind*. Random House, London, UK: Harvill Secker
- Heilbroner, Robert L. (1985) *The Nature and Logic of Capitalism*. New York, USA: W.W. Norton & Company.
- Heilbroner, Robert L. & Milberg, William (13th edition, 2012) *The Making of Economic Society*. Upper Saddle River, New Jersey, 07458. USA: Pearson Education, Inc.
- Kaldor, Nicholas (1996) Causes of the Slow Rate of Economic Growth of the United Kingdom: *Mainstream Economics*, p. 225 - 242
- Kolbe, Kerry (26 January, 2017) *Secrets of the Space Race*. UK: The Telegraph. Retrieved, 14/10/2019 <https://www.telegraph.co.uk/films/hidden-figures/the-space-race/>
- Laloux, Frederic (2014) *Reinventing Organizations: A Guide to Creating Organizations Inspired by the Next Stage of Human Consciousness*. Brussels, Belgium: Nelson Parker
- Landes, David S. (2003 Second Edition) *The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present*. UK: Cambridge University Press
- Lissaman, P.B.S., and Shollenberger, Carl A. (1970 May 22) California Institute of Technology, Pasadena. Science, Vol 168, Issue 3934 pp 1003-1005 doi: 10.1126/science.168.3934.1003
- List F. (1909) *The National System of Political Economy*. London, UK: Longmans, Green and Co.
- Madrick, Jeff (2012) *Age of Greed: The Triumph of Finance and the Decline of America, 1970 to the Present*. New York, USA: Vintage Books
- Mang, Pamela and Reed, Bill. (2012) *Designing from Place: A Regenerative Framework and Methodology*. Building Research & Information, 40:1, 23-38, [doi:10.1080/09613218.2012.621341](https://doi.org/10.1080/09613218.2012.621341)
- Mazzucato, Mariana (2018) *The Value of Everything: Making and Taking in the Global Economy*. UK: Allen Lane, an imprint of Penguin Random House Books.
- Meagher, Gabrielle (2011) The Political Economy of Gender. P34-37. *Readings in Political Economy: Economics as a Social Science*. Third Edition. Edited by George Argyrous and Frank Stilwell. Australia: Tilde University Press Limited.
- Milberg, William & Winkler, Deborah (2013) *Outsourcing Economics: Global Value Chains in Capitalist Development*. Cambridge, UK: Cambridge University Press.
- Milanovic, Branko (2019) *Capitalism Alone*. USA: Harvard University Press
- Montgomery, David R. (2017) *Growing a Revolution: Bringing Our Soils Back to Life*. 500 Fifth Avenue, New York, USA: W.W. Norton & Company, Inc.
- Morris, Ian (2002) Hard Surfaces. In Paul Cartedge et al., eds., *Money, Labour and Land: Approaches to the Economics of Ancient Greece*. Pp. 8-43. London, UK: Routledge.
- Morris, Ian (2013) *The Measure of Civilisation: How Social Development Decides the Fate of Nations*. Princeton, NJ, USA: Princeton University Press.
- Morris, Ian (2015) *Foragers, Farmers and Fossil Fuels: How Human Values Evolve*. Princeton, New Jersey 08540 USA: Princeton University Press.

- Morozov, E (2015a) *Silicon Valley Likes to Promise “Digital Socialism” – but it is Selling a Fairy Tale.* UK: The Guardian
- Morozov, E (2015b) *Where Uber and Amazon Rule: Welcome to the World of the Platform.* UK: The Guardian
- Pagano, Ugo (1985) *Work and Welfare in Economic Theory.* Oxford, UK: Basil Blackwell Ltd.
- Pasinetti, (1981) On the Ricardian Theory of Value: A Note. *The Review of Economic Studies*, vol.48, pp. 673–675
- Pauli, Gunter (2010) ZEN and the Art of Blue: How to Connect the Quality of Your Life to the Blue Planet Earth. Berlin, Germany: Konvergenta Publishing
- Piketty, Thomas (2014) *Capital in the 21st Century.* Cambridge, MA, USA: Harvard University Press
- Pinker, Steven (2011) *The Better Angels of Our Nature: Why Violence Has Declined.* New York, USA: Viking
- Polanyi, Karl (1944) *The Great Transformation.* New York, USA: Beacon Press
- Raworth, Kate (2017) *Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist.* UK: Random House Business
- Reinert, Erik S. (2008 [2007]) *How Rich Countries Got Rich ...and Why Poor Countries Stay Poor.* London, UK: Constable & Robinson Ltd.
- Rifkin, Jeremy (2011) *The Third Industrial Revolution: How Lateral Power is Transforming Energy, the Economy, and the World.* USA: Palgrave Macmillan
- Rifkin, Jeremy (2014) *The Zero Marginal Cost Society: The Internet of Things, the Collaborative Commons, and the Eclipse of Capitalism.* New York, USA: Palgrave Macmillan
- Rockström, J., W. Steffen, K. Noone, Å. Persson, F. S. Chapin, III, E. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H. Schellnhuber, B. Nykvist, C. A. De Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P. K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R. W. Corell, V. J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, and J. Foley. (2009) *Planetary Boundaries: Exploring the Safe Operating Space for Humanity.* *Ecology and Society* 14(2): 32. [online] URL: <http://www.ecologyandsociety.org/vol14/iss2/art32/>
- Rodrik, Dani (2011) *The Globalization Paradox.* New York, USA: Norton
- Roncaglia, Alessandro (2006) *The Wealth of Ideas: A History of Economic Thought.* Cambridge, UK: Cambridge University Press.
- Ryan, Alex J. (2014) *A Framework for Systemic Design.* FormAkademisk. Vol.7, Nr.4, 2014, Art. 4, 1-14. <https://doi.org/10.7577/formakademisk.787>
- Samuelson, Paul Anthony & Nordhaus, William D. (19th edition, 2010) *Economics.* New York, USA: McGraw-Hill/Irwin, International Edition.
- Sandel, Michael (2010) *Justice: What’s the Right Thing to do?* UK: Penguin Books
- Sanford, Carol (2011) *The Responsible Business: Reimagining Sustainability and Success.* USA: Josey-Bass
- Sanford, Carol (August 10, 2016) Regenerative Supply: What is Regeneration? Part 3 – Potential. Terra Genesis. Retrieved August 15, 2019 <http://www.terra-genesis.com/tag/carl-sanford>
- Scheidel, Walter and Friesen, Steven (2009) *The Size of the Economy and the Distribution of Income in the Roman Empire.* Journal of Roman Studies 99, pp. 61-91.
- Schumacher, E.F. (1973) *Small is Beautiful.* UK: Blond & Briggs Ltd
- Sloan, Alfred (1990) *My Years with General Motors.* Reissue edition. New York, USA: Doubleday
- Sloan Wilson, D. and Wilson, E.O (2008) Evolution “for the Good of the Group”: The Process Known as Group Selection Was Once Accepted Unthinkingly, Then Was Widely Discredited; It’s Time for a More Discriminating Assessment. *American Scientist* Vol. 96, No. 5 September-October 2008, pp 380-389 (10 pages)
- Smith, Adam (1978 [1776]) *Lectures on Jurisprudence.* ed. R. Meek, D. Raphael, and P. Stein, Oxford, UK: Clarendon Press

- Smith, Adam (2003 [1776]) *The Wealth of Nations: An Inquiry into the Nature and Causes of the Wealth of Nations*.
- Stahel, Walter R (2006) *The Performance Economy*. Hampshire, UK: Palgrave MacMillan.
- Steel, Carolyn (2009) *Hungry City: How Food Shapes Our Lives*. London UK: Vintage Books.
- Stiglitz, Joseph E. (2002) *Globalization and Its Discontents*. New York, USA: Norton
- Thoreau, Henry David (2009) *The Journal 1837-1861*. 8 January 1842 Entry. New York, USA: New York Review Books Classics
- Turner, Adair (2015) *Between Debt and the Devil: Money, Credit, and Fixing Global Finance*. Princeton, NJ, USA: Princeton University Press
- Todd, John (2019) *Healing Earth: An Ecologist's Journey of Innovation and Environmental Stewardship*. Berkeley, California, USA: North Atlantic Books
- Turner, Adair (2015) *Between Debt and the Devil: Money, Credit, and Fixing Global Finance*. Princeton, NJ, USA: Princeton University Press
- Ure, Andrew (1835) *The Philosophy of Manufactures: Or an Exposition of the Scientific Moral and Commercial Economy of the Factory System of Great Britain*. London, UK: Kessinger Legacy Reprints.
- Veblen, Thorstein (1994 [1899]) *The Theory of the Leisure Class*. New Edition. New York, USA: Dover Thrift Editions
- Warring, Marilyn (1988) *If Women Counted: A New Feminist Economics*. San Francisco, USA: Harper & Row
- Wilson, E. O. (1980 July). Caste and Division of Labor in Leaf-Cutter Ants (Hymenoptera: Formicidae: Atta). *Behavioral Ecology and Sociobiology*. Volume 7, Issue 2. Pp 143–156. doi: 10.1007/BF00299520
- Wilson, E.O. (2012) *The Social Conquest of Earth*. USA: Liveright
- Young, Allyn (1928) Increasing Returns and Economic Progress. *The Economic Journal*. Vol. 38, No. 152 (Dec., 1928), pp. 527-542.

Images

- Leeshypooh (Nov. 4 2013 [Oct. 4 2011]) <https://pixabay.com/photos/bluebottle-portuguese-man-o-war-205072/>
- ntrief (Sept 24 2019 [July 3 2019]) <https://pixabay.com/photos/lay-hen-chicken-farm-poultry-4501112/>