

## **Monopoly, the Vivarium and Game Theory: default limitations of simulation models**

*Von Neumann and Morgenstern showed that a wide range of non-zero-sum competition and optimisation scenarios may be reconstrued as zero-sum. This paradigm has had a wide influence in such fields as socio-biology, economics, management, military and political strategy and individual values. Widespread unawareness of the range of interaction perspectives serves to limit our strategic repertoire and miss crucial features of real complex systems.*

To begin by explaining the vocabulary of this talk, a vivarium is about the size of a domestic fish tank, fairly sealable at the top, into which teachers in progressive primary classrooms put a variety of plants and minibeasts to simulate the interactions of nature. After a few days or weeks the only creature left is one very fat spider – which then dies. The similarity with the game of monopoly, allegedly a simulation of capitalism, is pretty obvious. One individual becomes very rich, bankrupts everyone else and therefore has nobody else to play with – and is probably left to do the packing up. All good fun but hardly an elucidation of life or economics.

There are two obvious flaws in both of these efforts at simulation, firstly the poverty of the environment and secondly, as an aspect of this, the very limited ability of the players to “hide” or refuse interaction. Nevertheless the model of forced interaction – which is agreed to in a game and generally assumed in the fields to which games theory is applied - can obviously lead to misleading conclusions.

As cyberneticians we are interested in identifying common or essential properties of large complex systems and rather than identifying individual essences we look for useful notions of paradigms of interaction in order to do this; for example, branching chain reactions, feedback, games theory, information theory, chaos, complexity and network theory notions, 2<sup>nd</sup> order cybernetics and ternary perspectives.

Popular everyday language which people and cultures use to model their interactions uses additional models such as a journey, a dance, story construction, tapestry weaving, chance, Karma and morality to flesh out the notions of co-operation and competition (or the third possibility of parallel monologues like Leibniz’s monads<sup>1</sup>, certain conversations and programmes for change). However certain models dominate in particular cultures. For example popularly and scientifically an explanation of behaviour by virtue of human selfishness is considered more plausible than an explanation grounded in a tendency to altruism.

Cyberneticians are generally aware that von Neuman and Morgenstern<sup>2</sup> in their *Theory of Games and Economic Behaviour* established as their paradigm for interaction the two person, finite zero-sum game and stimulated a research paradigm which sought to reduce as many situations as possible to this framework. This has the intuitive appeal of simplicity. The concept of all-out-war or playing “hardball” is at least as old as Sun Tzu (The Art of War)<sup>3</sup>

or more recently von Clausewitz<sup>4</sup>. In the last chapters of their *oeuvre* von Neumann and Morgenstern seek to reduce non-zero-sum games, where there could be a co-operative product, to zero-sum, on the grounds that either player would prefer to take the whole of the co-operative surplus.

A step away from the party line was established by John Nash<sup>5</sup> in his concept of a stable equilibrium position for players where for any party to change their strategy in the hope of greater gains would in fact lead to a loss\*. – A position midway between the Lockean war of all against all portrayed by simple games theory and the beneficent “invisible hand” of Adam Smith in which the pursuit of selfishness (c. = short term payoffs) gives the greatest possible collective gain (A position refined by Milton Friedman<sup>6</sup> in his critique of socialist and centralist schemes of organisation where restricted information networks lead to a reduced collective product.)

The concept of the “Prisoners’ Dilemma” was formulated as an implicit challenge<sup>7</sup> to the significance of the Nash Equilibrium in that the payoffs for co-operation with, as opposed to dishing the dirt on, one’s collaborator were set to lead to a Lockean rather than a Smithsonian or Panglossian world.

The general position emerged that mutual knowledge of the opponent’s / interactor’s / collaborator’s strategy tended to soften the ferocity of the game strategy, and this strategy might be inferred by the interactor’s previous history of play. It is intuitively plausible that it makes less sense to rip off or exploit someone whom one expects to meet again (or whose associates you might meet).

Hence it should not have been such a surprise when Axelrod<sup>8</sup> set up a competition between a variety of computer programs designed to play the prisoner’s dilemma game according to a varying range of strategies and emerged with the result that the overall winner was the least punitive program, - the one that responded to a deviation from the co-operative strategy with the least ruthless withdrawal of co-operation in turn, known as *tit for tat* or approximately in more ferocious Old Testament terms, *An eye for an eye and a tooth for a tooth*. This strategy was also virtually the simplest but it continued to win against more complex or devious tactics.

Note that even the Axelrod paradigm was one of forced interaction. Clearly where programs could select a subset of the other programs to interact with, and there was some kind of historical input by which they could assess one another’s strategies, it would be in their interests to select the most “altruistic”. And those most selected would have more opportunities to accumulate positive pay-offs. Hence there are scenarios where the softest players can gain the highest rewards.

In one sense this is blindingly obvious: the shopkeeper who sells cheap can expect most customers and probably the greatest overall profit. Although it is worth remembering that in classical economic theory in a perfect market with

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\* However the “co-operative surplus” is still viewed in a similar reduction-to-zero-sum way.

an established product no profit is possible – which at least serves to show the marginal utility of mathematical and logical modelling when the initial axioms do not accord with reality.

The mathematics of games theory cannot yet cope with most long run multiple interactor non-zero-sum games any more than physics can cope with the three body problem. And there is a strong suggestion that, in Stephen Wolfram's terms, many of these situations are *computationally irreducible*<sup>9</sup> – which could imply that the only way to calculate outcomes is by simulation and the simulation might take as long as running the situation in reality, and given sensitive dependence on initial conditions and the randomness associated with uncertain information transmission among the actors a simulation could in any case be a poor predictor of a “real” outcome.

Nevertheless it is appropriate to look at the trajectory of outcomes or best strategies associated with increasingly complex and large-scale interaction situations.

The hypothesis of this talk is that with a large, complex and relatively information rich environment ( $\approx$  many rules or axioms) the payoff for deceit, deviousness and severe aggression diminishes and the payoff for what approximates to a transparent, straightforward co-operative co-evolutionary agenda increases. In other words the overall thrust of morality/ies is an attempt to codify long-term payoffs over the broadest range of scenarios.

It is already fairly well accepted in evolutionary biology that in a society of hawks there is an increasing payoff in being a dove.<sup>10 11</sup> It is more radical to suggest that a large (and potentially overwhelming) majority with “dovish “ game plans could form an evolutionarily stable strategy and that in general with complexity, in the long run, the more intelligent and (when all payoffs are evaluated) self-interested strategy more closely approximates to altruism.

What is perhaps more surprising is that this viewpoint is not canvassed more widely. After all it is in the interest of both hawks and doves to promulgate it for others. (Maybe because of this the opposite looks more “honest”)

While commentators have been drawing spurious lessons from nature at least since the time of Aesop and the Old Testament<sup>12</sup> it is worth considering how the more complex human arena might modify the allegedly, “red in tooth and claw” strategy of nature.

Plausibly humans can retain longer histories and more variegated strategies with a larger number of fellow actors than can dandelions or sharks. However the notion of the game itself is a human invention (albeit with antecedents in animal play) and to work requires adherence to set rules or principles which pre-suppose a mutual reliability constraining the local drama. (i.e. a morality surrounding the ruthlessness) If a game over time is unsatisfactory to one player they will seek to change the rules or leave. If one party appears to be perpetually winning it is probable that other parties are gaining extrinsic benefits of which the winner is unaware. (e.g. a parent or teacher may let an insecure child repeatedly win because they have actually construed the

situation as a one of learning. (reverse ditto losing -The child who “fails” at his/her lessons is placed in a less demanding situation.) An individual may seek martyrdom in order to orchestrate a wider change in perceptions to mobilise a superior opposition to the ostensible ruler.)

Equally fluid in practice is the notion of the pay-off or the scoring system. Staying alive tends to be regarded as the sine qua non of success; however it does not necessarily follow that the death of another party merits an equal number of points. Nevertheless the popular science default message from socio-biology implies that the most successful organism would be one that destroys all near competitors and possibly other life forms and then proceeds to fill the universe with clones of itself. Arguably there is something even more counter-intuitive in this notion of success than the soft arguments of successful strategies which I have been pushing. However the basic circular idea of, “that which replicates itself, replicates itself” is the fundamental driver of such notions as, “the selfish gene<sup>13</sup>,” in which an unjustified notion of agency can be plumbed into that-which-is-the-case.

Hence the link of most game or interaction goals with the existence pay off (i.e. is the goal worth while? the game worth playing?) is highly conjectural and at best is frequently connected only by the perception or presumption either that it is connected, or that enough mugs believe it so, to make it partly true. (You may think the view of most traders that internet companies will make profits is nonsense; nevertheless you will “lose” money in a certain time frame if your betting strategy does not back their evaluations. (nb parallel with certain intellectual and management innovations)) For example cricketers put enormous effort in becoming more able to throw accurately although in a non-hunting society it has no obvious link to survival. Arguably investment in such skill may still increase the player’s reproductive capacity (some women (/men) do watch cricket) however the energy investment required to win in one scenario is frequently inappropriate in the larger context. (cf. negative correlation between winning post-graduate degrees, income and longevity.)

The most obvious illustration of this is in the paradoxes of the “target-setting” scenarios set up in public service utilities where there is no real clear easily measurable summative bottom line. Typically in an unscored situation there are some easily measured correlates of success – treatment waiting time, survival rates, percentage of pupils reaching an exam threshold, attendance levels. And some objectives are less easily measured – overall improvement in health in a fuzzy catchment area, development of more functional personalities, initiative in learning, contribution to future economic achievement.

If simplistically we regard the total product of an organisation as the result of combining (multiplying) four outcomes – two measurable  $m_1$ ,  $m_2$ , and two fuzzy  $f_3$ ,  $f_4$ , then if the organisation has say 40 units of resource or effort to deploy it should deploy them evenly between  $m_1$ ,  $m_2$ ,  $f_3$ ,  $f_4$ , to gain a total product of  $10 \times 10 \times 10 \times 10 = 10,000$  “cost benefits”. If however as the result of targeted performance management linked to organisational funding the managers focus resources on what is measurable, giving say  $m_1$ , and  $m_2$ ,

each 19 units of resource and  $f_3$ , and  $f_4$ , just one unit each, the total product is reduced to  $19 \times 19 \times 1 \times 1 = 361$  "cost benefits".

The link of all this to more general games and decision theory is that typically, outside the threat of immediate destruction, players are involved in, or elect into, playing several games at once and the scoring system is not even equally valued or symmetrical between players. Changing outcomes will change strategies, a football team near relegation will choose a different style to one mid-league. The effort of "winning" in one scenario may reduce the resources available for survival in another. Winning as well as losing can be costly. The degree to which winning in one scenario impacts on a wider ecology or environment depends on the communications structure of individuals of that wider environment within which the game is played. In other words the more individuals who can be attracted into "evaluating" the game the greater the extrinsic positive and negative payoffs for the core players (and in some cases the more unstable) as the larger field evolves its own payoff criteria.

The degree of "extrinsic" evaluation of play will also moderate the optimal player strategies, for example by increasing the downside for more "selfish" strategies (although a "hard" reputation can have local payoffs).

Effectively mid-way between individual (economically) "rational" calculations and those modified by the external audience or rule setters are the so called "irrational" "emotional" strategies developed by players which are the bane of economic theorists, psychotherapists, teachers and spouses. The prime example given by the Dramatec<sup>14</sup> group who have developed this is of two economists who expecting to be overcharged by a taxi-driver agreed not to negotiate their fare until the end of the journey when his position would be weakened by having delivered the goods. When the inevitable dispute arose the angry taxi-driver locked the doors and drove them back to the starting point, irrationally losing his fare but perhaps rationally boosting the longer term income prospects of taxi-drivers relative to economists as the story percolated.

My admiration for a relative of mine was similarly boosted when with a rolling up loan which had started at £50K she decided to sell her house close to the bottom of the early 1990s slump in house prices. Despite having a few respectable offers at the then market rates, her debt rolling up at compound interest and even the advice of her children she refused to sell on the grounds that the various prospective buyers were not the right sort of person for the house, so that the estate agents threatened to walk away and warned prospective purchasers before-hand. Eventually a couple of potential buyers appeared who were prepared to engage in her rather fuzzy additional game and began to court her; this started a bidding war which steadily moved the offers up by £200K, over eighty percent from the original – at which point she accepted.

You may recall a more conscious attempt to transcend conventional rationality in the Nixon era when the policy of Mutually Assured Destruction was shored up by Washington spreading dis-information to the USSR that Nixon really

was mad enough to start a nuclear war for minor slights – effectively the game of “chicken”. (It may be worth noting that some theorists have explained the emotional “irrationality” of love as functioning to bridge from negative short-term payoffs to potentially positive long term ones.) Most recently capuchin monkeys appear to have used emotion to induce “fair play” in refusing “deals” which provide a “rational” pay-off in simple game theory but would breach conventional human ideas of justice.<sup>15</sup>

While drama theory is interesting in that it acknowledges the potential for an evolving strategy and value system and reduces some of these notions to logical notation; like Wolfram and others it acknowledges the limits of computability in its inability to capture all the details.<sup>16</sup>

The permeability of the “frame” (to use dramatec nomenclature for the games theory meta-game) which may become relevant to the games situation is indicated by developments in network theory which show that larger numbers of actors may become connected (into the situation) at relatively low information costs.

Exploration of the “small world phenomena”<sup>17</sup> has delimited the field within which involvement of a wider group/ matrix of nodes/ coalition may spread or fade. The typical matrix of human relationships shows a “power law” distribution of connections, which means that some individuals are far better connected than would be predicted from a normal distribution, and that though scope to engage a much wider population of players or actors is usually limited there will inevitably be occasion for some outbreaks of connectedness which radically transform the game rules, and these can not always be anticipated from their apparent distance from the original game.

Such situations as the renegotiation of commissions with wider market interest, the collapse of bubbles with market sentiment and saturation, the role of auditors, courts, commissions of enquiry, executive salary committees, gossip and media all indicate how changing the range and connection of actors changes the payoffs. Note the converse, sectarianism, isolation, fractionation, swamping with local connections to insulate against distant ones will tend to have simplifying reverse effects.

Thus network theory (with its notions of thresholds and activation levels in engaging actors with different degrees of connection) is likely to model a richer environment for many simulations than game theory has done so far. Simulations involving both would provide a better, if still imperfect, modelling of markets.

Initially games theory tried to reduce multi-person games to two person games by the concept of coalitions; and the degree to which international negotiations (and democratic party systems) tend to collapse in this direction shows that it can be functional. However the coalition concept raises the issue of the identity boundary of the player.

Richard Dawkins famously attempted to explain altruism of individual humans and animals as merely the outcome of self-interested genes and gene sequences in colonising the universe by creating lumbering robots to provide an optimum environment for them - ready to self destruct to maximise the spread of similar gene sequences in a larger number of robots. At the same time he insisted that the unit of selection was at the level of the individually reproducing organism so that notions of selection at say the clan or species level with subsets working to achieve this were an idealisation. This shibboleth has been attacked by other theorists<sup>18</sup> and to the extent that elements of a coalition are connected and see some groups as allies and others as competitors this challenge seems reasonable. Some species and nationalities do get exterminated. (Some establish norms of collaboration and internal subordination which give them greater collective influence.) Bacteria can swap genes around by other means than sex.<sup>19</sup> Beyond the “game” of genetic selection some cognitive science emphasises that the notion of a unitary “self” is flaky.<sup>20</sup>

Thus the notion of the player can become fuzzy (and even irrelevant). The fluidity of players is recognised by the dramatec notion of Characters and sub characters.

From this flexible perspective of the identity of a player or coalition at a particular level of organisation further paradoxes of successful games playing become apparent. A cell that is able to reproduce itself without constraint from its neighbours is known as a cancer. Lynn Margulis<sup>21</sup> has demonstrated how plants and animals are the result of symbiotic unions of different bacteria. - Plants can be seen as simply a variety of strategies by chloroplasts to spread themselves more widely. (Different designs of candelabra?) Dry land could only become forested after symbioses of algae and fungi became woody plants.<sup>22</sup> Ten per cent of our weight (and 90% of our bodies' cells) consists of the symbiotic (mostly gut) bacteria we cater for. And we can see ourselves (and the co-evolution of our colour vision) as among other things strategies by fruiting plants to provide their offspring with a healthy initial supply of fertiliser.

The popular imagination is still not up to speed with the kind of “welfare state for plants” system run by webs of underground fungi. For example some sugars produced by a well exposed fir tree may be transferred to a more sheltered plant while the mycorrhizae benefit from maintaining and gathering the metabolic by-products of both. The fact that more than 90% of plant species have associated symbiotic fungi illustrates that co-operation evolves and is selected for under evolution at least as much as competition. For those who are impressed by size one single fungus underlying 15 hectares of Montana forest weighs around 100 metric tons and the average fairy ring weighs about half a metric ton underground.

The multi-level coalition perspective also fuzzes the participants' identities at a societal level. Is economic competition and co-operation between companies to the benefit or at the expense of consumers? Will paying their employees less make them richer or poorer? To paraphrase J P Getty, “I need high salaries so people can buy more of my petrol,”<sup>23</sup> Certainly this can be

(uncertainly) modelled but the employer is also the consumer (and also the employee).

Thus the concept of trading emerges as a wider model of life's interactions than simply winning or losing but the various roles of the trader limit the applicability of even that concept.

Paradoxically as we move towards greater levels of information the concept of a game or competition becomes more redundant as outcomes are more apparent before the start – just as nobody plays noughts and crosses beyond a certain level because two competent players are guaranteed always to draw. (Although we may try “posing” strategies both to communicate or fuzz - and reduce ourselves to games again.) In other words games are only worth playing (for their ostensible pay offs) where there are significant informational transactional costs or blockages. It follows from this that they will tend to be a more attractive mode of interaction to simpler systems/ organisms with less variegated information processing capacity. It is usually better to research what outcome can almost certainly be achieved at the start and save resources.

Another implication from the foregoing is that it is often easier to change the rules, the scoring system or the avowed objective of the game (ideally once you know the outcome) than to calculate the contingencies and supply the resource inputs to succeed on the initially declared game. One example of this is called “reframing”<sup>24</sup> (– for example when the teacher tells the oldest pupils that their goal is not to overthrow the system but to take it over.)

What is not generally enlightening, even though it is possible, is to regard the outcome of almost all interactions as the upshot of winning a game. A half-baked grasp of evolutionary theory can easily degenerate to the misattribution of teleological or agentive motivations behind the unfolding of any process. (Which gets rather close to the thinking patterns of paranoia.) The role of chance, in its various guises, and systems seeking their most stable energy level has its role in the truism that that which easily gets copied easily gets copied and tends to fill up the available space, without it being any kind of victorious strategy.

In her most recent philosophical work<sup>25</sup> Professor Margaret Midgley inveighs against our tendency to apply a concept beyond its appropriate range. We might also note the warnings of Norbert Wiener himself to avoid applying cybernetics to the social sciences because of its inherent unpredictability.<sup>26</sup> We have made some progress in half a century. It is worth scanning for appropriate games theory scenarios to compute because sometimes coherent order does emerge from uncomputable chaos, and developing an awareness of the limits of such scenario analysis will almost certainly refine the implicit knowledge in our neural nets which will guide our practical interaction decisions.

The difficulty of unambiguously declaring the benefits on the bottom line has provided an escape clause for theologians (and creative accountants)

throughout their long professional histories. The point was made in the Bhagavad-Gita, but it was summarised more mellifluously by Emerson<sup>27</sup> about 150 years ago in his poem Brahma. –

“If the red slayer think he slays,  
Or if the slain think he is slain,  
They know not well the subtle ways  
I keep, and pass, and turn again.”

- which I think gives the gist of what you have been listening to.

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### Linked notions/illustrations for discussion session

#### Player Identity boundary

Genes, molecules? Society, planet, possible planets, apparent anthropic principle. Contentious but intriguing link with A Booth's mathematics on the emergence of discontinuities from continuities and dual perspectives. (choosing the arena, environment/ identity boundary)

Chung Tzu – harmless uselessness (no games, no communication) can be a good survival strategy – plant examples (cf. 2<sup>nd</sup> para.)

Arrow's Paradox (Kenneth not Zeno) link with non-computability (and possibly Godel's theorem limits (non-decidability within a set frame of axioms [corroborated by S Hawkins giving up on Grand Unified Theory on analogous basis] ))

Also linked to set theory paradoxes of ambiguities of essential sets.

How to transcend Hume's Law (You can't get *ought* from *is*.) – started by R B Braithwaite *Theory of Games as a tool for the Moral Philosopher* 1955, 1994 – notion of *prudential*.

Simon Lee new VC LMU 5 9 03 THES P16 *Teach Students Ethics* – this stuff above gives it a more “rational” motivating basis.

Logically the meaning of anything can be transformed by placing it in an appropriate wider context.

General creep from Games to Optimisation Theory approaches but n.b. general disappointment with much Operations Research and suffering from some of the same computational weaknesses.

Ambiguity of the “extra mile” (>1 mile breaches the Roman soldier's regulations on what he can ask of the native) and “turning the other cheek” (involves aggressor in using unacceptable hand). Link with Thoreau passive resistance.

Why the meek sometimes do inherit the earth – or at least a self-effacing acquaintance got a fair chunk of Surrey for 25 years.

Moralities, similarity to a kind of Nash Equilibrium, or in Chaos Theory terms a “strange attractor”.

Parallel between teaching Asbergers (Autistic Spectrum) pupils the rules of social interaction and society ( $\approx$  the morally average) the rationale and payoffs for morality more effectively. (Many kids, adults & postmodernists can't give a rationale for what makes good good independent of the reward or punishment to them from superiors.) While much of the talk's thrust of changing rules and payoff matrices appears to accord with postmodernism (auto-invalidation) I believe it can be squared with modern, updated utilitarianism without being too Procrustean.

If Ashby's Law of Requisite Variety were true it would support the “no absolute winners” hypothesis. Unfortunately it is logically flawed<sup>28</sup> – but it can be a decent working strategy.

*Trust* Fukuyama, Warren Buffet's strategies (link with dramatec model– only deal with people you like) n.b. “Why large fierce animals are rare.”

Relevance to US evolving Iraq strategy from simply “we have the strength” also UK presentational difficulties.

Analogy of Toyota suppliers to co-operative slime mould organisation after the Aisin Seiki fire (P258 DW 6<sup>o</sup>) Potential self-destruction (or seeding) of AS benefits employees. cf. mother spider which is eaten by her offspring. c.f. Aikido philosophy – best martial artists “win without fighting”. (also in Sun Tzu but more threat than seduction)

J C's evaluation of most effective CEOs – they do not tenaciously pursue or fight for a single strategy but use an “evolutionary” approach of trying several things at once and seeing what gets the best response from the “environment”.

New Statesman article – mid August '03 – recognises the idea that co-operation/ altruism can “pay” at least as well but perpetuates the myth of psychopathy necessary at the top. N.b. J Huxley's & HG Wells '29 *The Science of Life* “As in the more plastic of human relationships, casual association may pass over into mutually helpful partnership, or transform partnership into parasitism. How difficult it may be to distinguish between service and slavery.”

Conflict is more noisy and wasteful and therefore more visible – hence people overestimate its use as a strategy. c.f. Conflict-theory-individuals as a model of society – usually only allowing conflict situations through awareness filters. (co-operation (and just default 2<sup>nd</sup> law thermodynamics) works more smoothly and is therefore less noticed.)

- link with Midgely caveat – ideas and models will always tend to get over-generalised unless/until we one day arrive at some final ultimate “truth”

“If you can't beat 'em join 'em” Harvard Negotiation Project (Fisher & Ury)  
win/win etc.

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