Modelling Collaboration to optimise Innovation

Ben Heslop

Mail To: 46 Hibberd St Hamilton South, NSW Australia 2303

Ph: +61402 898 539

Email: ben.heslop@gmail.com

Innovation fuels economic growth through 'creative destruction' of stagnant companies, rewarding those willing to embrace change. Requiring combination of diverse knowledge, structural impediments prevent efficient transfer of knowledge between agents. Past policies of intellectual property protection lead to delays and mistrust while new approaches remain marginally effective. This paper is a first approach by the author to understand, evaluate and improve collaborative performance of agents such as companies and universities. It is shown that a holistic understanding of collaboration should inform market-based policies that promote innovation. It has been found that a collaboration 'system' consists of five parameters that can be traced back to fight/flight response circuitry of the human brain. When the model is examined for 1st order feedbacks, the emerging structure is found to balance forces resisting change with those that reinforce it. The parameter 'Identity' is found to be critical in driving collaboration success or failure, with the remaining four linked in a stable ring of self-reinforcing and self-correcting feedback. This interpretation of collaborative behaviour delivers a systemic and pragmatic understanding of innovation, replacing what had previously been aspirational and anecdotal. With it, the author ventures policy to grow economies by liberating their under-employed capacity.

Keywords: innovation, collaboration, entrepreneurship, immigration, feedback, policy.

Innovation is important for national wealth (1) and for firm survival (2), with the second contributing to the first through 'creative destruction.' This paper seeks to understand collaboration and its relationship to innovation. Findings will show that, in order understanding of innovation should move away from a simplistic view based upon new products and services, instead that innovation requires collaborative groups to maintain high levels of relationships, activity, knowledge and communication recognises the fertile environment from which change can arise. The link between innovation and collaboration is investigated via System Dynamics modelling analysis of feedback loops.

The methodology to build the model of collaboration is guided by Sterman's (3) recommendations of model building within a qualitative, part empirical and part conceptual, framework. With an eye to understanding how innovation arises from university-business collaboration, empirical data was gathered from the author's own Australian National University via action research and then from four UK universities (4). Twenty five staff employed by Oxford, Bath, Surrey and Strathclyde Universities to facilitate university-business collaboration gave unstructured interviews, which were recorded and codified. The data led to a conceptual model (5) that after several iterations (6) resulted in a system dynamics model. This paper takes the model of collaboration and confirms logical consistency using Sterman's (3) 'structure assessment' test.' Model behaviour is then investigated by removing all bar 0^{th} and 1^{st} order feedbacks, allowing observations to be made, and thereupon policies to optimise innovation suggested.

The collaboration model is now presented. First described are the parameters, which are investigated for memory and potential-based definition. The structure assessment test is explained via equations that explore parameter behaviour. Impacts are investigated through decisions made by members when in collaboration.

1 Endogenous Parameters

In the model discovered, each parameter is defined by potential and memory.

1.1 Parameter Potential

Collaboration performance is the aggregation of member contributions, but is not limited by the sum of their potentials. This implies that members can exceed their individual potential when in collaboration. However, members of a poorly-performing collaboration will have low parameter levels compared to their respective potentials.

- *Transfer* describes the rate at which collaboration members receive and transmit knowledge, measured as the rate of information *absorption* (receipt).
- *Activity* is the rate of constructive work accomplished by members of the collaboration, measured *exergy* or 'useful work.'
- *Knowledge* is theoretical and practical knowledge held by the group, measured as known - and therefore *accessible* - expertise.
- *Cohesion* is the health of relationships within collaboration, measured as emotional energy invested.
- *Identity* is the importance members place upon their position within the collaboration, measured as anticipated distress should it be lost or the collaboration close.

1.2 Parameter Memory

System Dynamics differentiates between variables with and without memory. Variables with memory, also known as stocks, accumulate or dissipate with past events exerting influence via the accumulated value of the stock. Instantaneous variables without memory value rely solely upon the current state of the system. Each of the five collaboration variables is now investigated for memory and therefore accumulation.

Plans and timelines coordinate Activity for efficient resource utilisation. Deviation is undesirable since tasks cannot be commenced or halted without repercussion. The parallel considerations of planning make Activity a variable with memory.

People tend to acclimatise to a level of knowledge transfer based upon their accustomed rate of information processing (7). A mind made sharper demands to be exercised with new inputs, and seeks to output knowledge to others. Those unaccustomed to mental exercise find it difficult to quickly adapt to a high rate of knowledge transfer. Transfer is therefore seen to have memory.

According to the model of knowledge transfer, knowledge only resides in the mind. Learning allows knowledge to build slowly, and is only gradually forgotten. Knowledge is therefore seen to accumulate.

Artists commonly feel they are 'only as good as their latest work,' which suggests Identity is changeable. If work is received poorly, the subsequent loss of confidence will cause a sudden drop in Identity. Entrepreneurs are known for their chameleon-like ability to suppress or evoke ego depending upon the situation. This implies that Identity is an instantaneous variable.

Relationships take time to grow or deteriorate, and only children will make friends without question. While friends can be 'dropped' in an instant, the relationship nevertheless persists emotionally. It is more usual for relationships to grow or die over time, and in this sense, Cohesion has memory.

The parameters are now shown in the form of a stock and flow diagram (Fig. 1). Flows supply the attached 'stocks' (parameters with memory) and allow it to be emptied into, or filled by, the 'infinite source' (shown as a cloud), depending upon the directionality of flow.

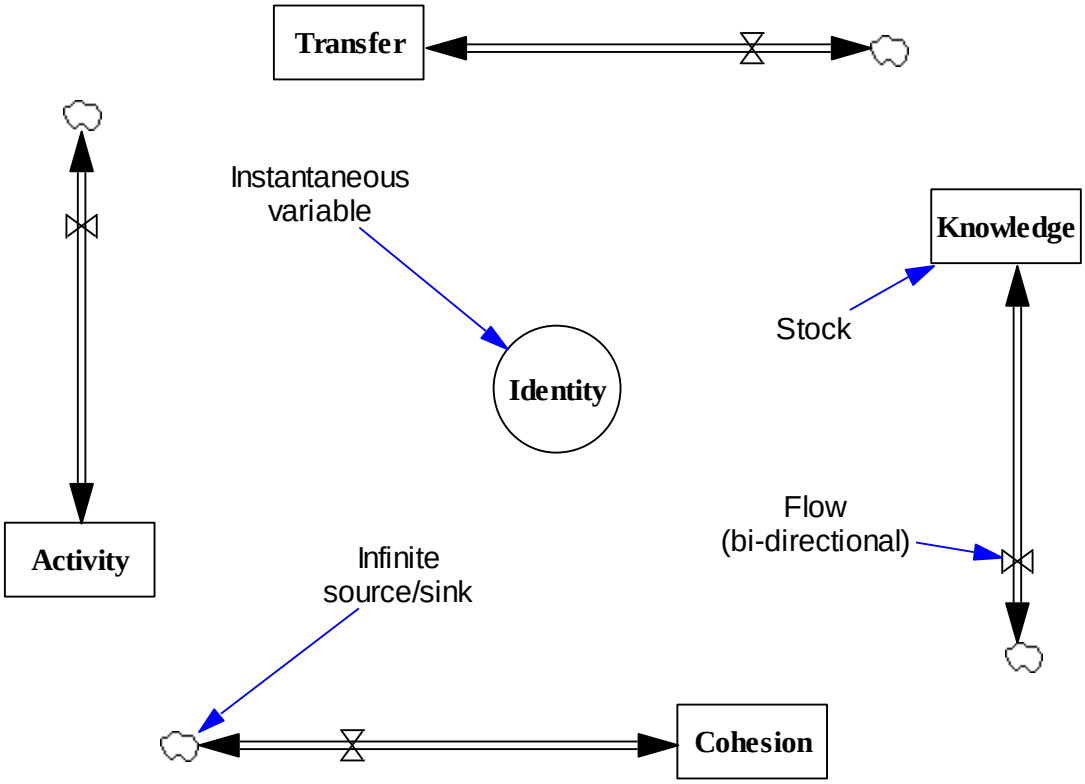

Figure 1: Collaboration model without impacts

1.3 Impact Equation

Quantitative validation of the collaboration model through numerical data and computer simulation would be desirable but falls outside the scope of this research. Testing logical consistency is however possible using the structure assessment test. A flow is first stimulated by a high or low parameter and the impact ascertained. The parameter is then reversed and it is assessed whether the impact is also reversed. Mathematically, this can be expressed as:

$$\text{Impact}_{\text{destination flow}}(\text{Positive} \mid \text{Negative}) = f_{\text{source parameter}}(\text{Level, Factor/s})$$

Certain exogenous factors have a bearing on decision-making regarding a source parameter, and are introduced at the beginning of each section. Consistency of impact (negative or positive) must be established to satisfy the structure assessment test.

2 Impacts of Transfer

Knowledge transfer is unique[1] among the parameters in that it intrinsically involves at minimum two people. Even if the audience is unknown to the speaker or writer, it is necessary to consider their likely response to the information spoken or written.

When the knowledge transfer is without precedent, and no collaboration yet exists, it is reasonable to posit that occurrence of Transfer invokes full collaboration as a means of harmonising future interaction. This means that transmitter and receiver are, however temporarily or slightly, considered in collaboration as a result of their having participated in knowledge transfer. The collaboration might never go beyond this act, but while it is remembered, further interaction with that individual (or imagined audience) will be considered in light of it.

The first factor is consistency of impact on the transmitter and receiver of Knowledge. If these impacts opposed one another, the Transfer parameter would not behave consistently. A second factor is that the communications medium can be direct (discussion) or indirect (documents).

Whereas other parameters will be seen to have an observer (or 'witness'), Transfer does not. Transfer is not visible to those uninvolved since the actuality of transfer can be easily disguised. The outside observer cannot reliably judge the efficacy of Transfer in which two others have engaged. Listening or reading can be accomplished without actual knowledge being absorbed. According to the structure assessment test, the impact of high Transfer will have opposite effect of low Transfer. A lack of knowledge transfer is a refusal to communicate when an opportunity and need exist. This may take the form of silence or a message empty of Knowledge, or refusal to listen or read, and means Transfer is low.

Impact (Pos) = f (Transfer = Low | High, Transmitter & Receiver, Direct & Indirect)

Impact (Neg) = f (Transfer = High | Low, Transmitter & Receiver, Direct & Indirect)

Transfer is high when opportunities to communicate are taken and low when they are not.

2.1 Impact of Transfer upon Activity (T→A)

Tasks that require knowledge exact what is known as 'demand pull' (8). Yet the immediate effect of absorbing new knowledge is distraction from Activity (9). Tasks need focus that is unavoidably lost in the very act of seeking the Knowledge that was demanded by the task. Once knowledge is internalised and ready to apply (K→A), Activity recommences.

Transmitting complex Knowledge is a delicate task that must remain sensitive to the audience. Writing a book requires the author to be cognizant of the state of the listener. Go into too much detail or skim over complexity and the audience become bored or confused. For example, scientists, engineers and other in-depth experts can become distracted from the task of communication by the difficult Knowledge they are transmitting. Receiving Knowledge can also potentially be distracting, for instance internet surfing where an initial query can remain unaddressed after a succession of interesting diversions.

Transfer has a negative effect on Activity; whether direct or indirect and involving the transmitter or receiver.

[1] A relationship can be 'one sided,' such as the fans of music idols, but still have relevance to decision-making.

2.2 Impact of Transfer upon Knowledge (T→K)

After absorption, Knowledge is internalised and the mind begins to associate it with pre-existing pieces of information. For both the transmitter and receiver new connections are made and realisations occur. The receiver correlates their new and old Knowledge to extract relevant insights.

The transmitter packages Knowledge to make it coherent and succinct, taking memory and moulding a stream of intelligible, linked concepts. This requires the transmitter to cross-correlate experience and fact with less-certain assumptions and suppositions. Unrecognised flaws and gaps may be uncovered in the process of connecting Knowledge varying by type and context. Authors profess that writing a book is partly to advance and crystallise their own understanding (10).

Does a lack of Transfer then reduce Knowledge? Given a physiological requirement (11) for the mind's connections to be activated in order not to be lost, the answer is yes. Further, as the world itself changes, Knowledge becomes gradually redundant. Transfer is necessary to keep abreast of the latest technology and techniques required by a position.

Transfer increases Knowledge whereas no Transfer decreases Knowledge, whether for the transmitter or receiver, and by direct or indirect means.

2.3 Impact of Transfer upon Identity (T→I)

A person's Identity is highly-personal yet multi-layered, and collaboration partly defines it. This may be formalised as a role, such as job title or rank, but also informally understood by the member and their colleagues. Roles are usually associated with specialisation; of responsibility but also of Knowledge. Transfer smoothes out these differentiations by making Knowledge more commonly held. As people become less 'special' they disassociate their Identity from their role and the collaboration in general (12).

A transmitter volunteers to share Knowledge, but in doing so lessens his power and importance. A receiver is the beneficiary of this Knowledge, but is made aware of three potential realities. First, if the existence of the Knowledge was a surprise, they are less knowledgeable than they initially believed. Second, they are less knowledgeable in this matter than the transmitter. Third, the transmitter is liable to share their Knowledge further, rendering the receiver's recent acquisition less valuable still. Any of these three will reduce the receiver's Identity.

Consider now that Transfer is replaced by a message empty of Knowledge, of which religions are perhaps the best known proponent. Supposedly-instructional sermons consist of stock phrases familiar to their congregation. An inherently-unchanging sermon will be attended for years and any deviation from the script is discouraged. No unexpected change to awareness will threaten roles defined by righteous piety. A vacuous message will increase Identity felt by the transmitter and receiver, which not only religions but politicians can use to gain support.

Transfer has a negative impact on Identity, regardless of transmitter or receiver and whether direct or indirect.

2.4 Impact of Transfer upon Cohesion (T→C)

Transfer increases Cohesion because it indicates a relationship is strong enough to withstand risk of either transmitter or receiver changing their world view. Both the decision to speak and the decision to listen signify confidence that the relationship can withstand any changes that might ensue. Psychology is familiar with justification-in-hindsight where people post-rationalise decisions (13). Imagined belief in a strong relationship will presage its existence, and in hindsight see that success was anticipated.

The alternative is the transmitter and receiver refusing to Transfer, damaging their relationship. Just as lies breach trust, so silence creates distance.

> *The most important part of telling the truth is that it actually binds you to people," explains Seidman, "because when you trust people with the truth, they trust you back." Obfuscation from leaders just gives citizens another problem - more haze - to sort through. (14)*

The belief that a relationship is too fragile to withstand Transfer means it is downgraded, perhaps as a risk-minimisation measure, or a loss of respect that the other party had no chance to disprove. A lack of communication is bad for a relationship (15), and while it is acknowledged that truth might be worse, a strong bond makes this unlikely. Otherwise, role-dependent relationships remain stable by selective communication of low-risk information.

In summary, Transfer has a positive impact on Cohesion, for both transmitter and receiver and regardless of the communication medium utilised. This and other impacts of Transfer are added to the previous stock-and-flow diagram (Fig. 1). A descriptive label is affixed to each impact, with blue (solid) arrows positive and red (dotted) arrows negative (Fig. 2).

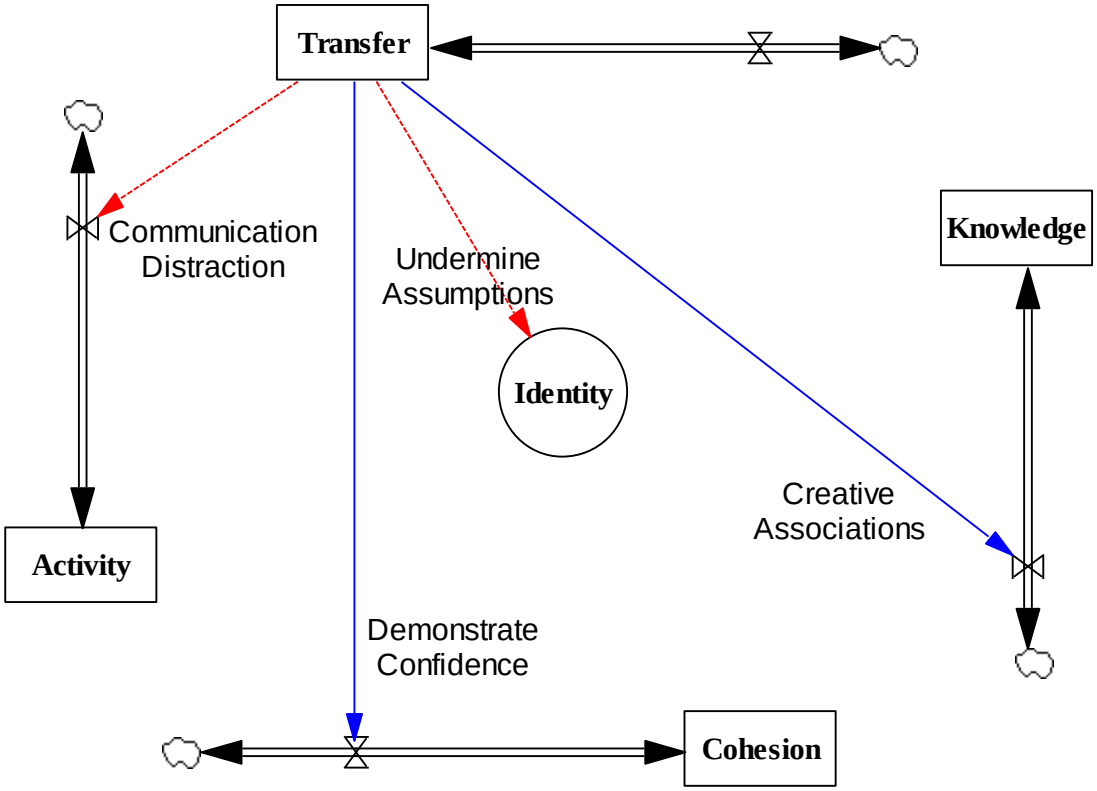

Figure 2: Collaboration model showing impacts of Transfer

3 Impacts of Activity

Unproductive endeavours, such as fiddling or procrastinating are a modern phenomenon allowed by economic wealth. In early history, genuine Activity would have been the norm since wastrels threatened group survival and were quickly identified. Activity affects others in the collaboration, and we evolved to notice it. Whether directly observed or indirectly informed, both are considered witnessing. The model must show a consistent reversal of impact between occurrence and non-occurrence of Activity.

It is also recognised that some collaborations tend to be hierarchical with others more anarchic. In the first case Activity is ordered by a superior while in the second it is undertaken on the member's initiative.

Impact (Pos) = f (Activity = Low | High, Protagonist & Witness, Orders & Initiative)

Impact (Neg) = f (Activity = High | Low, Protagonist & Witness, Orders & Initiative)

Activity is high when the protagonist is achieving their potential and low when they are not.

3.1 Impact of Activity upon Knowledge (A→K)

Valid Activity builds collaboration-relevant Knowledge. Similarly, watching another undertake Activity can build Knowledge as methods (and mistakes) are observed. Hearing a second hand account of Activity; recounting of an achievement or 'cautionary tale,' can also increase Knowledge. There is no explicit wish to Transfer but a valuable lesson may be imparted nonetheless. Observational or anecdotal learning does not imply Transfer, and vice versa.

While ordered Activity will build Knowledge, anarchic Activity can have greater effect since the protagonist's curiosity will deliberately be made to match a gap in understanding. Activity undertaken against orders is exogenous since it betrays the definition of Activity as being planned within a collaborative context.

The impact of Activity on Knowledge is positive for both protagonist and witness, regardless of being taken on orders or initiative.

3.2 Impact of Activity upon Transfer (A→T)

Activity gives rise to situations that require Knowledge to be attained. Successful completion of tasks will often require Knowledge that necessitates Transfer (16). It could be assumed that absent Activity, more time would be available for Transfer. Yet people become accustomed to a certain level of productivity, and when indolence is the norm, additional effort to learn or teach is unwelcome. Busy people are more likely to both transmit and receive.

Observing others as busy will stimulate Transfer. If transmitters observe Activity that requires their knowledge, they will endeavour to assist. Witness receivers will learn in anticipation of duplicating colleague's endeavours.

Taken together, Activity has a positive impact on Transfer

3.3 Impact of Activity upon Identity (A→I)

Accomplishment valued by the protagonist is a source of pride and allows increased investment in a position. This is a subjective evaluation whether under orders or initiative. A witness can also increase their Identity observing another's achievement because difficult and subtle details of a task are not apparent. Just as an acrobat's performance looks easy to the untrained eye, so a witness to Activity feels greater pride in their own accomplishments.

Not undertaking Activity means the protagonist's time is underutilised. If due to a supervisor's neglect or incompetence, the protagonist loses attachment to a role in which they are not valued. If this is due to the protagonist's lack of initiative then internal guilt or external blame is conceived. This is evident when lazy employees complain that a job is uninspiring. When idleness is observed, pride in the witnesses' own Activity is diminished. Observing another's irresponsibility is cause for witnesses to question their own dedication, perhaps seeing it as foolishness instead. This loss of confidence may spread, for instance workplace strikes that grow quickly.

Whether under orders or initiative, lack of Activity reduces protagonist and witness Identity, while the opposite is true for occurrence of Activity.

3.4 Impact of Activity upon Cohesion (A→C)

Collaborative Activity requires a team, which builds Cohesion. For example close-knit units in guerrilla or regular armies demonstrate the effect regardless of orders or initiative.

A witness to a team is prone to be well inclined to those they observe. Successful teamwork is a recommendation of good character and also signifies a desirable ally. Alternatively, not being a part of a team is an undesirable social signal that threatens existing relationships and causes those in potential to be avoided.

Activity has a positive impact on Cohesion, along with all other impacts (Fig. 3).

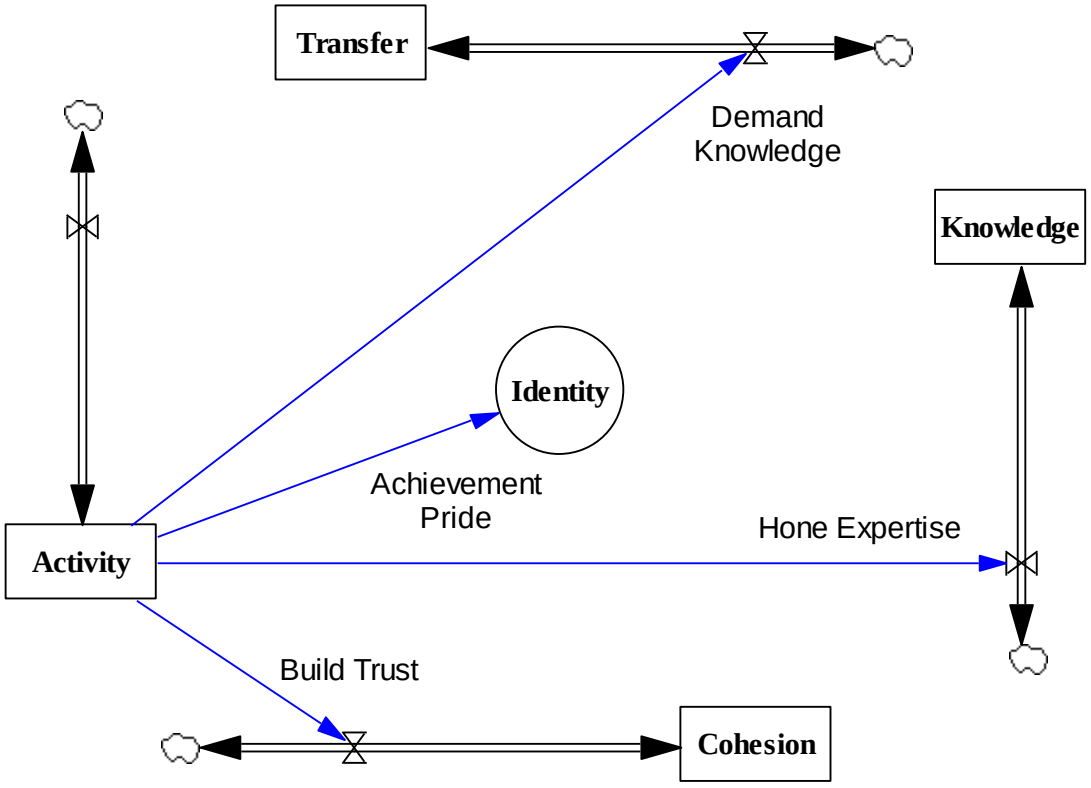

Figure 13: Collaboration model showing impacts of Activity

4 Impacts of Knowledge

It is important to note that a particular collaboration will decide what constitutes 'their' Knowledge. Objective truth exists but collaborations are not mechanisms to identify it. For instance, religion and science have different opinions of truth, yet a scientist will be unable to carry out a priest's responsibilities, and vice versa.

Innovation can be helped by unorthodox Knowledge, often sourced from outside the collaboration. While not officially approved, unorthodox Knowledge can provide alternative perspectives and approaches. Highly-proficient individuals often possess unorthodox Knowledge alongside mainstream. People new to the collaboration will tend to focus on attaining mainstream knowledge first.

Knowledge cannot be directly observed, but Activity and Transfer tend to reveal it. Licenses and accreditation are no guarantee of expertise. A witness to Activity and a recipient of Transfer will infer another's level of Knowledge.

Impact (Pos) = f (Knowledge = Low | High, Protagonist & Witness, Mainstream & Unorthodox)

Impact (Neg) = f (Knowledge = High | Low, Protagonist & Witness, Mainstream & Unorthodox)

Knowledge is high when people know how to perform their jobs, and weak when they do not.

4.1 Impact of Knowledge upon Activity (K→A)

Activity requires knowledgeable protagonists for optimal undertaking. Activity is also encouraged when Knowledge is witnessed. A witness calculates that if the protagonist has substantial Knowledge in one arena, they are likely to possess it in another and can help if called upon. If Knowledge is observed to be lacking, the opposite conclusion is drawn.

While promoting Activity, unorthodox Knowledge may also have undesirable political consequences. Melbourne's 'Father Bob' was by congregation size and charitable works a successful priest. Yet his unorthodox attitudes on contentious subjects, including equality of religion, rendered him a political threat (17). Here, witnessing unorthodox Knowledge encouraged Activity in the form of attendance at church, but also removing him from office.

Collaboration will allow unorthodox Knowledge if it achieves a desired result. While often producing surprising rulings (18), notably in litigation, the legal system does not adapt itself to allow child witnesses to testify on camera (19). Christianity[2] invents the quasi-science of 'intelligent design' (20) or justifies wealth-seeking Pentecostalism (21) but proscription against homosexuality and abortion remain core dogma[3]. Yet if unorthodox Knowledge is not permitted to prove itself, it cannot become mainstream, and innovation is prevented. Market capitalism is innovative when it comes to results the consumer judges are important but in the arena of environmental protection, trees or whales do not have buying power. For this reason, market solutions such as carbon trading are intrinsically unworkable since no consumer exists to provide oversight on results (22).

Knowledge has a positive impact on Activity for the protagonist whether mainstream or unorthodox. For the witness, only mainstream Knowledge consistently increases Activity.

4.2 Impact of Knowledge upon Transfer (K→T)

Knowledge is valuable when utilised (23) rather than kept hidden, and the protagonist's desire for recognition drives their transmission. Academic publication without prior demand is known as 'supply push' (8) but low quality findings reflect poorly and will not be disclosed. Similarly unorthodox Knowledge may not be well received and does not necessarily encourage transmission.

Learning becomes easier once a mental framework exists. A knowledgeable protagonist will seek to receive more Knowledge since less effort is required, and staying informed is preferable to being found ignorant, with ensuing reputation damage. A results-driven collaboration will expect an expert to have unorthodox Knowledge, and new ventures employ eccentric geniuses for this reason (24). On the other hand, a 'learning curve' means substantial time before Knowledge is useful, and is why companies prefer to avoid the expense of training.

A witness to Knowledge will themselves be encouraged to Transfer. In undertaking interviews, the author professed personal theories to elicit data from subjects. Being rare, unorthodox Knowledge was potentially of greater value, and inclined the subjects to transmit themselves. Teachers can foster class

[2] Marxism is similar to a religion, and the author's critique of Foucault**Invalid source specified.** was deemed "wrong" by a sociology professor as a result of its (unwelcome) conclusions rather than method.
[3] Ironically there is clear instruction against wealth in the Bible, but little mention of abortion or homosexuality.

interaction by allowing children to demonstrate specific Knowledge. Alternatively, transmission after witnessing ignorance is an unfair exchange as the witness has less to gain in collaborating. Witnessing ignorance will reduce Transfer, and if smarter children in a class are not listening to the teacher, others will follow.

In summary, Knowledge has a positive impact on transmission and receipt for both the protagonist and witness. Unorthodox Knowledge may have political implications in some instances but otherwise follows the same pattern.

4.3 Impact of Knowledge upon Identity (K→I)

Knowledge is power in the sense that it provides opportunity for effective action. Knowledge often justifies greater pay, respect and authority, all of which signify that the protagonist can feel confident in their ability. This applies equally for unorthodox Knowledge, where even if not useable due to specific restrictions, confidence is still felt.

A protagonist with poor Knowledge cannot build Identity on the basis of their position, regardless of whether they honestly appraise their own value or else dishonestly avoid exposure as a charlatan. Those possessing unorthodox Knowledge are however advised to keep their ego in check, since different does not equal better, yet believing so (C→K) may cause group fragmentation between mainstream and unorthodox supporters

For a witness to low Knowledge, effort will be made to sideline or remove the protagonist in question. Knowledge is position-specific, but the collaboration is collectively rendered weaker, and the witness's position by extension. When the situation is reversed, a capable colleague will have the opposite effect.

Overall, Knowledge has a positive impact on Identity, regardless of protagonist or witness. Identity based upon unorthodox Knowledge may cause group fragmentation.

4.4 Impact of Knowledge upon Cohesion (K→C)

Under stress, survival takes precedence and relationships are deprioritised. Knowledge helps relationships by reducing uncertainty and stress. All animals react poorly to unfamiliar surroundings or stimuli, but humans can also be stressed in the abstract. Examples include asylum seekers who under indefinite detention report that their uncertain status is most stressful (25). Another is 'closure' experienced after loved ones are found.

This is also true for witnesses since expert colleagues are reassuring even if never utilised. The appearance of confidence helps, and emergency workers are taught to stay calm. Religious people congregate for mutual reassurance, where personal doubt is assuaged by general fervency.

Overall Knowledge has a positive impact (Fig. 4) on Cohesion for both protagonist and witness. Orthodoxy is irrelevant since confidence is delivered regardless.

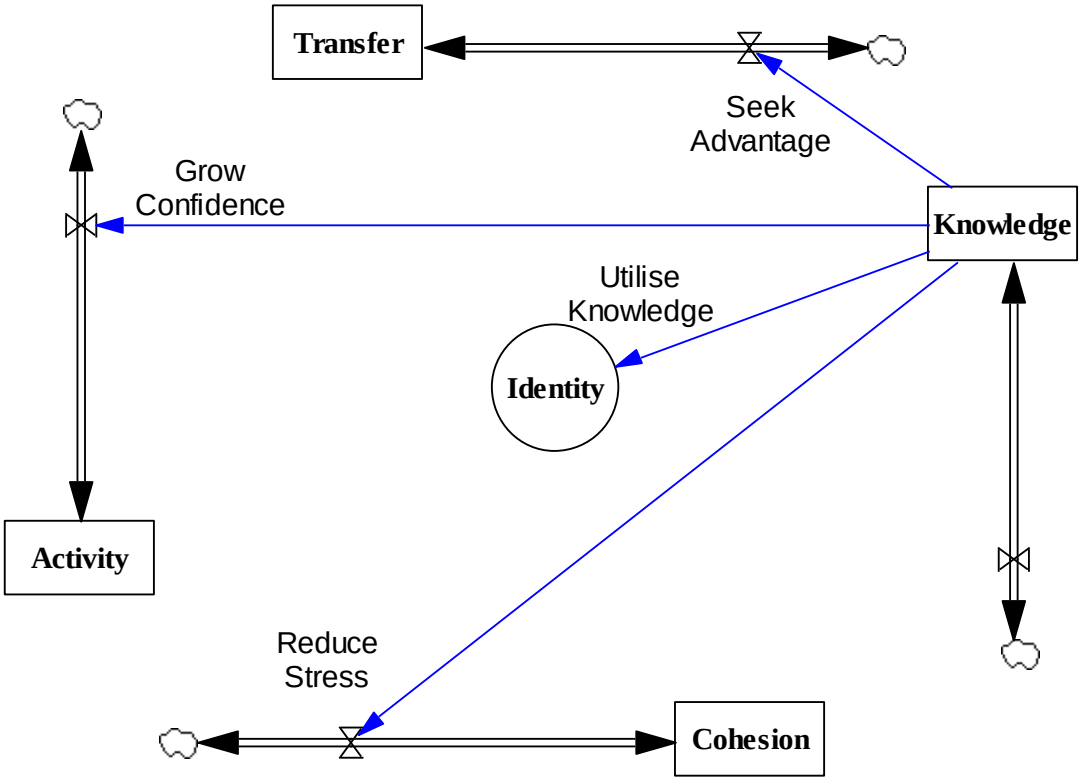

Figure 4: Collaboration model showing impacts of Knowledge

5 Impacts of Identity

Every person must identify themselves somehow, often in a variety of ways (26). Employment, family, friends, sports and ethnicity are among a myriad. Having different Identities to draw upon provides resilience as Identity is dynamically assigned depending upon the situation. With no single collaboration being critical a person can adapt easily, and survive failure in one particular realm. The evidence lies in entrepreneurs who graft self-confidence to their business idea, creating motivation to work hard and find eventual success. If the business fails, another is easily embraced (27). Depending upon when it is advantageous, entrepreneurs are arrogant and decisive, yet can also listen and respond with humility,

The opposite of dynamic Identity is that which remains static, and may be high, low or anywhere in between. Identity is static-high when a specific role and collaboration is of great significance. Identity remains low if the person is unable to place enough importance on their own effort. Static-low Identity is apparent in many of those who disassociate after childhood abuse (28). Static-high Identity is often the result of critical and emotionally-distant parents, where over-achievement hopes to find praise (29).

When in power, those with static-high Identity become dictatorial as political threats to a valued position are systematically removed and active worship demanded, such as in Hitler's Germany or Stalin's Russia. Alternatively, static-low leaders indecisively vacillate between competing forces, such as to tribe, religion or family, Karzai's Afghanistan for instance. An in-between case is 'static-medium' Identity where the nation is ignored as long as the leaders' interests remain unthreatened. Such heartless pragmatism can be seen in many quasi-democracies; Iran and Syria at time of writing or Putin's Russia (30).

Different to Activity and Knowledge, Identity cannot be observed directly and may only be weakly inferred over time as patterns of behaviour are observed and correlated. In some cases Identity may never

become apparent, evidenced by long term relationships ended with announcement of homosexuality or similarly emphatic reason.

Impact (Pos) = f (Identity = Low | High, Dynamic & Static)

Impact (Neg) = f (Identity = High | Low, Dynamic & Static)

Identity is high when importance is placed on a position and weak when it is not.

5.1 Impact of Identity upon Activity (I→A)

Identity provides an incentive to act since Activity provides evidence of the wisdom of making a personal investment in the position. Strong Identity requires more Activity to substantiate it, whereas weak Identity is justified by a lack of Activity.

Modern India is a blend of traditional castes and British colonial influence (31) that has created today's weak leadership (32). Nineteenth Century Britain was renowned for two things: a diligent public service and an aloof upper class, and many of the latter were sent to manage the Indian colony (33). India had previously been governed by monarchies that were removed or weakened under occupation. There was no Indian tradition of public service to offset introduced British aristocrats and their primary duty of protecting trading interests. Observing lazy, callous British rulers bred an expectation in upper caste Indians that achieving high office only carried responsibility to oneself and powerful interests. Today's Indian leaders corruptly seek alliances with industrialists, but also religious and nationalist zealots (34) (35). None of these is concerned with outcomes such as poverty, education, health (including family planning) and infrastructure (36) (37).

Such behaviour is not limited to India, and America's religious conservative politicians are commonly caught in corruption or sexual scandals. Collaboration's tendency towards conservatism is dangerous in the fast changing modern world. In earlier times, the tribe depended upon tradition as a record of survival measures, and altering what had worked in the past was supremely dangerous. Yet today's technology advances, population increase and ecosystem failure requires society to adapt. Conservatism is no longer appropriate, and worse, leads to corruption as old methodologies become irrelevant and institutions find themselves without true responsibility and in a position to extract advantage. Social innovation requires entrepreneurial leaders with dynamic Identity (38) but unfortunately the Western norm is career politicians with an early and exclusive dedication to politics, and resulting static-high Identity from narrow rather than extensive collaboration.

Overall, Identity has a positive Impact on Activity.

5.2 Impact of Identity on Transfer (I→T)

A position usually has associated responsibilities to teach and learn, and those who place more importance on their position take these responsibilities more seriously. This includes a senior instructing a junior, but also a junior reporting upwards. Entrepreneurs are known for a capacity to listen when appropriate, and teach or otherwise delegate when required. Seniors with static-low Identity will not care to teach but those with static-high Identity will not delegate, so there may be no one to listen.

Low Identity means not feeling compelled to transmit requisite information, nor listen when it is made available. Those with low Identity will tend to not Transfer, but if they do, their Identity is lowered further (T→I), making the decision to not Transfer a self-preservation measure. For instance, the psychological state of those who are 'quieter than usual' will be enquired into. The audience to Transfer can offset ensuing low Identity by reflective listening (K→I) and shared solution development (A→I). On the other hand, if too warmly expressed, thanks can diminish Identity (C→I) and may be unwelcome if Identity is already low.

From the transmitter's point of view, those with static-high Identity experience conflicting emotions in the act of knowledge transfer. They are initially compelled to speak at length, but if the audience provides an informed response, they feel threatened and resentful as their Identity moves uncomfortably lower.

Overall, Identity has a positive impact on Transfer.

5.3 Impact of Identity upon Knowledge (I→K)

A side effect of strong Identity is a tendency to exclude information that does not support their ability to carry out responsibilities. Those with high Identity must believe in their capacity, and evidence that threatens this belief is unwelcome. Additionally, logical conflicts potentially threatening decision-making are found and removed. Over time, systemic analysis and censoring of internal memory means becoming progressively less knowledgeable as conflicting, yet potentially useful, information is lost.

Alternatively, low Identity allows all Knowledge to be kept, since it makes no difference if it threatens a position. While this allows logical conflicts to persist, the bulk of Knowledge remains in place. This may explain why some people are good at trivia or remembering jokes, while others are not.

In anticipation of this, the entrepreneur will lower Identity to consider new business opportunities or to understand threats. Managers with static-high Identity will use their (exogenous) authority to exclude Knowledge they find uncomfortable. Business owners with static-low Identity tend to not succeed due to indecisiveness when first operating (I→A) and thereupon employee disrespect (I→C).

Regarding employees, young employees with lower Identity are preferred for ease of training, while a mature worker must reduce their ego to 'learn new tricks'. Young people have intrinsically low Identity because they are still finding out who they are, and it is only unhealthy if persisting into adulthood. Highly desirable is the worker that can transition from static-low Identity when young to dynamic once they enter management ranks.

Identity has been shown to negatively impact Knowledge.

5.4 Impact of Identity upon Cohesion (I→C)

Others in collaboration feel more comfortable relating to those who actions and words are appropriate and expected. A strong Identity allows for a stable and comprehensible tone of voice, posture and facial expression. Information communicated in appropriate for the position and relationship.

Since those with low Identity have little of importance associated with their position, they have no compunction acting obliquely or changing style. Without the impetus of Identity, actions are not correlated against a role. Even should they wish to put their audience at ease, the body language and choice of words of those with static-low Identity will seem inappropriate and uncommitted. Others draw away as they instinctively react to perceived disingenuousness. In some cases, stuttering can be assisted by deliberately raising Identity, thereby better enunciating words and putting the audience at greater ease[4].

'Confidence men' such as cult leaders initially attract followers, but eventually falter when they cannot adapt to increased exposure to reality (39). The counter example is putting a 'puppet on the throne,' where low Identity is desirable. Before his ascendency Stalin hid his true nature behind a comedic, facile façade and senior comrades who promoted his ascendency (40) as the harmless, manipulable 'compromise candidate' lived to regret it. Stalin was a static-high cult leader who could not adapt, and maintained his power over an unchanging nation with a combination of brutality and propaganda.

[4] Personal experience of the author.

Entrepreneurs respond comfortably to their collaboration's demands to alter Identity. They seamlessly transition between varying situations; whether directing employees, speaking to shareholders or holding media interviews.

Overall, Identity has a positive impact on Cohesion, as shown in Fig. 5.

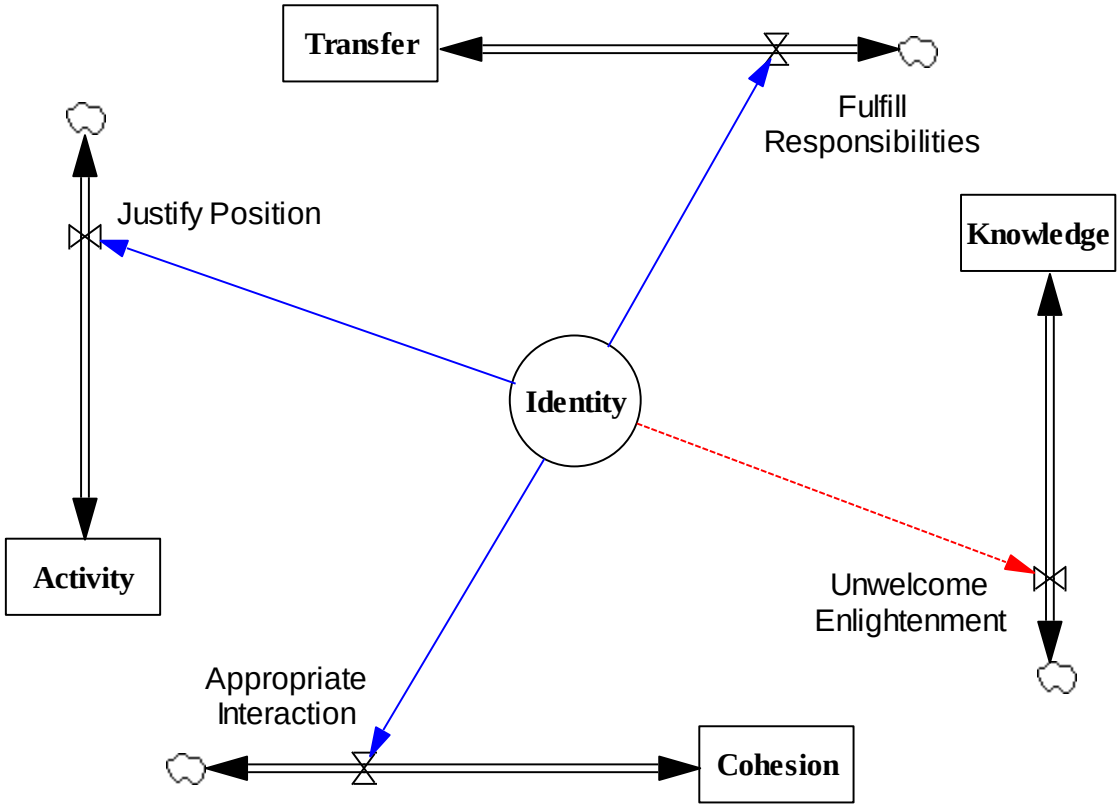

Figure 5: Collaboration model showing impacts of Identity

6 Impacts of Cohesion

Cohesion is observable and relationships often the subject of gossip. Witnesses observe relationship health in order to calculate political alliances. Not only is closeness between particular individuals important, but so is the general state of the collaboration.

Impact (Pos) = f (Cohesion = Low | High, Protagonist & Witness, Individual & General)

Impact (Neg) = f (Cohesion = High | Low, Protagonist & Witness, Individual & General)

Cohesion is regarded as strong when people trust and like one another, and low when they do not.

6.1 Impact of Cohesion upon Activity (C→A)

Relationships are a powerful motivator to action, and we help those we care about. Military forces are commonly cited examples of sacrifice, but in times of emergency even normal citizens will selflessly help those they have but an implicit relationship to. Alternatively, a country riven by conflict and desperation

will see its people ignore one another's suffering[5]. Poor relationships will persist (A→C) as there is no allegiance compelling unified action.

Physical evidence of Cohesion promotes people to act harmoniously, whereas evidence to the contrary produces the opposite result. For example, a famous experiment showed that quickly repairing broken windows in an urban neighbourhood reduced rates of crime (41).

If a person is observed to be popular, action is prompted by potential for a valuable ally, while also avoiding their (and wider) enmity. On the other hand, unpopular loners with poor relationships will not be assisted.

Cohesion has a positive impact on Activity, whether witness or protagonist and individual or general relationships are involved.

6.2 Impact of Cohesion upon Transfer (C→T)

We help others by better-informing them, and by listening we help ourselves. We speak or listen to those we like, taking time to write, and read their works. The stronger the protagonist believes the relationship to be, the more Transfer will be sought.

A witness to sincere interaction will seek to replicate it. To be an uncommunicative group in a room full of animated discussions reflects badly, and jovial conversation will be attempted. If however silence reigns, friends will mute their feelings temporarily in order to reduce interaction. It is commonly held that happiness is catching, but the opposite is also true, and catching a scowl will render us less well-disposed to others.

Both for general and individual, and for protagonist and witness, Cohesion has a positive impact on Transfer.

6.3 Impact of Cohesion upon Knowledge (C→K)

'Group think' in tightly-bound collectives (42) centralises views, often toward tradition or accepted perspectives and assumptions. Cohesion unifies thinking through cultural norms that reject unorthodox Knowledge. Mainstream is affected also, since once unorthodox Knowledge disappears, that which is left is re-divided into mainstream and unorthodox. The norm is then narrowed, and rejection of unorthodox Knowledge repeated; a process ironically most common in religious zealots or 'extremists.'

In a further twist, those heading extremist groups are often psychopaths with intrinsically weak individual and general Cohesion, and have no compunction identifying the most beneficial path for themselves or their organisation. They are however intelligent enough to recognise that unorthodox Knowledge threatens their control, and diligently suppress it.

In individual relationships, people will self-censor to 'keep the peace' whereas internet forums characterised by weak relationships are replete with strong opinion. A witness to censorship will be warned to act similarly but a frank exchange allowed by a weak relationship encourages liberated thinking in others.

Cohesion has a negative impact on Knowledge, regardless of whether protagonist or witness and individual or general.

[5] The Chinese superstition of transmissible misfortune is consistent with their history of turbulence and deprivation.

6.4 Impact of Cohesion upon Identity (C→I)

Two people in a strong relationship will tend to replicate one another's behaviour[6]. This includes providing constructive feedback to alter another's behaviour, or altering their own in sympathy, such as by adopting mannerisms. Regarding general Cohesion, a member will adopt group norms if they like the collaboration, but will otherwise reject them, as do rebellious children of parents they dislike.

When people copy another's behaviour, they are lowering Identity since a role becomes associated with another, and losing it becomes potentially less painful. For a similar reason, those afraid of failure will not put their best work on display, or even self-sabotage.

Relationships are not lost when a position is lost, or necessarily even when collaboration is left. If it were true that relationships depended upon position, then Cohesion would have a positive impact on Identity, but this is not the case.

A witness to a group with high Cohesion will accept lower Identity to fit in. Alternatively, groups where members are distant from one anther will encourage the witness to remain independent, with ensuing high Identity.

Cohesion has a negative impact on Identity, for general and individual relationships and both protagonist and witness (Fig. 6).

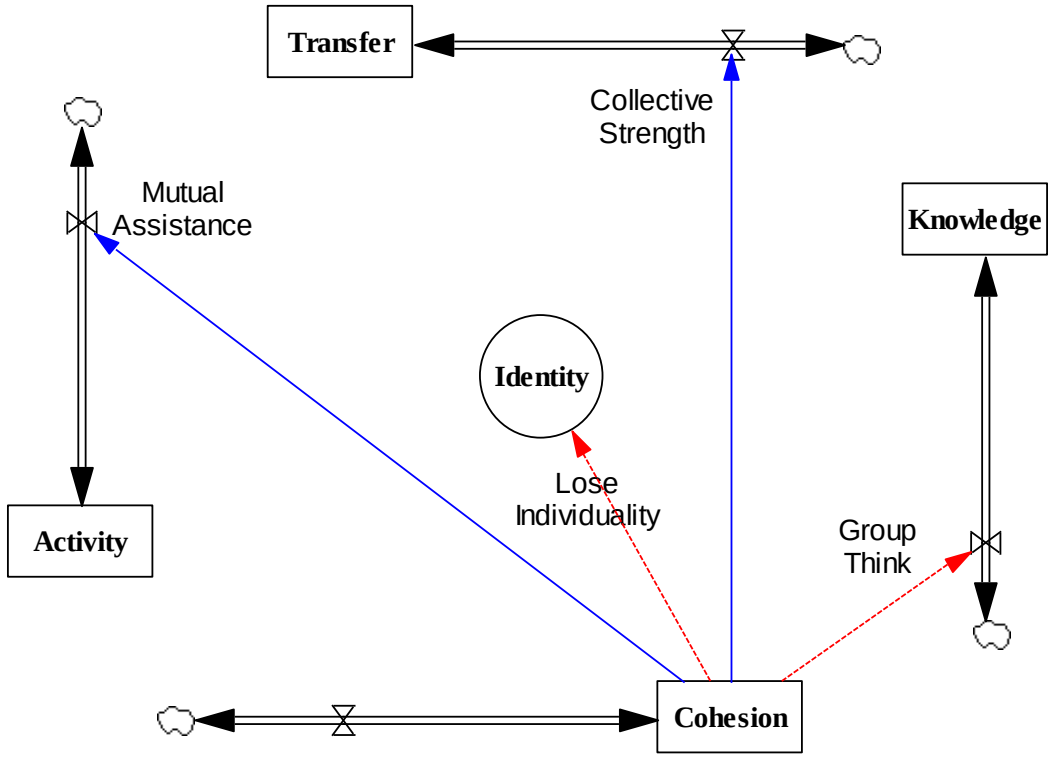

Figure 6: Collaboration model showing impacts of Cohesion

[6] The extreme case of impact of Cohesion on Identity is neatly encapsulated by the 'Borg' from Star Trek who formed a collective consciousness without individual identities.

This concludes presentation and logical testing of the collaboration model. Before policy implications are drawn, analysis and further exploration is required.

7 Model Behaviour

The advantage of full interconnection of parameters is revealed through system behaviour. Control theory recognises that feedback (43) is the strongest predictor of model behaviour. The necessary condition of feedback is that a change at one point will eventually come back to affect it again.

Feedback is either self-reinforcing or self-correcting. Feedback is also designated by order that depends upon the number of impacts (order = impacts - 1). All else being equal, the lower the order, the more immediate and powerful feedback will be. Prioritising 0^{th} and 1^{st} order feedback allows behavioural analysis of the collaboration model, even without knowing the relative strength of particular impacts.

7.1 Self-feedback (0^{th} order)

Self-feedback [SF] involves one impact and is therefore 0^{th} order (1-1=0). To simplify presentation, SF has not been represented thus far, however all SF in the collaboration model is based upon the assumption that people prefer to perform at their potential (§1.1).

Potential Transfer combines 'mental fitness' and natural cognitive ability. Operating at a higher level is uncomfortable and at a lower level boring.

Potential Activity combines physical fitness with focus and attention to detail. Operating at a higher level is exhausting and at a lower level unsatisfying.

Potential Knowledge is memory capacity. If information is added beyond capacity then older information is lost. Below memory capacity, expertise is continually gained.

Potential Cohesion is dictated by introversion or extroversion and a person's available emotional warmth. If emotionally over-extended, the introvert will seek time alone. To satisfy their need for Cohesion, the extrovert seeks further relationships, or greater closeness in those existing.

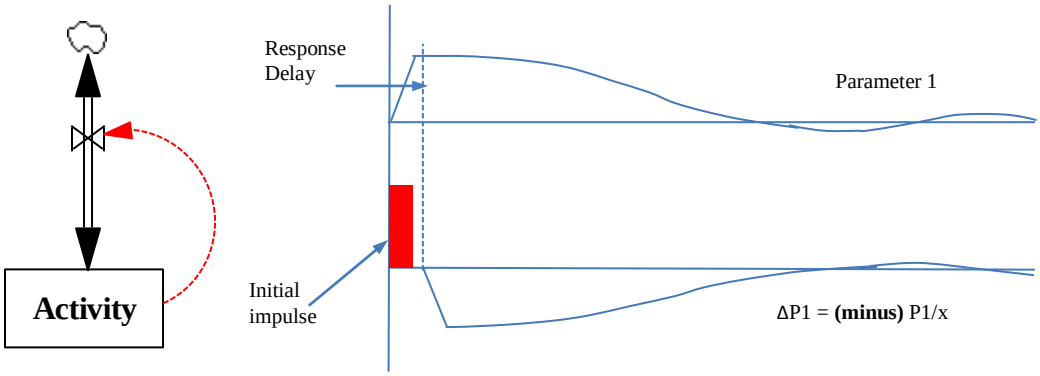

Figure 7: Self-correcting SF

Identity is instantaneous and therefore without feedback. Dynamic Identity is capacity to adjust quickly without discomfort, while those with static Identity prefer their set level. Nevertheless, Identity is still set by other parameters and the person wishing to behave consistently within collaboration must accede to it. Those leaving as a result of oscillations do so because they cannot tolerate being forced to assume an

unwelcome Identity during cycles of peak amplitude. For example, if given high Identity by the collaboration but preferring low Identity, psychological illness may result[7].

SF can be self-reinforcing or self-correcting but all four SFs just discussed are self-correcting since they automatically return to a preferred value. This can be shown graphically in the case of a positive change to a parameter then forced to return (Fig. 7).

7.2 First Order Feedback

While 0th order feedback includes only one impact, 1st order has two, which can be exclusively positive or negative or a mixture. Two positive impacts are termed *positive self-reinforcing* [SR] and an initial change in one parameter will become amplified in both parameters (Fig. 8). Two negative impacts are called *negative self-reinforcing* and one parameter will increase while the other decreases. There are none of these in this collaboration model.

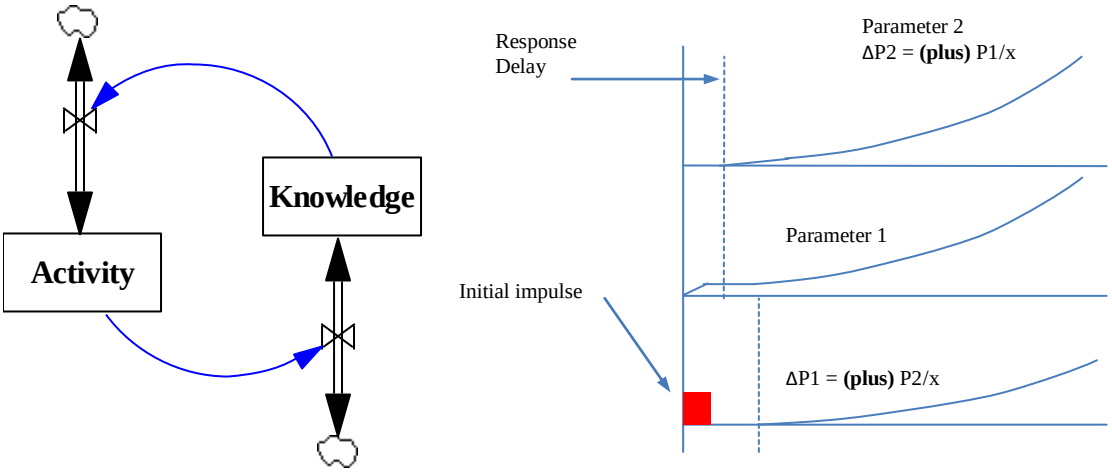

Figure 8: Positive self-reinforcing 1st order feedback

If one impact is negative and the other positive, feedback is *self-correcting* [SC] and any initial change will cause oscillations that eventually return to their starting levels (Fig. 9). Acting like a spring and dampener system, the energy of the original impetus is absorbed over time. If the first parameter is increased, the second parameter will either increase or decrease, with the return leg having an opposite effect.

An important difference between SF and SC is amplitude of oscillation. SF will over-shoot when returning to the starting level, but only at low amplitude (Fig. 10). The SC parameters actively move in opposition and so experience significantly higher oscillations. SF tends to immediately dampen any change, whereas SC acts like a spring taking longer to return to its original state. Only SC (grey) and SR (blue) are shown in the feedback model (Fig. 10) but SF remains in effect.

6.3 Interpreting the Feedback Model

The collaboration model has in total five SR and five SC, with the addition of four stabilising SF. However, Identity uniquely has one less SR, one more SC and no SF. The three SC will superimpose and combined with the loss of SF dampening produce higher amplitude oscillations. If the remainder of collaboration parameters have recently changed, Identity oscillates higher and lower. In addition, if

[7] The troubled winner of a television talent contest, Susan Boyle is a recent example.

Activity has undergone substantial change, SR will force a temporary shift in Identity in addition to the peak. In the longer term, oscillations will dissipate and Identity will once again be governed by the summation of impacts.

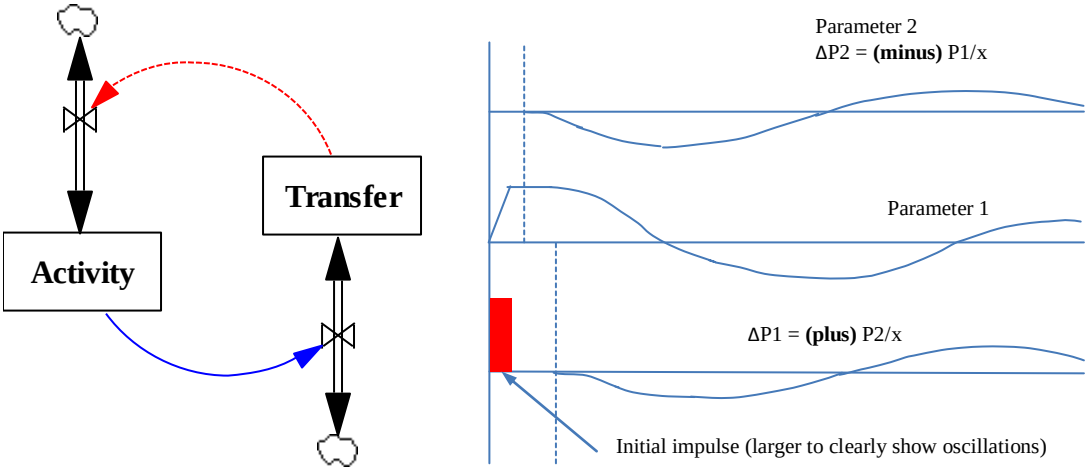

Figure 9: Self-correcting 1st order feedback

The remaining parameters are arranged in a central ring of SR feedback. A change to one of these parameters will circulate around the loop in both directions, creating a reinforcing 'meta-feedback.' Combatting this are two cross-wise SC feedbacks, but there are twice as many SR feedbacks as SC. The four SF pathways reduce the likelihood of infinite growth or diminution, although both are possible and equally destructive[8]. The four parameters will tend to rise and fall synchronously in wave patterns created by the interaction of SC and SR and their respective response delays. Due to SF dampening these will however be of lower amplitude than oscillations on Identity.

Yet alongside its disadvantages Identity has use. The central ring parameters are inherently difficult to deliberately raise (or lower) due to their SF and SC feedbacks. An analogy is that Identity has less mass (inertia) so takes less effort to move. Identity connects to the central via Activity, and uses SR to 'get the ball rolling'.

For example, introducing new technology or systems requires a short-term increase in Knowledge and Transfer to enable understanding before previous approaches can be phased out. Identity is disrupted as people associate themselves to different roles, with ensuing achievement or failure affecting self-confidence. An inspiring leader will help those struggling push through this initial stage, perhaps moving those with static Identity to positions better-reflecting their disposition. A leader with dynamic Identity will be able to show confidence as they experience less personal discomfort, inspiring those members with static Identity to tolerate their own, more-severe, distress. Entrepreneurial leadership is exogenous to the model, but allows Identity to be artificially raised. Identity can then drive innovation through short-term[9] increase in member performance, initially via SR with Activity.

[8] 'Superhuman' or 'subhuman' feats lead to burnout and frustration, damaging collaboration whose members move outside the SCARF domains and into the exogenous realms of exhaustion and anger respectively.
[9] Temporary improvement in performance is differentiated from sustained and permanent.

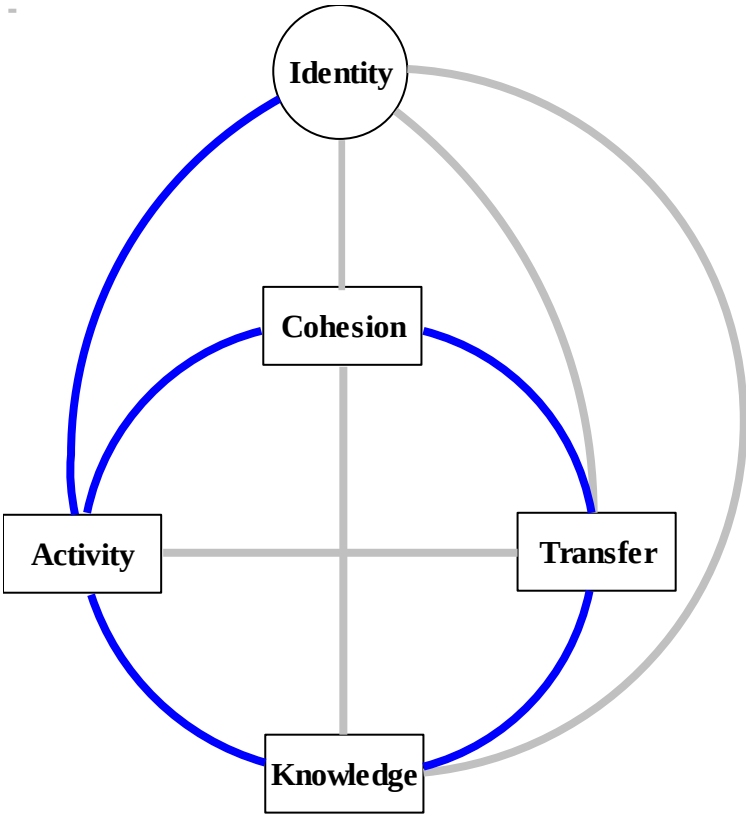

Figure 10: 1st Order Feedback Collaboration Model

8 Policy Recommendations

Collaboration model behaviour depends upon the frequency space. At low frequency, the collaboration rises and falls in a pattern, but can be significantly influenced by Identity via Activity since Identity has no 0th order feedback. At high frequency, the central ring imposes unpredictable oscillation on Identity. Whether the central ring or Identity controls behaviour depends largely upon the dynamic skill of its members, and particularly leadership. A well led collaboration will control growth or contraction depending upon what is most wise given foreseeable exogenous conditions. A poorly led collaboration will remain in stasis rather than face internal instability, but is therefore at the mercy of exogenous forces (24) for which no preparations have been made.

Within the remit of these early findings, it is recommended that attention is paid to fostering dynamic Identity. Resiliency results from good parenting, but also diverse opportunities for participation in collaboration. Government should find ways of allowing collaborations to develop between monolithic institutions so that citizens become equipped with the capacity to change them.

Immigration is important to the success of America, and specifically Silicon Valley (44). Governments would be well-advised to use immigration as a means of creating opportunities among those with multiple sources of Identity.

8.1 Future Work

The author intends to seek confirmation of the collaboration model in neuroscience and mammalian evolution (45). Human foetal brains are indistinguishable from reptilian forebears, and even when mature shares a structure in common with all mammals (46). Additionally, the individual and societal challenges as people moved from hunter gather tribes to larger settled communities would be useful to examine.

Finding resonance and support there would provide theoretical credibility to support and inform detailed policy design for implementing the aforementioned 'between institution' collaborations.

9 Bibliography

1. **Beinhocker, Eric D.** *The Origin of Wealth.* s.l. : Random House, 2006.

2. *The Learning Economy.* **Lundvall, Bengt-Äke and Johnson, Bjorn.** 2, s.l. : Journal of Industry Studies, 1994, Vol. 1.

3. **Sterman, John.** *Business Dynamics.* s.l. : McGraw Hill, 2000.

4. *Towards an integrative model of knowledge transfer: a comparative study of Australian and UK universities.* **Turcan, Romeo V. and Heslop, Ben.** 90, s.l. : Institutions & Transition Economics: Microeconomic Issues eJournal, 2011, Vol. 3.

5. *Entrepreneurship in Knowledge Transfer: A Comparative Study of Australia and UK Universities.* **Heslop, Ben and Turcan, Romeo V.** Montreal, Canada : McGill International Entrepreneurship Conference, 2004.

6. **Strauss, A and Corbin, J.** *Basics of Qualitative Research: Grounded Theory Procedures and Techniques.* s.l. : (Sage Publications , 1990.

7. **Gilkey, Roderick and Kilts, Clint.** *Cognitive Fitness.* s.l. : Harvard Business Review, 2007.

8. **Chidamber, Shyam R. and Kon, Henry B.** A research retrospective of innovation inception and success: the technology-push, demand-pull question. *International Journal of Technology Management, Volume 9, Number 1.* May 1994, pp. 94-112.

9. **Kuehn, Bridget M.** Willingness to Work Hard Linked to Dopamine Response in Brain Regions. *news@JAMA.* [Online] 2012. http://newsatjama.jama.com/2012/05/02/willingness-to-work-hard-linked-to-dopamine-response-in-brain-regions/.

10. **Zinsser, William.** *Writing To Learn.* s.l. : HarperCollins, 1993.

11. **Goldman-Rakic, P.** *Handbook of Physiology Vol. 5.* Bethesda : American Physiological Society, 1987.

12. *Knowledge management in the learning economy.* **Lundvall, Bengt-Åke and Nielsen, Peter.** 2006, Druid Working Paper.

13. **Nickerson, Raymond S.** Confirmation bias: A ubiquitous phenomenon in many guises. *Review of General Psychology, Vol 2(2).* June 1998, pp. 175-220.

14. **Friedman, Thomas L.** The Rise of Popularism. *New York Times.* [Online] 24 April 2012. http://mobile.nytimes.com/article?a=966132&f=28.

15. **Lundvall, Bengt-Äke.** *The University in the Learning Economy: Working Paper 02/06.* Aalborg : Danish Research Unit for Industrial Dynamics, 2006. ISBN 87-7873-122-4.

16. **Cohen, Wesley M. and Levinthal, Daniel A.** Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly Vol. 35, No. 1, Special Issue: Technology, Organizations, and Innovation.* March 1990, pp. 128-152.

17. **Gross, Dick.** Community and the legacies of faith. *Sydney Morning Herald.* [Online] 2011. http://www.smh.com.au/opinion/blogs/godless-gross/community-and-the-legacies-of-faith-20111007-1ld1u.html.

18. **O'Sullivan, Maria.** Malaysia Solution: High Court ruling explained. *The Conversation.* [Online] 31 8 2011. http://theconversation.edu.au/malaysia-solution-high-court-ruling-explained-3154.

19. *Matters of Suggestibility, Memory and Time: Child Witnesses in Court and What Really Happened.* **Motzkau, Johanna F.** 2007, Forum Qualitative Sozialforschung / Forum: Qualitative Social Research 8(1).

20. **Wikipedia.** Intelligent design. [Online] http://en.wikipedia.org/wiki/Intelligent_design.

21. —. Pentecostalism. [Online] http://en.wikipedia.org/wiki/Pentecostalism.

22. **Mirowski, Philip.** Climate, Science and Denial. *Late Night Live.* [Online] Australian Broadcasting Commission, 30 7 2012. www.abc.net.au/radionational/programs/latenightlive/climate2c-science-and-denial/4163970.

23. **Chesbrough, Henry.** *Open Business Models: How to Thrive in the New Innovation Landscape.* Boston : Harvard Business School Press, 2006.

24. **Bornstein, David.** For Some With Autism, Jobs to Match Their Talents. *Opinionator, New York Times.* [Online] 2011. http://opinionator.blogs.nytimes.com/2011/06/30/putting-the-gifts-of-the-autistic-to-work/.

25. **Amnesty.** Australia: Indefinite detention harms asylum seekers' mental health. [Online] 23 2 2012. http://www.amnesty.org/en/news/australia-indefinite-detention-harms-asylum-seekers-mental-health-2012-02-23.

26. **Yang, Juan, et al., et al.** Self-esteem modulates dorsal anterior cingulate cortical response in self-referential processing. *Neuropsychologia, Volume 50, Issue 7.* June 2012, pp. 1267-1270.

27. **Babbage Science and Technology.** Difference Engine: Pilgrim's progress. *The Economist.* [Online] 30 7 2012. http://www.economist.com/node/21559734.

28. *Dissociative identity disorder.* **Ross, Colin A.** 2006, Current Psychosis and Therapeutics Reports 4(3), pp. 112-116.

29. **Spreier, Scott W., Fontaine, Mary H. and Malloy, Ruth L.** *Leadership Run Amok: The Destructive Potential of Overachievers.* s.l. : Harvard Business Review, 2006.

30. **Gessen, Masha.** *The Man Without a Face: The Unlikely Rise of Vladimir Putin.* s.l. : Penguin, 2012.

31. **Matthew, K. Lange.** British Colonial Legacies and Political Development. *World Development, Volume 32, Issue 6.* June 2004, pp. 905-922.

32. **Amba-Rao, et al., et al.** Comparative performance appraisal practices and management values among foreign and domestic firms in India. *International Journal of Human Resource Management, Volume 11, Number 1.* 1 January 2000, pp. 60-89(30).

33. **Courcy, Anna de.** *Fishing Fleet.* s.l. : Hachette, 2012.

34. **Arvind, Verma.** Cultural roots of police corruption in India. *Policing: An International Journal of Police Strategies & Management, Vol. 22 Iss: 3.* 1999, pp. 264 – 279.

35. **The Hindu.** Rise of right-wing 'forced' Sonia to enter politics: WikiLeaks. *The Hindu.* [Online] 17 December 2010. http://www.thehindu.com/news/article958789.ece.

36. **The Economist.** Farewell to Incredible India. *The Economist.* [Online] 9 6 2012. http://www.economist.com/node/21556576?scode=3d26b0b17065c2cf29c06c010184c684.

37. **Das, Satyajit.** The great pretender: India's failure to capitalise. *The Drum, Australian Broadcasting Corporation.* [Online] 2012. http://www.abc.net.au/unleashed/4037122.html.

38. **Watson, Don.** *Recollections of a Bleeding Heart: A Portrait of Paul Keating PM.* s.l. : Random House Australia, 2002.

39. **Schoetz, David.** Sex Charges for Leader of Doomsday Sect. *ABC News.* [Online] 2008. http://abcnews.go.com/US/story?id=4796801&page=1#.T-Pp2xe_GSo.

40. **Dubofsky, Melvyn.** The devil is not in the details: he is Stalin! *American Communist History Vol. 2, Iss. 2.* 2003.

41. **Wikipedia.** Broken windows theory. [Online] http://en.wikipedia.org/wiki/Broken_windows_theory.

42. **Baron, Robert S.** So Right It's Wrong: Groupthink and the Ubiquitous Nature of Polarized Group Decision Making. *Advances in Experimental Social Psychology, Academic Press, Volume 37.* 2005, pp. 219-253.

43. *Keep it Simple: Dominance Assessment of Short Feedback Loops.* **Oliva, R and Mojtahedzadeh, M.** 2004, International System Dynamics Conference.

44. **Saxenian, AnnaLee.** *Regional Advantage: Culture and Competition in Silicon Valley and Route 128.* s.l. : Harvard College, 1994.

45. **Rock, David.** *Your Brain at Work.* s.l. : HarperCollins , 2009.

46. *Understanding Vertebrate Brain Evolution* . **Northcutt, R. Glenn.** 4, s.l. : Integrative and Comparative Biology, 2002, Vol. 42.