Diffusion of Creative Design: Gatekeeping Effects

Ricardo Sosa and John S. Gero

A computational framework for design is presented to show that certain social structures can determine how novel solutions are created and spread. This paper suggests that creativity transcends the individual inasmuch as situational factors such as the role of gatekeepers can determine who is considered creative in a society.

1. Introduction

Designers are interested in understanding creativity and innovation [1]. These two phenomena can be seen as dimensions of the differentiation cycle that gradually reduces novelty through commoditisation [2]. Whilst design practitioners are considered change agents of their societies, a deeper understanding of the micro-macro link between creativity and innovation is needed. Creativity is increasingly considered as a system property occurring in the interaction between the individual generator of an idea and a social group of evaluators [3]. However, most studies define the specification of a solution -and not its social impact- as the outcome of the creative process [4]. On the other hand, innovation studies tend to exclude the generative process and focus on diffusion using a collective unit of analysis.

This paper focuses on a key aspect of the link between generation and evaluation of creative design: the role of gatekeeping. Invention is an example of creative design where the role of gatekeepers is manifest [5]. An invention is first devised by an individual or a team who presents it for evaluation at least at three social levels: a group of authorised experts who assess its novelty and feasibility, a population that may adopt (and adapt to) it, and fellow practitioners who may develop further solutions made possible within the new design space. Although creativity is an ambiguous term, its evaluation has been defined by the combination of expert judgement, popularity, and peer recognition [4, 6]. Inventions and inventors can be considered creative by the combination of these processes although in some cases some of these criteria may not apply. The well-known term *H-creativity* or historical creativity [7] implies that some sort of social agreement is necessary to distinguish a creative designer from the rest. Certain aspects of this evaluative process are believed to emerge in a bottom-up direction through social interaction. Other top-down determinants are controlled by institutional structures such as patenting and intellectual property legislation (Australian Designs Office 2004).

Gatekeepers are defined as individuals that qualify the merits of creative solutions particularly their novelty. Apart from patent examiners, other types of gatekeepers in creative design may include venture capital firms, exhibition curators, journal editorial committees, and competition juries. In most cases, approval or endorsement of gatekeepers is necessary to turn an invention into an available product or design artefact. Nonetheless, little is known about the role of gatekeeping in a) promoting or deterring the generation of creative solutions and b) encouraging their diffusion and the ascription of the 'creative' label. In a study of patterns of creative figures Gardner [8] suggests that the hierarchical structure of a field has an important effect on the emergence of prominence. In more hierarchical fields (i.e. "where a few powerful critics render influential judgments about the quality of work") it is easier for a small number of creators to emerge and gain recognition and influence [8]. This paper presents a computational multi-agent framework of design to explore the idea that gatekeeping structures can determine how new solutions are created and spread in a society.

2. Artificial societies

A framework of design as a social activity is described in this paper where the focus is on the interaction between designers and adopters, i.e. the impact that artefacts have in a social group and the social conditions within which individuals create. This framework is based on a systems view of creativity where interdependent stakeholders are studied. The DIFI (Domain-Individual-Field Interaction) model [9] addresses the roles that the individual, the field and the domain play in the definition of creativity. Emphasis is on the interaction between agent, social, and epistemological levels of analysis respectively [10].

The implementation of this conceptual framework is carried out through the modelling of artificial societies [11]. Multi-agent systems of this type have been extensively used to model the link between individual actions and resulting macro structures. Inasmuch as human behaviour can be seen as a function of individual and social structures [12], social agents are defined as interdependent units of behaviour that complement individual cognition with interaction with others. Social agents are thus aware of the emergent structures collectively built by the social group [13], which feed back into individuals determining their behaviour.

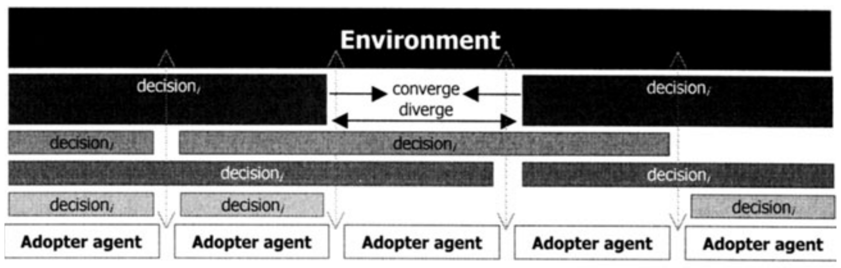
In this paper, social agency is implemented to addresses the combination of individual and situational factors in a system of generation and evaluation of designs. Individual factors are those that differentiate agents such as abilities and preferences. Situational factors are those that determine external factors such as time and environmental conditions.

3. Adopters, opinion leaders and designers

In this multi-agent system of design, members of an adopter population evaluate available design solutions and formulate adoption decisions where individual thresholds of perception and preference are complemented by social interaction by exchanging opinions with other adopters. At the implementation level, Figure 1 shows a group of adopter agents where elements of the adoption process become part of the group structure. Decision components can consist of perceptions, preferences, and choices. Group structures emerge from agent interaction and mediate their interaction with the environment. These structures are shared by agents at different times causing them to exhibit different degrees of normalised behaviour. Perceptions may become collectively biased, preferences may be emphasised by groups at different times, and socially permissible actions may be established.

One of the effects of this type of social behaviour is the emergent formation of 'opinion leaders', i.e. adopter agents that exert influence over the adoption decisions of others. Structures of dominance emerge where the most influential adopters acquire the role of gatekeepers to the domain. Therefore, an influential agent is defined as one that transmits an adoption decision component such as a preference to another agent. A dominant agent is defined as one that exerts this type of influence over a large number of agents.

Gatekeepers in this model consider design solutions generated by designers for their inclusion into the domain or repository of their societies. Whilst no strict criteria have been proposed to define domains [10], design domains can be defined as collections of artefacts that are selected by gatekeepers based on their evaluations as experts.



► Figure 1. Adoption architecture where decision components become part of group structures. Adopters build decision components which become part of the social group as they are spread.

Designer agents create and transform solutions that are adopted by the population and are considered by gatekeepers for their inclusion in the repository. Some of the resulting phenomena of interest are the size of adopter groups (a measure of popularity) and the number of entries to the repository (a measure of critics' endorsement). The design process consists of generating alternative solutions by learning (a measure of knowledge) or by imitating other designers (a measure of peer-recognition). Lastly, adopter groups manifest their satisfaction with their adoption choices (a measure of quality). In the literature creativity is defined by such components as aesthetic appeal, novelty, quality, unexpectedness, peer-recognition, influence, intelligence, learning, and popularity [4]. In this framework, creativity is defined by a set of complementary processes including adoption of a solution by a population, nomination by specialists and colleague recognition.

Designers are said to be considered creative by their social group when their designs reach large adopter groups, their artefacts are selected by gatekeepers, other designers imitate their artefacts, they transform the design space by formulating knowledge, and their adopters have high satisfaction levels. Not all criteria may apply simultaneously, however these are considered as operational criteria in the experiments presented here. Experimentation in this framework consists of exploring the effects that both individual and situational factors have on determining the performance of designers.

A formal description of these framework elements including artefact representation and adoption functions is given elsewhere due to space limitations [14]. Designers generate artefacts that have multiple interpretations and adoption is a multi-objective function based on a random distribution of preferences and perceptions. This paper concentrates on the mechanisms of social interaction, influence, and gatekeeping.

3.1 Social interaction

During a system run adopters rely on social interaction to validate their perceptions, spread preferences and in general to conduct their adoption decisions. To this end different social spaces are defined as social networks where adopters interact [15]. At initial time adopter agents are randomly assigned a location (node) and random neighbourhoods (links) in each space. These social spaces have different rules of interaction. Two aspects addressed in this paper are social tie strength (T) and neighbourhood size (H).

The concept of social ties is well-known in the literature and is defined as interaction links between nodes in a social network where nodes represent the relationship between adopter agents in that particular social space [15]. The strength of social ties, T, is determined by the probability that associated nodes may interact over a period of time [16]. Strong social ties exist between nodes in a kinship network, whilst weak ties exist in networks where casual encounters occur between strangers or acquaintances. Neighbourhood size, H, is determined by the number of links from a node, also called ego-centred networks [15]. A basic notion of tie strength is implemented as a probability $0.0 \leq T \leq 1.0$ that the link between a possible pair of adopter agents will remain at the next time step [17]. $T \approx 0.0$ brings higher social mobility, i.e. adopter agents are shuffled more often and get to interact with different adopters over a period of time. In contrast, $T \approx 1.0$ bonds adopters together causing a decrease in social mobility, i.e. adopter agents interact within the same groups for longer periods of time. In other words, weak ties cause neighbours to be replaced often whilst strong ties cause neighbours to remain together.

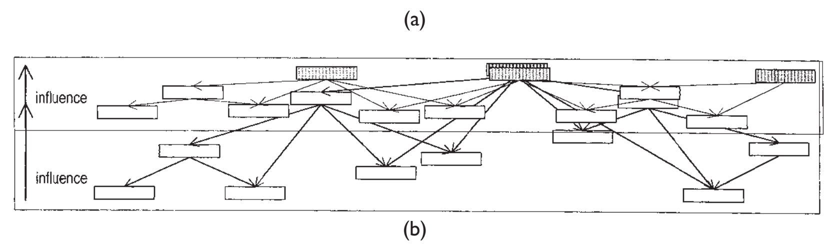
3.2 Influence

At initial time agents are randomly assigned extroversion thresholds in every social space [18]. An adopter agent is assigned different thresholds in different social spaces. Extroversion values are not fixed during a system run but change as a result of exerting influence over other agents.

In the first social space in this framework adopter agents exchange individual preferences. Within a second social space percepts are traded and a third space is set where agents exchange adoption decisions. In all spaces H has a constant initial value (H = 2) which varies during a system run according to the influence that an adopter exerts on others. Influence and neighbourhoods are increased when an adopter agent transmits its opinions to other adopters. Neighbourhood size, H, is tied to social influence so that more influential agents develop larger neighbourhoods.

Exchange between any pair of adopters starts by a comparison of their extroversion thresholds. In the social space where preferences are exchanged, in a pair of adjacent neighbours the adopter agent with the highest extroversion of the pair influences the less extrovert adopter on the criterion with highest preference. A negotiation process occurs by which the influenced adopter increases its preference by a difference between their preferences. However, if the chosen artefact of both adopters is the same and their preferences too similar, the more extrovert changes its focus of attention by shifting its preference to another criterion. This is a way to implement uniformity-avoidance and novelty-seeking behaviour, i.e. "x is an adopter's top preference until x becomes commonplace". The exchange of percepts and adoption choices in their corresponding social spaces takes place in the same form.

The distribution of influence in an adopter population is measured by the Gini coefficient γ, a summary statistic of inequality [19]. The Gini coefficient, γ, measures the distribution of influence in a society. When $\gamma \approx 0.0$, influence is more distributed among adopters. In contrast, $\gamma \approx 1.0$ indicates that influence is concentrated by a few adopters and more stable dominance hierarchies have formed. Figure 2(a) shows adopters (rectangles) in a group with low γ where influence is distributed and dominance is low. In contrast, in Figure 2(b) a hierarchy of influence exists in a group with high γ where a dominant agent influences the decisions of many adopters.



► Figure 2 Influence structures with different distributions; in (a) Gini coefficient $\gamma \approx 0.0$, whilst in (b) $\gamma \approx 1.0$

3.3 Gatekeeping

Adopter populations collectively define opinion leaders as a result of their aggregate interaction. At initial time the set of opinion leaders is empty. As a result of social interaction over time, adopter populations form influence hierarchies. Adopters that gain a dominance level of two standard deviations above the mean are nominated as opinion leaders. An adopter population may have characteristics that enable many agents to gain opinion leadership temporarily or may have characteristics that generate only a limited number of stable opinion leaders. In Figure 2(a) three adopters become opinion leaders, whilst in Figure 2(b) one influential adopter gains this role.

Opinion leaders become gatekeepers of the field by nominating artefacts for entry into the domain, i.e. a repository of artefacts that defines the material culture of a population [10]. They assign scores to potential entries based on the same adoption evaluation function used by adopters. Selected artefacts that receive a score above an entry threshold, ε, are included in the domain. The repository of artefacts is initialised with an entry threshold $\varepsilon = 0$. During a system run ε is gradually increased with every entry. Two possible selection modes are addressed in this paper. Gatekeepers can nominate artefacts that either increase the population's entry threshold ε or perform well in different adoption criteria than existing entries.

4. Gatekeeping effects

The following experiments address the role of social ties in the formation of influence structures in a population and the associated effects on creativity and innovation. A series of simulations are run where the initial configuration of adopters and designers is kept constant (i.e. control random seeds) and T is the independent variable. MonteCarlo runs are conducted to explore the range T = 0.0 to 1.0 in increments over 7500 iterations in populations of 10 agents, i.e., where agents remain in their social location at all times and where agents change social locations at all times, respectively. Preliminary runs showed that dependent variables stabilise between 2500 and 5000 iterations. The resulting dataset is then filtered in order to exclude outliers, i.e. values 1.5 standard deviations from the mean. All the following results represent means of 30 simulation runs.

Each simulation run is initialised in a converged state to avoid biases by random initial artefact configurations. Therefore at iteration step 0, adopters perceive no differentiation between artefacts and all abstain from adopting. It is only after a designer first modifies an artefact that adoption commences. Parameter relationships are analysed with Pearson correlation with a significance value $p < 0.05$, given by a sample size of 30 cases for each experiment.

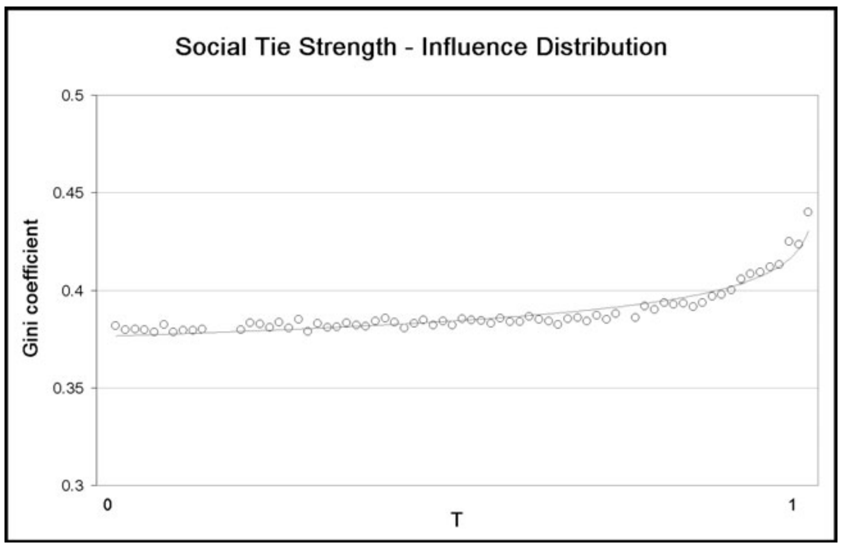
4.1. Dominance hierarchies

The results of varying T from 0.0 to 1.0 show that concentration of influence increases with social tie strength, i.e. in societies with strong ties, a few opinion leaders gain high levels of dominance. In contrast, as social ties become weaker, social mobility increases and agents have contact within a varying group of adopters causing structures of dominance to be more distributed ($\gamma \approx 0.0$). Figure 3 shows a scatter plot of the power-law relation of tie strength T and Gini coefficient γ with fitness $r = 0.927$. Whilst cases with very strong social ties yield a high Gini coefficient, in most cases it is comparatively low. Figure 3(a) plots the full range on the axes with the non-linear distribution of data points. Figure 3(b) shows the same plot but on a double-logarithmic scale. The same distribution now shows itself to be linear, a characteristic signature of a power-law. It is particularly interesting to obtain a pattern of self-organised criticality [20] by manipulating linear increments of an independent variable in this framework. These types of patterns are prevalent in biological and social phenomena and have been found to characterise relations such as the frequency of words in natural language, the growth of cities, metabolism, and the topology of the World Wide Web [21].

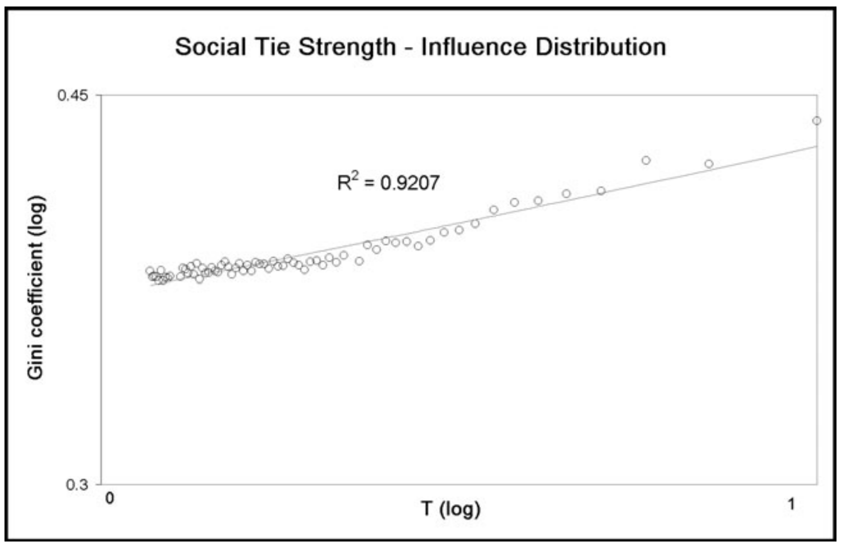
In these results a power law relates influence distribution to social tie strength raised to a constant power. In this case the power law coefficient is –0.37. Social groups with strong ties $T \approx 1.0$ reach a mean Gini coefficient $\gamma = 0.44$. As T decreases marginally, there is a sudden drop of influence hierarchies rapidly going below $\gamma = 0.39$. However, once this threshold is crossed, even a significant decrease in T does not pull $\gamma < 0.38$. This pattern of the relationship between tie strength and influence hierarchies is a typical result of complex, dynamical systems consisting of many constituents where a critical state can be reached without any exogenous control at which point a system changes radically its behaviour or structure [20]. In the critical state, a small local perturbation may spread to the whole system and form an avalanche. In this case this point consists of a minimum of social mobility.

This result suggests that in most cases influence hierarchies can be expected to be rather flat, the exception being only when adopter agents

► Figure 3. A power-law function is observed between social tie strength (T) and Gini coefficient; (a) social tie strength versus Gini coefficient; (b) the same data as a log-log plot.



(a)



◀ Figure 3. Continued

(b)

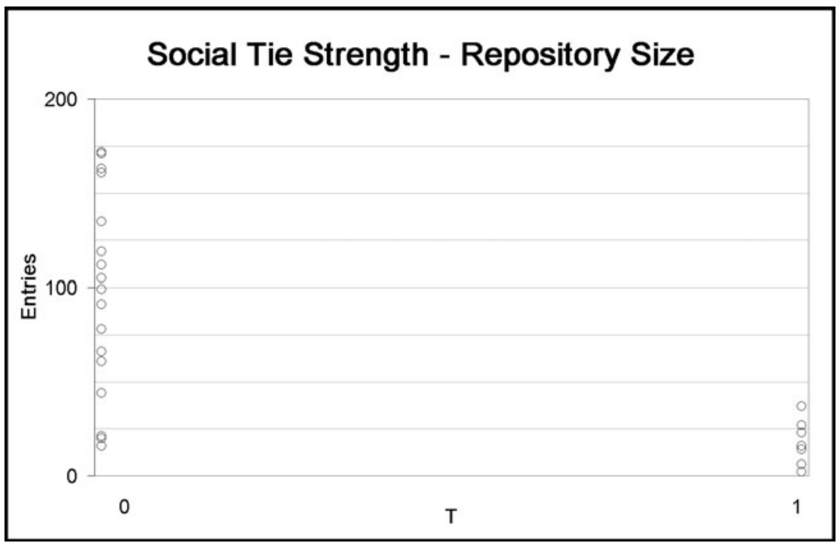
tend to remain in constant social positions. In social groups with strong ties there is lower mobility and the spread of values occurs in a hierarchical structure of influence between adopters. As a result, in groups with strong links influence hierarchies guarantee that a few individuals become dominant in the spread of ideas. In contrast, in weaker social settings adopters can be expected to influence their peers to a lesser degree. Influence is more diffused in groups with weak social ties. Small amounts of social mobility in societies of strong ties rapidly reduce disparities. As tie strength decreases further, influence becomes more egalitarian up to a point at which even large changes in social tie strength and mobility do not have a significant impact.

4.2. Domain effects

The formation of dominance structures shows unexpected effects in adoption and design behaviour. An inverse correlation is shown to develop between tie strength T and number of entries to the repository. Lower values of T are correlated with larger repositories as shown in Figure 4 (Pearson = 0.6706, $p = 0.001$). In these and subsequent figures only the extreme values $T = 0$ and $T = 1$ are shown for clarity.

In societies with weak social ties a mean of 97 artefacts with a standard deviation of 43.4 are selected by gatekeepers, whereas in societies with strong social ties a mean of 16 artefacts with a standard deviation of 11.7 are selected. From the results of the previous experiment it can be seen that in societies with strong ties, a constant set of adopter agents tends to remain in the role of gatekeepers. Namely, gatekeeping is more stable and controlled by a small unchanging group of influential experts. Therefore, interpretations in which the evaluation of artefacts is based remain constant over time. As a consequence repositories tend to be smaller. In contrast, in societies with lower tie strength T and therefore where influence is distributed rather than concentrated there is a higher change rate of gatekeepers. The gatekeeping group is constantly composed of different adopters. Consequently, more diverse evaluations mean a larger number of artefacts are included in the repository.

► Figure 4. Social spaces with weak social ties tend to produce larger domains.



A principle of tie strength and repositories can be stated as follows: In fields where social ties are strong and influence is concentrated, an unvarying group of gatekeepers generates smaller artefact repositories. In fields where social ties are weak and influence is more distributed, there is a high rotation of gatekeepers and this generates a larger and less predictable domain size. Social groups where individuals have stronger links produce more stable gatekeeping, i.e. the process of selecting artefacts for a collective repository remains in the same hands for long periods of time. One direct result is that such repositories are of smaller size than in equivalent societies where social ties are weaker. The artefacts of designers that operate within weaker social spaces are more likely to be recognized by experts of the field.

4.3. Differentiation effects

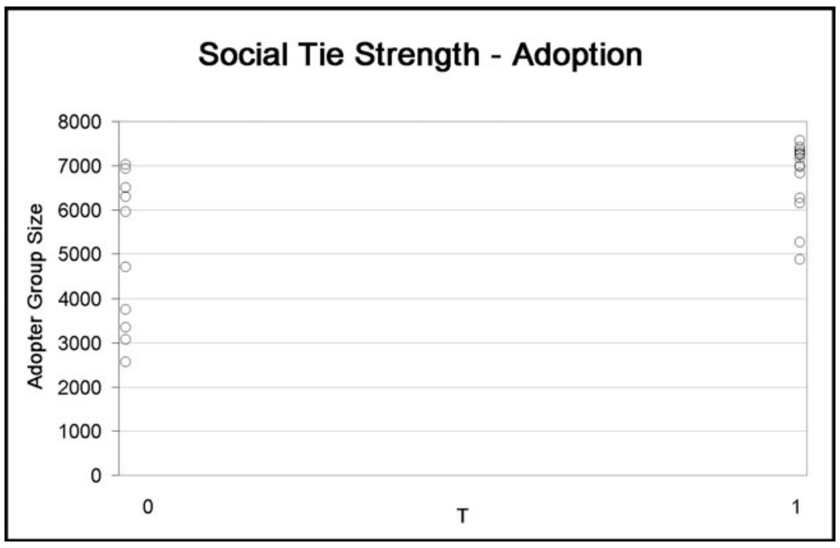
The differentiation of design artefacts is measured through the Strategic Differentiation Index (SDI) [22]. SDI is an aggregate measure of artefacts' differences as perceived by adopters. These experiments show that SDI is inversely correlated with T. Designer agents operating on tight social spaces where influence structures are rigid tend to generate more similar artefacts whilst the same designers operating in wider distributed influence social spaces have a tendency towards higher differentiation (Pearson = 0.5755, p = 0.004).

This effect on design behaviour can be explained by the normative nature of strong social ties. In societies where a few influential opinion leaders exist, the adoption choices can be expected to be more similar. As a result, designers engage in aggressive competition to improve their artefacts. In contrast, in societies with weaker links, adoption opinions are expected to diverge and provide designers with a wider range of preferences. In such cases, different artefacts are adopted.

4.4. Prominence effects

Lastly, effects on the size and nature of adopter groups are addressed. Results show that T is positively correlated with adopter group size as shown in Figure 5(a) (Pearson = 0.608, p = 0.001). The standard deviation of adoption in weak ties (1718.74) is also significantly higher than in strong ties (726.53). This illustrates that weak social ties increase abstention and make adoption less predictable. This is a consistent result with the notion that in more rigid societies there is a higher agreement of adoption opinions.

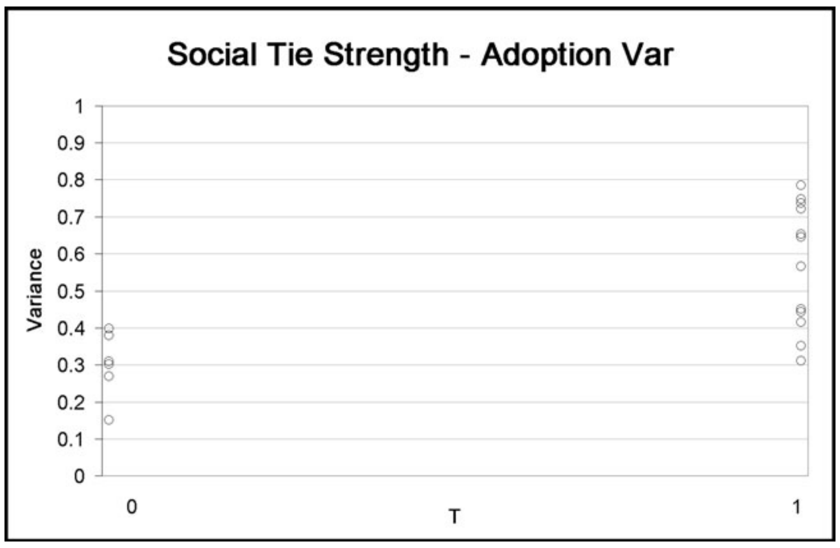
Adoption variance, on the other hand, is given by the distribution of adopters by designer agent. When adoption variance ≈ 1.0 most adopters choose the artefacts of one designer whereas when adoption variance ≈ 0.0 adopters distribute their choices amongst all designers. The strength of social ties T is correlated with adoption variance as shown in Figure 5(b) (Pearson = 0.6796, p = 0.001). Namely, in social spaces with weak ties adoption choices tend to be more distributed across designers. In contrast, T ≈ 1.0 increases total adoption and concentration of choices around a few designers.



(a)

◀ Figure 5. Social spaces with strong social ties (T ≈ 1.0) tend to produce more aggregate adoption and more concentration of adoption choices around a few designers; (a) social tie strength versus adopter group size; (b) social tie strength versus adopter variance.

▶ Figure 5. Continued



(b)

5. Discussion

The experiments presented in this paper support the idea that creativity transcends the individual and is a property of a complex system where interdependent stakeholders interact. Patterns of creative figures show that characteristics external to the individual may determine how and who is considered creative in a society. Albert Einstein, Pablo Picasso and Sigmund Freud have been characterised as extraordinary creators. Whilst their personality traits and abilities have little in common [23], similarities exist between the structures of the fields within which they operated. Namely, a few powerful critics rendered influential judgements about the quality of their work [8].

Our experiments with a multi-agent framework confirm this observation. When the tie strength between members of a population is high, adoption is more likely to concentrate on one designer. That is, keeping everything else constant and varying only the way in which adopter groups interact makes one designer more likely to become more prominent than the rest. Moreover, when prominence is more concentrated the behaviour of designers is also more differentiated as an effect of the strength of ties in the adopter population. On the other hand our experiments suggest that in societies where ties between agents are stronger, the domain tends to contain fewer entries.

The findings obtained from this framework point to a better understanding of creativity and innovation. However, they need to be validated against evidence from empirical observations. This is a difficult task given the methodological limitations to experiment with these variables in real cases of invention and innovation. One way to validate this type of systems is to relate their output to observed patterns. If the gatekeeping process had this type of effect, it would contribute to the exceptionality of historical creative figures. Creativity could be understood as the combination of exceptional individual and situational conditions, i.e. generative and evaluative processes. This type of explanation helps avoid the tautology implicit in the prevalent talent account of creativity [24].

Differences in the hierarchy of influences and their possible effects on creativity and innovation may exist between different fields or at different stages of development of a field. In early stages of field formation, when influence is more distributed, it may be harder for a single designer to be recognised as creative. As the field advances and gatekeeping hierarchies develop, the distribution of prominence may become more concentrated. With the arrival of a new paradigm, hierarchies in the field may collapse reinitiating the cycle of effects on prominence [25].

A corollary of these experiments is that in studying prominent designers, it seems necessary to consider the properties of the field within which they operate, in this case the people who play the role of gatekeepers.

Acknowledgements

This research is supported by an International Postgraduate Research Scholarship and a University of Sydney International Postgraduate Award. Computing resources were provided by the Key Centre of Design Computing and Cognition: http://www.arch.usyd.edu.au/kcdc

References

1. von Stamm, B., *Managing Innovation, Design and Creativity*, Wiley, Chichester, 2003.
2. Schumpeter, J.A., *Business Cycles: A Theoretical, Historical, and Statistical Analysis of the Capitalist Process*, McGraw-Hill, New York, 1939.
3. Sawyer, R.K., et al., *Creativity and Development*, Oxford University Press, Oxford, 2003.
4. Runco, M.A. and S. Pritzker, *Encyclopedia of Creativity*, Academic Press, San Diego, 1999.
5. Lemelson-MIT Program and National Science Foundation, *Invention*: Cambridge, 2004.
6. Simonton, K., Creativity, *American Psychologist*, 2000, **55**(1): pp. 151–172.
7. Boden, M.A., *Dimensions of Creativity*, MIT Press, Cambridge, 1994.
8. Gardner, H., The creators' patterns, in: D.H. Feldman, M. Csikszentmihalyi, and H. Gardner, eds. *Changing the World, a Framework for the Study of Creativity*, Praeger: Westport, 1994, pp. 69–85.
9. Csikszentmihalyi, M., Society, culture, and person: a systems view of creativity, in: R. Sternberg, ed. *The Nature of Creativity*, Cambridge University Press: Cambridge, 1988, pp. 325–339.
10. Feldman, D.H., M. Csikszentmihalyi, and H. Gardner, *Changing the World: A Framework for the Study of Creativity*, Praeger, Westport, CT., 1994.

11. Gilbert, G.N. and J. Doran, *Simulating Societies: The Computer Simulation of Social Phenomena*, UCL Press, London, 1994.
12. Ross, L. and R.E. Nisbett, *The Person and the Situation: Perspectives of Social Psychology*, Temple University Press, Philadelphia, 1991.
13. Malle, B.F., et al., Conceptual structure and social functions of behavior explanations: Beyond person-situation attributions, *Journal of Personality and Social Psychology*, 2000, **79**(3): pp. 309–326.
14. Sosa, R. and J.S. Gero. A computational framework for the study of creativity and innovation in design: Effects of social ties. in JS Gero ed. *Design Computing and Cognition*'04, Kluwer, Dordrecht, 2004, pp. 499–517.
15. Wasserman, S. and K. Faust, *Social Network Analysis: Methods and Applications*. Structural analysis in the social sciences, Cambridge University Press, New York, 1994.
16. Granovetter, M., The strength of weak ties, *American Journal of Sociology*, 1973, **78**(6): pp. 1360–1380.
17. Marsden, P.V. and K. Campbell, Measuring tie strength, *Social Forces*, 1984, **63**(2): pp. 482–501.
18. Eysenck, H.J., Dimensions of personality: 16, 5 or 3? – Criteria for a taxonomic paradigm, *Personality and Individual Differences*, 1991, **12**(8): pp. 773–790.
19. Dorfman, R., Formula for Gini coefficient, *Review of Economics Statistics*, 1979, **61**(2): pp. 146–149.
20. Bak, P., Self-organized criticality, *Physica A: Statistical and Theoretical Physics*, 1990, **163**(1): pp. 403–409.
21. Strogatz, S.H., *Sync: The Emerging Science of Spontaneous Order*, Theia, New York, 2003.
22. Nattermann, P.M., Best practice does not equal best strategy, *The McKinsey Quarterly*, 2000, **2000**(2): pp. 38–45.
23. Gardner, H., *Creating Minds: an Anatomy of Creativity seen through the Lives of Freud, Einstein, Picasso, Stravinsky, Eliot, Graham, and Gandhi*, BasicBooks, New York, 1993.
24. Csikszentmihalyi, M., *Creativity, Flow and the Psychology of Discovery and Invention*, HarperCollins, New York, 1997.
25. Kuhn, T.S., Second thoughts on paradigms, in: F. Suppe, ed. *The Structure of Scientific Theories*, University of Chicago Press: Chicago, 1974, pp. 459–482.

Ricardo Sosa and John S. Gero
Key Centre of Design Computing and Cognition,
University of Sydney,
NSW 2006 Australia

r.sosa@usyd.edu.au, john@arch.usyd.edu.au

Announcements