PROFIT and honour are two ſharp ſpurs, which quicken invention, and animate application ; it is therefore propoſed, that a ſcheme be ſet on foot for giving both theſe encouragements to the liberal ſciences, to the polite arts, and to every uſeful manufactory. That with this view a fund be raiſed by ſubſcription for the diſtribution of ſome ſuitable premium or honorary gratification for any and every work of diſtinguiſhed ingenuity.

HOW TO BE INGENIOUS

Comedians, Engineers and Survivalists

Jamie Young

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RSA Projects

In the face of constrained resources, some people demonstrate ingenuity; they are able to do unexpectedly more for less. How can their capability be enhanced and spread to others?

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ABOUT THE RSA

For over 250 years the Royal Society for the encouragement of Arts, Manufactures and Commerce (RSA) has been a cradle of enlightenment thinking and a force for social progress. Our approach is multi-disciplinary, politically independent and combines cutting edge research and policy development with practical action.

RSA Projects put enlightened thinking to work in practical ways. We aim to discover and release untapped human potential for the common good. By researching, designing and testing new social models, we encourage a more inventive, resourceful and fulfilled society.

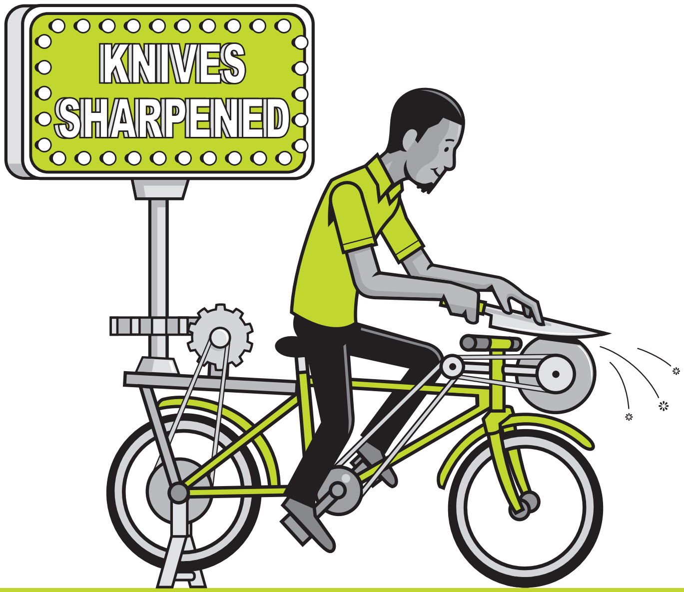
Front cover image
Shipley, W., 1753, *Proposals*.

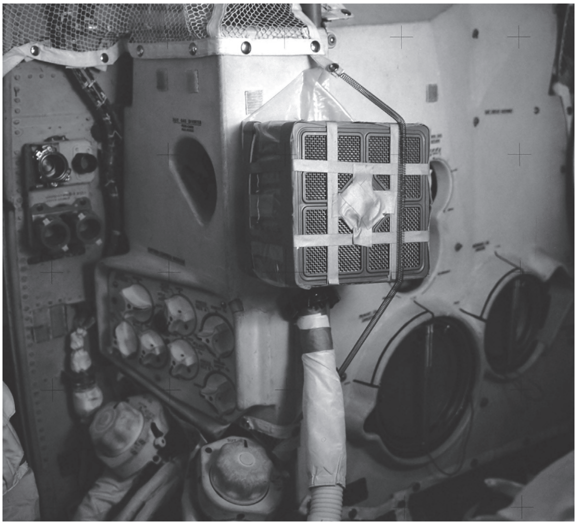
INTRODUCTION

Certain invented or man-made things share a special quality. They solve practical problems by combining remarkably few resources in a surprising way. We call it *ingenuity*.

Ingenious people are consistently good at devising these solutions: whether through cultural influence, professional imperative, education or natural bent, they have learned to be ingenious. They are found in a wide variety of contexts.

There is ingenuity in everyday life. Kenyan villager Peter Kahugu used a set of pulleys, a sharpening stone and an inner tube to modify his bicycle. Re-using the inner tube as a rubber belt, he offers a peripatetic, pedal-powered knife-sharpening service and earns about $10 a day[1].





Ingenuity turns up regularly in certain professions. Some software engineers eke as much utility as they can from the resource of computer memory and processing power available. As they devise ingenious work-arounds, the creation of economical and elegant code becomes a source of competition and pride[2].

Unusual circumstances can force ingenuity. The film *Apollo 13* celebrates Ed Smylie and his team of engineers that improvised maps, duct tape and other to-hand materials into a device that purified the astronauts' tainted oxygen[3].

In each of these situations, individuals and teams take a frugal approach to resources and combine them in unexpected ways. We believe that the capability exemplified in each of these scenarios is needed now more than ever.

The RSA aims to understand and enhance human capabilities. In particular, we contend that contemporary society must become more engaged, pro-social and resourceful so that we are better equipped to tackle the challenges of the 21st century.

Ingenuity is one form of resourcefulness, and this paper investigates ways in which it could be enhanced.

We have collated academic literature, content from an RSA seminar, and interviews with ingenious people. We draw on these to propose principles and specific methods that could enhance the ingenuity of individuals and teams within government organisations, businesses and communities.

Above
The air purifier constructed from maps and duct tape by Apollo 13 Astronauts (Photo: NASA, scanned by John Fongheiser), see http://www.hq.nasa.gov/alsj/a13/images13.html#8929

1 Afrigadget, 2007, *The Knife Sharpening Bicycle*. Available at: http://www.afrigadget.com/2007/06/21/the-knife-sharpening-bicycle/

2 See the Mix10k Challenge: http://mix10k.visitmix.com

3 See http://www.hq.nasa.gov/alsj/a13/images13.html#S7035013

WHY WE NEED TO BE MORE INGENIOUS

Many of our most urgent challenges have been aggravated by the over-consumption of resources. We need to become increasingly ingenious in response.

In the public sector, a long period of plenty is giving way to intense austerity. Public servants have been compelled to reduce costs by up to 35% while maintaining public services. The budget of the Department for Communities and Local Government, for example was reduced by 35.6%, with a knock-on impact for local councils of a 7.1% budget reduction each year[4]. Ministers have appealed for advice on creative cutting: "Don't hold back. Be innovative, be radical, challenge the way things are done."[5] wrote the Prime Minister and Deputy Prime Minister in a letter to public sector workers last year.

Public sector leaders aren't alone in seeking creativity. A recent survey of CEOs labelled the business world "substantially more volatile, uncertain and complex" than ever, voting creativity the most important capability of today's leaders[6]. Businesses in the UK became leaner in response to this uncertainty by making many staff redundant, causing unemployment to rise sharply in 2008/09[7].

'Small government, Big Society' bluntly describes the Government's direction. For many in the voluntary and community sector, a society in which people "feel both free and powerful enough to help themselves and their own communities"[8] is attractive. However critics complain Big Society rhetoric is incompatible with such drastic cuts for the sector that currently strengthens communities.

In the public, private and third sector, creativity and innovation are certainly important, but a better term may be ingenuity. Neither *creativity* nor *innovation* conveys the meaning we think implicit in *ingenuity*.

4 BBC News, 2010, *Spending Review: In graphics*. Available at: http://www.bbc.co.uk/news/uk-politics-11583746

5 Cameron, D. & Clegg, N., 2010, *PM and Deputy PM letter to public sector workers*. Available at: http://www.number10.gov.uk/news/statements-and-articles/2010/06/pm-and-deputy-pm-letter-to-public-sector-workers-52319

6 IBM, 2010, *Capitalising on Complexity*.

7 Office for National Statistics, 2011, *Employment*. Available at: http://www.statistics.gov.uk/cci/nugget.asp?id=12

8 Cameron, D., 2010, *Big Society Speech*. Available at: http://www.number10.gov.uk/news/speeches-and-transcripts/2010/07/big-society-speech-53572

9 Institute for Government, 2009, *State of the Service*. Available at: http://www.instituteforgovernment.org.uk/news/article/37/new-report-state-of-the-service

10 Kim, K., 2010, pers. comm.

"The central question [of my research] was: 'how and whether societies could respond in an innovative way to the environmental stresses of resource scarcities they were facing — and if they didn't, or couldn't, then they were much more susceptible to societal breakdown and violence."

Thomas Homer-Dixon author of *The Ingenuity Gap*, speaking at an RSA seminar

"We're continually alienated from the world around us, anything from technological objects to banking and economics, we're just trained out of being involved."

"Things are presented as this is 'the solution to the problem' but it's been done by somebody else. Thirty years ago the computer came with the schematic, now you can't imagine any device coming with the circuit diagram. Whether or not people examined it, the fact that it was possible to show it and that people were expected to be able to understand it..."

"My Dad's response if anything broke at home (he was never brought up to work with his hands) was; 'I'll just work harder, so I'll earn more so I can pay someone to come and fix it' ."

Discussion at an RSA seminar on ingenuity

How can public servants make their diminished budgets stretch further? How can business leaders recover the enterprising spirit which they used to form ventures out of familial donations and chance encounters? How can volunteers and communities improvise with what they can lay their hands on in order to create stronger neighbourhoods?

The demand for ingenuity is clearly there — but can we supply it?

At one level, suggests Canadian academic Thomas Homer-Dixon the answer is 'not yet'. In *The Ingenuity Gap* he develops a theory of ingenuity, arguing that the world's increasing complexity, unpredictability and sheer pace create a demand we're currently unable to meet. For Homer-Dixon, one of the indicators of the gap between demand and supply of ingenuity is our continued degradation of the natural environment.

Homer-Dixon is interested in ingenuity at the global level. But other sources closer to home tell an overlapping story. In the public sector, the *State of the Service* report characterised UK civil servants "committed but somewhat conservative"[9], looking towards senior managers rather than frontline staff for innovation. More generally, a study of forty-two years of data (272,599 scores) from Torrance's Test for Creative Thinking suggests school children may be becoming less creative[10].

Many have speculated about the existence of a creativity deficit. Multiple scapegoats have been identified; declining numbers employed in manual labour, increasingly pervasive and inaccessible technology, and a throw-away culture for example. However whether creativity is decaying, surging or stable, we suggest that our problems require not just a creative, but an ingenious approach. But what is ingenuity, and how can we understand what it means to be ingenious?

INGENUITY IN THEORY

In 1941, psychologist John Flanagan joined the US Army Air Force. Charged with identifying personnel capable of becoming air force pilots, he identified ingenuity as a critical capability. Flanagan developed a definition and psychometric test to identify ingenious individuals[11].

Flanagan hypothesised people were either ingenious or not. An ingenious person, he wrote, "will be able to think of the clever solution very quickly, whereas the individual lacking this quality will be unable to think of such solutions even if given a large amount of time". Although through his test and theoretical development he made a valuable contribution, Flanagan's work on ingenuity was not significantly developed by other researchers.

Fifty years later, Thomas Homer-Dixon developed a different definition. He conceived of ingenuity as a *product* rather than a *process* of mind[12]: "ideas that can be applied to solve practical technical and social problems"[13]. To Homer-Dixon, ingenuity describes an artefact or system, rather than a personal capability.

Study of ingenuity was dormant during the years between Flanagan and Homer-Dixon. In this paper we combine elements of each scholar, together with perspectives from the broader academic literature and lay definitions to inform our own fledgling definition of ingenuity.

The RSA's interest in the human element of the system has led us to define ingenuity in terms of a *capability* that some people exhibit. It has three elements at its core; an inclination to work with the resources easily to hand, a knack for combining these resources in a surprising way, and in doing so, an ability to solve some practical problem.

Using the Resources at Hand

Homer-Dixon proposes ingenuity could be represented by "sets of instructions"; a list of the steps required to put a solution into practice, like a recipe or algorithm.

As part of a manufacturing process, the inside lip of a deep cup-shaped casting is machine threaded. The company found that metal chips produced by the threading operation were difficult to remove from the bottom of the casting without scratching the sides. A design engineer was able to solve this problem by having the operation performed...

A.	*i – – – – p*	*h – – h*
B.	*m – – – – n*	*c – – e*
C.	*f – – – – r*	*w – – l*
D.	*l – – – – d*	*b – – k*
E.	*u – – – – e*	*d – – n*

A question from Flanagan's ingenuity test

"I'm setting up a notion of ingenuity as 'recipes', sets of instructions, that tell us how to arrange the constituent parts of our physical and social worlds that tell us how to achieve our goals. Think of recipes. And the question then becomes can we supply sufficient number of the right kinds of recipes to respond to the problems we're facing."

"The measure of ingenuity then becomes the length of those instructions ... or the length of the algorithm ... in some rough and ready sense, we can think of the length of the algorithm as a measure of the amount of ingenuity that's represented by that solution."

Thomas Homer-Dixon author of *The Ingenuity Gap*, speaking at an RSA seminar on ingenuity

For example, he imagines that a malevolent person has locked him into his study. He decides his only option of escape is to signal his presence to people passing on the street in front of his house. His desk contains several resources:

"...a large number of books, journals, and newspaper clippings; a thick pad of large sheets of white butcher paper ... an assortment of pens, markers, paper clips, and sticky tape ... and a long aluminum pole with a special connection on the end that allows me to close the blind on the skylight."[14]

He escapes from his predicament by seeing that the aluminium pole unscrews into sections. To the first of these he tapes one of the large sheets of paper, then feeds it into the study's fireplace and up the chimney. He adds as many successive sections as he needs until he gauges the makeshift flag has emerged above the chimney stack. Waving the end vigorously to attract attention, he waits to be rescued.

While longer (more complicated) sets of instructions represent a greater *quantity* of ingenuity, Homer-Dixon suggests that "a set of instructions would represent higher quality ingenuity than another if it's simpler or shorter"[15].

In other words, better ingenuity is characterised by frugality or elegance, and implies a tendency to first use resources that are easily to hand.

Ingenuity is also therefore related to the inclination noted by anthropologist Claude Lévi-Strauss in his description of the bricoleur's (or handy-man / tinkerer) approach to problem solving:

"...the rules of [the bricoleur's] game are to always to make do with 'whatever is at hand', that is to say with a set of tools and materials which is always finite and always heterogeneous because what it contains bears no relation to the current project."[16]

The Bricoleur also has a frugal approach to resources. Rather than procuring exactly the right tool for the job, the bricoleur uses whatever is available, no matter how seemingly irrelevant.

11 Flanagan, J. C., 1963, *The Definition and Measurement of Ingenuity*. In: Taylor, C. W., *Scientific Creativity. Its Recognition and Development.* p.89-98.

12 Homer-Dixon, T., 2010, pers. comm.

13 Homer-Dixon, T., 2000, *The Ingenuity Gap.* p.21.

14 Homer-Dixon, T., 2000, *The Ingenuity Gap.* p.191.

15 Homer-Dixon, T., 2000, *Ingenuity Theory*, Available at: http://www.homerdixon.com/ingenuitygap/theory.html

16 Lévi-Strauss, C., 1962, *La Pensée sauvage.*

Above
Ingenious behaviour captured in IDEO's *Thoughtless Acts* (Photo: IDEO)

Left
Ingenious football (Photo: Erik Hersman), see http://www.flickr.com/photos/whiteafrican/841569706/

Right
Karl Duncker's Candle Problem, with ingenious solution overleaf

Surprising Combinations

The second attribute of ingenuity is the ability to combine the chosen resources in a way that few would expect. Ingenuity is the ability to solve a problem "in an unusually neat, clever, or surprising way"[17] asserted Flanagan.

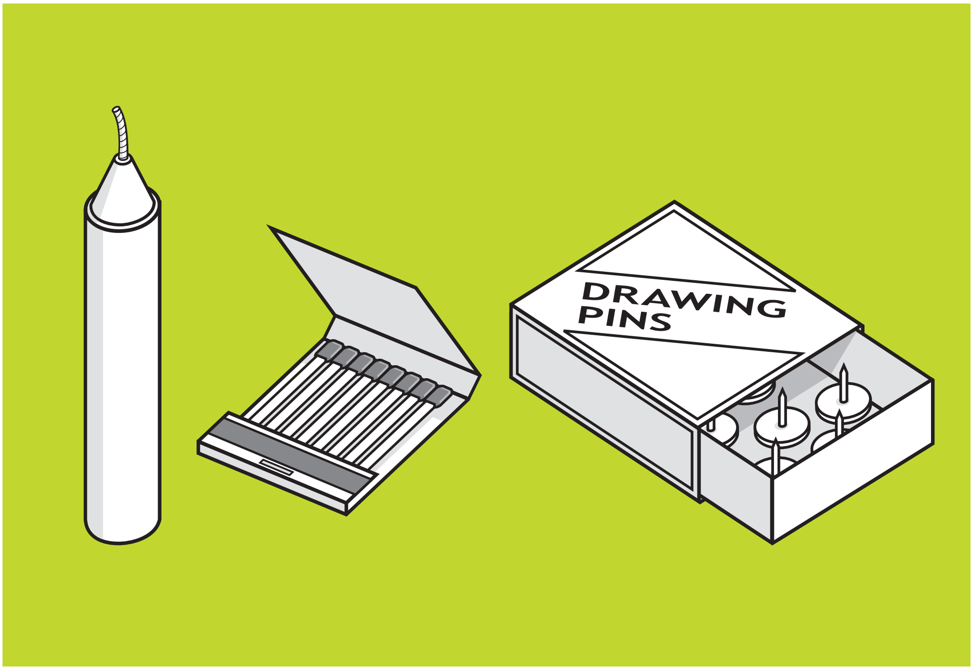
Unexpected combinations of artefacts are studied by psychologists interested in functional fixedness: the "tendency to think of an object only in terms of its typical functions"[18]. A cognitive bias, functional fixedness was illustrated by Karl Duncker, a psychologist who set this problem: given a candle, a box of drawing pins and a match, attach the candle to the wall.

Neither directly pinning the candle to the wall, or melting wax to use as an adhesive, works. The best — the ingenious — solution lies in re-seeing the box of drawing pins as something that can be emptied, pinned to the wall and used as a shelf for the candle[19]. The candle problem illustrates that the frugal use and unexpected assembly of resources can go hand in hand.

17 Flanagan, J. C., 1963, *The Definition and Measurement of Ingenuity*. In: Taylor, C. W., *Scientific Creativity. Its Recognition and Development*. p.89-98.

18 Finke, R., Ward, T., Smith, S., 1992, *Creative Cognition*. MIT Press

19 Duncker, K., 1945, *On Problem-Solving*, Psychological Monographs. Volume 58.



Solutions to Problems

Lastly, ingenuity is applied to solve practical problems. Flanagan described it as: "inventing or discovering a solution to a problem"[20]and Thomas Homer-Dixon explained it as "the subset of practical ideas that we apply to our practical problems"[21]. Not necessarily synonymous with technological invention, Homer-Dixon also writes that ingenuity (or ingenious solutions) can be social as well as technical in nature.

Defining what 'counts' as a problem can be contentious, but for our purposes we suggest concentrating on practical problems that threaten our basic (according to Maslow) needs. For example threats to our physiological needs, our needs for safety, personal and financial security, health and well-being[22] and so on.

There are other distinctive characteristics to ingenuity that we are beginning to identify. Things that are notable for their novelty become more familiar as time passes, and their novelty 'degrades'. But things that are ingenious are more persistent; the ingenuity of many old inventions is still obvious today, and as Thomas Homer-Dixon wrote, ingenuity "assumes that ideas don't have to be new to be useful"[23]. Similarly, many of the people we have canvassed suggest that ingenious things have an "aha" quality to them, evoking a feeling of "it's so obvious!" when seen.

Ingenuity, Creativity and Innovation

Why should we explore ingenuity when reams of papers are published on creativity and innovation? We believe *creativity* is too broadly defined to use as a call to action against the problems of resourcefulness that are emerging.

In the academic literature at least, creativity is usually defined as the "ability to produce work that is both novel and appropriate [or useful]"[24], and makes no requirement for solutions. Creative problem solving is a field of study in its own right, but unlike ingenuity does not imply constrained resources. We conceive of ingenuity as a sub-set of both creativity and creative problem solving. Ingenious things are novel and useful, but they are novel for their element of surprise, and useful because they solve practical problems. They are also frugal and elegant.

20 Flanagan, J. C., 1963, *The Definition and Measurement of Ingenuity*. In: Taylor, C. W., *Scientific Creativity. Its Recognition and Development.* p.89-98.

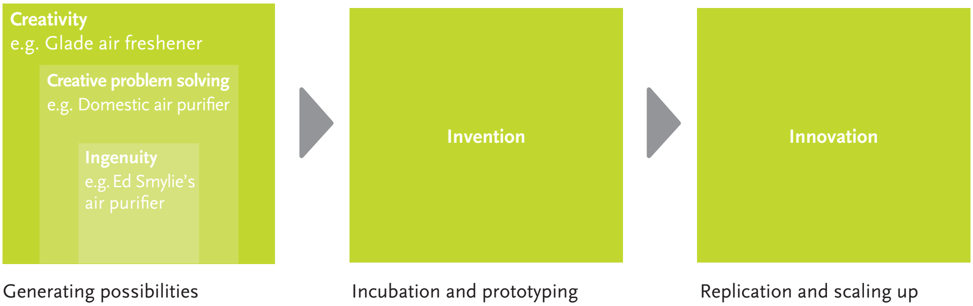
21 Homer-Dixon, T., 2000, *The Ingenuity Gap.*

22 Maslow, A., 1943, *A Theory of Human Motivation*, Psychological Review 50(4):370-96

23 Homer-Dixon, T., 2000, *The Ingenuity Gap.* p.230.

24 Sternbergan, R., Lubart, T., *The Concept of Creativity: Prospects and Paradigms.*

	Novelty	Usefulness	Solution	Frugality	Surprise
Creativity	X	X			
Creative problem solving	X	X	X		
Ingenuity	X	X	X	X	X



If creativity is the process that conceives of new ideas, then innovation is the process that executes them, scaling them up and monetising them as appropriate. Innovation inherits its definition from creativity, for example: "the successful implementation of creative ideas within an organization"[25]. In the present paper, our interests are focused on how to come up with ideas (or solutions) rather than what to do with them. We use innovation to describe the implementation of ingenious solutions, in the same way that it describes the implementation of creative ideas.

We believe that *creativity* is insufficiently focused to meet the challenges we face, and that in practice, both 'creative' and 'innovative' are too often applied to things that are neither.

Above
Distinctions between creativity, creative problem solving & ingenuity

25 Amabile, T. M., Conti, R., Coon, H., Lazenby, J., Henon, M., 1996, *Assessing the Work Environment for Creativity*, The Academy of Management Journal, 39 (5), 1154-1184.

26 Jenny and Dave, 2010, *Jugaad*. Available at: http://ourdelhistruggle.com/2009/10/07/jugaad/

27 See http://www.businessweek.com/innovate/content/dec2009/id2009121_864965.htm

28 Gibbert, M., Scranton, P., 2009, *Constraints as sources of radical innovation? Insights from jet propulsion development*, Management & Organizational History, 4 (4), 385-399.

"I was bundled into the back of a car, a metallic green Vauxhall Viva with my brother and sister on a family trip to London, we lived in north Lancashire. Pouring with rain, headed down the motorway, My Dad was in front. Suddenly the windscreen wipers stop working … half an hour later we were back on the motorway with the wipers working. What my Dad had done was simply go to the boot, got out a ball of string and rigged up a contraption — a pulley system — my brother on one side, me on the other, my sister in the middle calling time, and we were 'rowing' our way down the motorway with the windscreen wipers flip-flopping."

Matt Cole author of *How to Predict the Weather with a Cup of Coffee*, speaking at an RSA seminar on ingenuity

INGENUITY IN PRACTICE

Though the academic literature of ingenuity is scanty, colourful accounts of ingenious behaviour can be found in the practices, cultures, and training of individuals and teams who solve problems with sparing and surprising use of resources. This section highlights seven examples of ingenuity as a first step to identifying common principles of ingenuity.

Example One: Jugaad

The Bricoleur's heterogeneous stock of tools and materials is illustrated to an extreme by the Indian practice of 'jugaad' — synonymous in our minds with ingenuity. One impressed western resident of Delhi describes three examples of everyday sights in the city: "The clever repurposing of used water bottles as cooking oil containers. Rope spun from discarded foil packets. Cricket wickets made from precariously balanced stacks of rocks."[26]

The spirit and practice of jugaad takes whatever materials are available, converting them into a surprising new solution to an everyday problem. Cambridge University's Navi Radjou explains that "Indian engineers have long known how to invent with a whole alphabet soup of options that work, are cheap, and can be rolled out instantly. That is jugaad."[27]

Example Two: Technology Races

Towards the end of the second world war, Germany and the US competed for more powerful airplane jet-engines. More powerful jets fail more frequently; the higher temperature causes material fatigue in critical parts. The German teams had little funding and were isolated from new alloys that could cope with the heat, but the US had near limitless resources. However it was the German solution — to hollow out parts so that cooling air could flow through them — that became the standard in modern jet engines[28].

Similarly, during the energy crisis of the 70s, Danish carpenter Christian Riisager used wood, a car motor, lorry gears and other available items to fashion a wind turbine. His countrymen developed his low-tech turbine with incremental changes. The US attempted to leap-frog Denmark's rather agricultural approach with high tech know-how, but ultimately failed to lead the market. Denmark holds four of the six largest wind turbine firms in the world. "We thought in a typical American fashion that there would be inevitable breakthroughs that would make the 'pedestrian' Danish approach obsolete overnight" said one American wind turbine pioneer[29].

Example Three: Literary Ingenuity

An economical approach doesn't just mean making physical things. Journalists communicate ideas in as little space as possible. Félix Fénéon, a clerk in the French war department, wrote over 1000 *faits-divers* for Le Matin in 1906[30]. He communicated the essence of each piece of news, using the minimum of newspaper column inches. Another minimalist writer, poet Madoka Mayuzumi attributes the attraction of Haiku to the strict constraints of seventeen syllables, in the same way that a gymnast must perform within a floor that measures thirty nine by thirty nine feet[31]. Though perhaps less literary, text messages and Twitter[32] have inspired people to dispense with linguistic rules to fit within 160 character limits, forming more space-efficient language. As a runner up in T-mobile's Txt laureate competition wrote in 80 characters: "O hart tht sorz / My luv adorz / He mAks me liv / He mAks me giv / Myslf 2 him / As my luv porz"[33].

Example Four: New Institutions

The creation of new institutions can demonstrate efficient use of existing resources. David Stark, in his study of post socialist Hungary wrote of actors "rebuilding organizations and institutions not *on the ruins* but *with the ruins* of communism as they redeploy available resources in response to their immediate practical dilemmas"[34]. Others have studied how high-tech organisations adapt to the fast pace of technological change by spinning new and agile

Right
Jugaad (Photo: Pratul Kalia), see http://www.flickr.com/photos/pratulkalia/4752100609/

29 Garud, R., Karnøe, P., 2003, *Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship*, Research Policy, 32, 277-300.

30 See http://www.nybooks.com/books/imprints/classics/novels-in-three-lines/

31 Mayuzumi, M., Comments made during a speech at the Japanese Embassy in London, See http://www.uk.emb-japan.go.jp/en/event/webmagazine/jan11/mayuzumi_madoka.html

32 See http://twitter.com/search?q=%23haiku

33 See http://www.guardian.co.uk/books/2008/jul/05/saturdayreviewsfeatres.guardianreview

34 Stark, D., 1996, *Recombinant Property in East European Capitalism*, The American Journal of Sociology, 101 (4), 993-1027.

35 Ciborra, C., 1996, *The Platform Organization: Recombining Strategies, Structures, and Surprises*, Organization Science, 7 (2), 103-118.

36 Jacob F., 1977, *Evolution and Tinkering*, Science, 196 (4295).

"Scratching himself with a revolver with an overly sensitive trigger, M. Edouard B. removed the tip of his nose in the Vivienne precinct house."

"Scheid, of Dunkirk, fired three times at his wife. Since he missed every shot, he decided to aim at his mother-in-law, and connected."

"'To die like Joan of Arc!' cried Terbaud from the top of a pyre made of his furniture. The firemen of Saint-Ouen stifled his ambition."

Three of Félix Fénéon's *faits-divers*

ventures out of what already exists: "the platform is the resilient outcome manufactured from the ingenious reconciliation of existing organizational mechanisms and forms, picked by management according to subjective and situated plans and interpretations"[35].

Example Five: Biology

In a speech in 1977, French biologist François Jacob dismissed the then common metaphor that evolution is akin to engineering. "Natural selection does not work as an engineer works. It works like a tinkerer — a tinkerer who does not know exactly what he is going to produce but uses whatever he finds around him whether it be pieces of string, fragments of wood, or old cardboards; in short it works like tinkerer who uses everything at his disposal to produce some kind of workable object"[36]. Over eons of time, Jacob continued, the evolutionary process converts a leg into a wing, or a piece of jaw into an ear. The bent of natural selection to convert what is already there demonstrates a pragmatic and unexpected use of existing resources.

Example Six: Teaching

The ingenuity of some teachers is embodied by Mr. Raghuvanshi, a science teacher in a rural school in Madhya Pradesh. There are few resources available to him. The school rooms are small — 12 by 18 feet for 47 students — and contain just a blackboard and a few chalk pieces. Further constrained by local educational bureaucrats, he's strictly required to teach without deviation from the approved textbook (described as "barely comprehensible to the students and often left a native Hindi speaker ... flummoxed")[37].

Working within these constraints, Mr. Raghuvanshi often teaches without explicit reference to the textbook, instead using students' experience with electrical farm machinery to show the difference between direct and alternating current. He improvised an electrochemical cell from a *lota* (a copper container used for Hindu rituals), a water purification candle and chemicals, demonstrating that current flowed by placing a magnetic needle close to the circuit and showing the students that it twitched.

Mr. Raghuvanshi is not described as a defiant rebel. Rather he "accepted and wished to conform to the professional and school science discourses", but chose to combine them with "non-official, out-of-school discourses" to create richer lessons in the face of constraints.

Example Seven: 80s Television

No list of ingenuity would be complete without reference to two cult television shows. Each episode of the *A-Team* showed the outlawed protagonists trapped in seemingly hopeless situations by an enemy, only to triumphantly defeat or escape by assembling vehicles, weapons or tools from their surroundings. Though the *A-Team* ended in 1987, jury-rigging action heroes lived on in *MacGyver*, a series in which a scientist turned secret agent displays his ability to solve any problem with duct tape and a Swiss army knife. From using an old fridge's refrigerant gas to freeze and shatter a door lock, to replacing a blown fuse with chewing gum foil, the ability to solve any problem with materials to hand became widely known as a *MacGyverism*.

37 Sharma, A., 2008, *Portrait of a science teacher as a bricoleur: A case study from India*, Cultural Studies of Science Education, 3, 811-841.

Whether bones, column inches, characters, scraps of wood, stacks of rocks or old institutions, each of these examples illustrates people, teams organisations or countries that solved problems by frugal and surprising use of resources. But how do they do it? Why are these examples unusual rather than commonplace? Can the capability of being ingenious be more widely learned, and if so, how?

In the following section, we complement existing literature with findings from interviews with people from three professions in which ingenuity seems to be required. We identify principles and specific methods that enhance the ingenuity of individuals and teams.

ENHANCING INGENUITY

"Profit and honour are two sharp spurs, which quicken invention, and animate application"[38] wrote William Shipley when planning the RSA's first activity over 250 years ago; to reward ingenious inventors with financial awards. Some of the first premiums were £50 — valued today at approximately £5,000. MIT behavioural economist Dan Ariely, conducted an experiment that shows Shipley was at least partly right. Using Karl Duncker's candle problem, he found that offering people too significant a financial incentive to solve the puzzle correlated with reduced performance[39]; banks beware. But if large financial incentives don't enhance the ingenuity of individuals, then what does?

Traditionally, easy access to resources is seen as essential for innovation; resources allow activities like research, prototyping and testing to take place. Teams not worried about financial constraints can buy what they need and concentrate on innovating. However the theory continues that if resources are constrained, innovation may suffer as the teams involved may choose not to conduct these activities. Martin Hoegl, a professor at Otto Beisheim School of Management, summarises the potential pit-fall:

"Out of their perception of financial inadequacy [resource-constrained teams will] anticipate low performance from the outset, blame the organization for failing to provide the financial resources for getting the job done, regard the project as largely ill-fated, and will thus tend to disengage from the task given."[40]

But the case studies mentioned above, such as the United States' race with Germany to develop jet engines, and with Denmark to capture the wind turbine market, illustrate that abundant resources don't always mean better solutions.

Likewise, researchers Ted Baker and Reed Nelson studied 29 resource-constrained firms. They noted that some exhibited "an impressive ability to get by or do without resources that other firms considered essential".

38 Shipley, W., 1753, *Proposals.* In: Allan, D. G. C., 1968, *William Shipley.*

39 Ariely, D., Gneezy, U., Loewenstein, G., Mazar, N., 2005, *Large Stakes and Big Mistakes*, Federal Reserve Bank of Boston Working Paper No. 05-11

40 Hoegl, M., Gibbert, M., Mazursky, D., 2008, *Financial constraints in innovation projects: When is less more?*, Research Policy, 37, 1382-1391

41 Baker, T., Nelson, R. E., 2005, *Creating Something from Nothing: Resource Construction through Entrepreneurial Bricolage*, Administrative Science Quarterly, 50, 329-366.

42 Moreau, C. P. and Dahl, W. D., 2005, *Designing the Solution: The Impact of Constraints on Consumers' Creativity*, The Journal of Consumer Research, 32 (1), 13-22.

43 Specific methods of thinking 'inside the box' are discussed in more detail below.

"A trick I find is that if you know a bit about something but not too much you can probably design better for it, because then you do things you wouldn't normally do, because you know you shouldn't do them, but then you get brought up at the stage of: 'Ah I can't do that' and the trick is getting past that."

Discussion at an RSA seminar on ingenuity

The key skill of these firms, they remark, lies in "refusing to treat (and therefore see) the resources at hand as nothing"[41].

A further study asked consumers to create a toy by combining shapes. Participants were either given freedom to use up to five shapes of their choice from a pool of twenty, or constrained by being assigned five and asked to use them all. When given free reign, subjects tended to "follow a path of least resistance", creating toys that lacked novelty. When constrained, the toys were judged more creative[42].

If constrained resources don't always reduce innovation, it's clear they don't always lead to better outcomes — or every impoverished organisation would be a hot-bed of innovation. What makes the difference? What leads some individuals and teams to be ingenious and flourish in the face of constraints, and others to fail?

Hoegl side-steps the argument over whether constraints inspire or impede innovation. He proposes that financial constraints neither positively or negatively relate to project performance. Adherents to the traditional view (that constraints impede), he summarises, warn that constraints limit innovation by raising two barriers:

- Barriers of *capability* occur when resources prevent a team from conducting tasks that proved useful in the past; research, prototyping, testing and so forth
- Barriers of *will* occur when reduced resources affect motivation; the team reduce their commitment and effort because they perceive the project as under-funded

Drawing on the literature, Hoegl suggests five principles that moderate the effect of these barriers on innovation. To supersede the barrier of capability, two principles are:

1. Bounded creativity; teams who favour 'thinking *inside* the box'[43] in order to generate creative ideas will more naturally thrive within constrained environments
2. Leveraging domain-relevant skills; diverse teams whose members are able to transfer knowledge from one domain into a seemingly-unrelated one

Three further principles are advanced to surpass the risk of barrier of will:

3 Engaging project objective; a clear and exciting goal becomes essential under constrained resources giving team members a sense of "being on a mission"[44]
4 Team cohesion; members must feel "we are in this together", and want to remain with the team — particularly important given that diverse teams may struggle to get along
5 Team potency; a can-do attitude, or the team's self-assessment of their ability to perform, encourages more commitment, effort and persistence

As principles that help teams innovate under resource constraints, we contend that these principles also encourage ingenuity of teams. We have adopted Hoegl's framework as a starting point for our study of ingenuity.

As with many broad principles, critics may suggest these simply represent common sense. While it is true that engaging objectives and cohesive teams would benefit many projects, we suggest that these factors assume increasingly critical importance in resource-constrained situations.

We interviewed people who habitually exhibit ingenuity in their professional lives. The objective was to understand which of Hoegl's principles they also held critical to their professional activities, which other principles they value, and to give examples of the application of each principle across a range of practices.

44 Hoegl, M., Gibbert, M., Mazursky, D., 2008, Financial constraints in innovation projects: When is less more?, Research Policy, 37, 1382-1391

Interview One: Neil Mullarkey & Improvisation

Performers that improvise are ingenious. They draw on minimal and un-chosen resources; suggestions from the audience or a prop presented to them, and combine them in unexpected ways to form a cohesive scene that entertains a crowd.

One of the best known groups of improvisational performers in the UK are the Comedy Store Players, who have put on two shows a week for over twenty-five years. None of their shows are prepared in advance. Unlike ad-libbing there is no script to deviate from or embellish — the canvas is completely blank. Through a series of games played with the audience they obtain shreds of information; locations, professions, genres and weave them into an act.

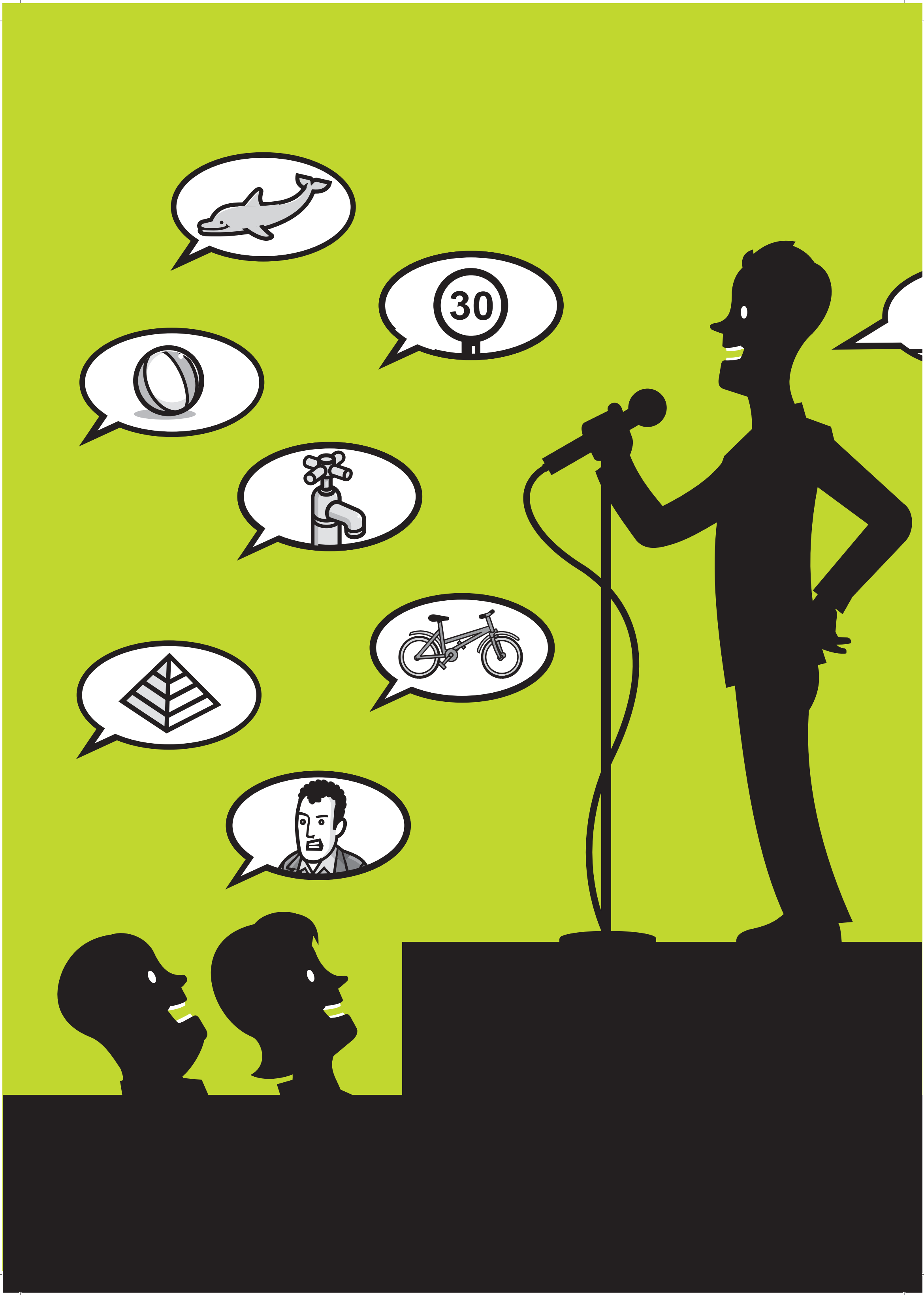
Neil Mullarkey is a founder member of the Players, who also uses improvisation techniques to help organisations become more effective. In sympathy with our working definition of ingenuity, when interviewed, Mullarkey describes improvisation as *“making the best out of what you’ve got”*. His use of improvisation in a professional context can result in some of the principles identified by Hoegl:

“I try and bring what I think are the rules of improv to that environment; sometimes it’s about creativity, sometimes it’s about working together as a team but I think it’s always about being in a story with improvised scenes which never quite finish and which no-one’s actually written a script for — and if someone had written a script for they’d be foolish to stick to that script.”

As for ingenuity, improvisation involves creativity that is bounded rather than wide open. In adapting cues given by the audience or another performer, Mullarkey compares improvisation to cooking:

“You look in the fridge, what have you got? It’s not quite perfect — I’ll make something up based on what I've previously done. It won’t be quite right, I’ll mix in ingredients that aren’t recommended, or aren’t in the recipe — or I don’t even have a recipe, I’ll just use my previous experience.”

Similarly, creating structures is important to improvisation: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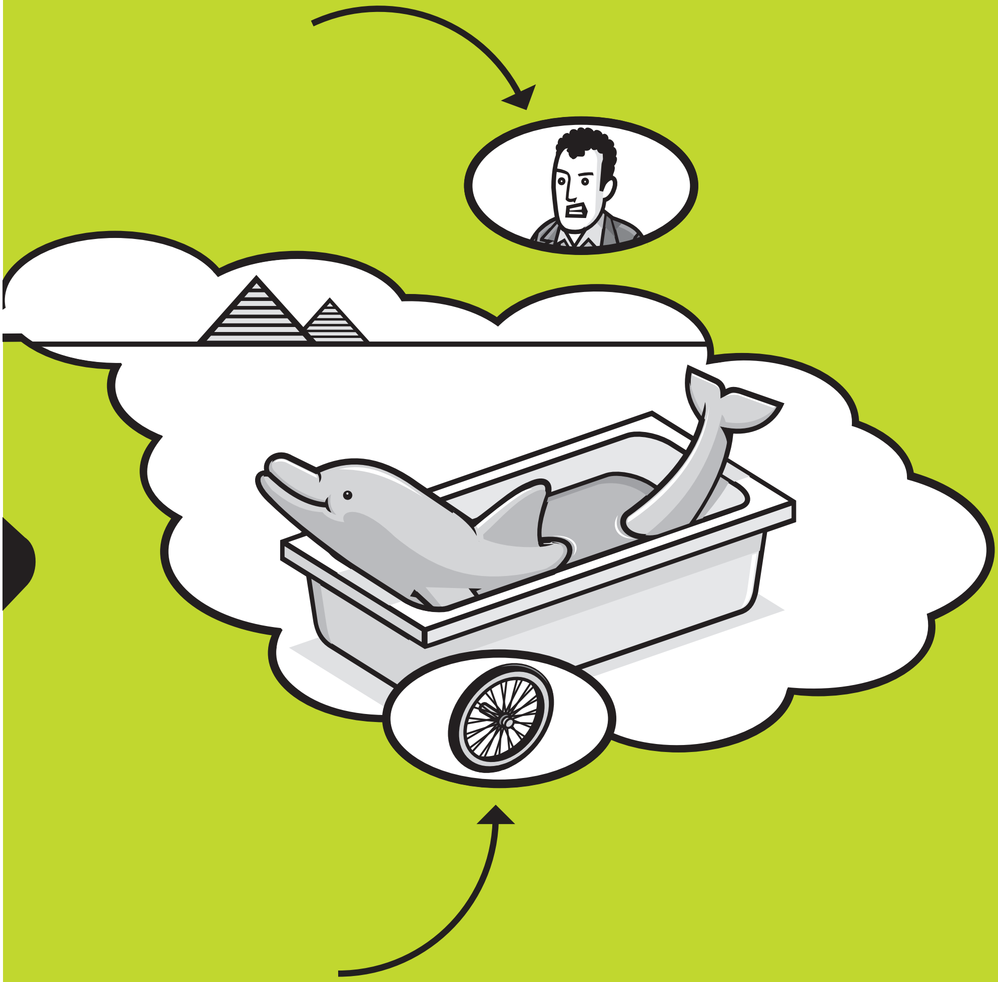


> *"People think improv is all about mess and stuff, but actually it may look like that, but you're trying to create a structure to make a satisfying improv scene, creating a structure that has some sort of narrative strength."*

Furthermore:

> *"You must make a scene that [shows]... why today; why have these people chosen to have this scene. Why have the gods of improv chosen to make this a scene today?"*

The charm of improvisation lies in the performers' ability to make the best out of a tricky situation. Mullarkey describes *Freeze tag*, one of the games played by the Comedy Store Players. Audience suggestions allow two performers to begin acting one scene. At one point a third performer will shout 'Freeze!', causing both performers to remain motionless in their current positions. The third performer replaces one of them, adopting their position and starts to act out a completely new scene. The other performer now has to justify his own position in the new scene:

> *"So you haven't chosen this [situation] at all, you're literally stuck, but the joy then comes, with you going 'How the hell can I justify this in the new reality?'. And instead of saying 'Oh I'll get out of it', or saying 'No I don't want to be here' you go 'I'm here, I must make sense'; that's when the audience loves it, because they can see that you have grappled with it; an unexpected and un-chosen offer ... So for example this looks like I'm reading a paper, but it could also look like I'm skiing, or milking a huge cow."*

The presence of an engaging objective for the performers also clearly comes across: *"basically I have loved performing this style of theatre"* says Mullarkey.

Perhaps the principles most emphasised by Mullarkey are concerned with team cohesion and potency. The Players often mention the closeness of their team and hold a Guinness World Record for the world's longest running comedy show with the same cast. Mullarkey maintains the secret of improvisation is the ability to listen to each other:

> *"...Listening to fellow players, listening to the director, listening to the writer, but in improv specifically listening to the other person as the other players..."*

The Players exhibit an uncanny ability to 'tune in' to each other's thought processes, but Mullarkey makes it sound simple in practice:

"Some people might think 'Well they're so confident, and they don't talk on top of each other, they must have a script!'. Those skills are we know when somebody is finished. We know not to talk on top of somebody else. We know to make it clear that we have finished."

When asked whether good improvisation performers are born or made, Mullarkey suggests: *"I believe improv can be taught, [though] I believe there are some people who are better at it than others"*. The potency of the team can be improved by practise. Mullarkey mentions the basic ideas:

"[Improvisation 'guru' Keith Johnstone] talks about the 'offer', an offer is something somebody gives you to do something with. An offer is when you start a scene where somebody makes you a doctor, then you make them a patient and you start a scene based on that."

The language of the performers is mutual; offers are made and accepted between performers. Often things don't go to plan:

"A classic impro moment I would say; is that what was seen as a mistake thereafter become a strength, and as you'll see tonight, some of the things we do are mishearing, misunderstanding, somebody hasn't said the thing they're meant to say. And that then becomes the spine of everything."

Mullarkey finishes with a comment that illustrates the frugality of good improvisation: *"Much of it is about simplicity, clarity, and not doing too much."*

Interview Two: Andrew Fitzgibbon & (Software) Engineering

Engineers also exhibit ingenuity. Working from the tools and materials known to them, they create technological solutions, which are often as frugal and economical as possible. Lévi-Strauss contrasted the bricoleur and the engineer to emphasise the bricoleur's ability to see anything as a potential tool, but a more recent perspective on engineering and technology suggests that technology has a similar nature:

> *"Early technologies form using existing primitive technologies as components. These new technologies in time become possible components — building blocks — for the construction of further new technologies."*[45]

New technologies evolve in the sense that they are constructed from the available resources.

Software engineering is one domain in which the ability to work within constraints is key. Writing algorithms and programmes to work within available resources, in this case computer memory and processor cycles, can result in ingenious work-arounds.

Like many large technology companies, Microsoft have a research division, part of which is based in Cambridge. Andrew Fitzgibbon is a principal researcher at Microsoft Research, with particular expertise in the field of computer vision.

Fitzgibbon suggests resource-constrained programming is perhaps best exemplified by the demoscene: a loose global collection of programmers who delight in making spectacular graphical demos, often on extremely limited hardware, such as the 30-year-old Sinclair ZX81. In some cases, the machines have been shown to have capabilities (such as high-resolution graphics in the ZX81) that even their inventors would have thought impossible. Although demosceners impose these stringent constraints on themselves, real-world programmers still face constraints:

> *"If you really want to find some working programmers who program to constraints, then go a games company where they have really hardcore programmers. These are people who know about every single [processor] cycle."*

45 W. Brian Arthur, 2009, *The Nature of Technology*, p.21.

When it comes to principles of successful programming, Fitzgibbon's account reinforces many of the principles required for ingenuity. Good programmers, for example, certainly adopt bounded approaches to creativity, first attempting to solve problems with the tools they have available:

"Good programmers have a lot of idioms, little riffs that they know that they can string together to solve a given problem. Sort of predefined routines that are handy... pretty much anywhere."

But if the problem is too new or difficult to be solved using his existing tools, the good programmer knows that somebody, somewhere must have already solved a similar problem:

"A crucial thing to do is not to invent the — [for example] 'heap' data structure — yourself because it already exists. So an important property of a good programmer is they know when to go to a book. They know when they have the feeling 'this has been done before' rather than 'I can figure this out'."

Making effective use of the available resources, in this case the collective knowledge of computer scientists and engineers, is key to good programming.

As a specialist in computer vision, Fitzgibbon was involved in the early stages of developing the Kinect, a full body sensor that allows people to interact with Xbox games without the need for a controller. Aspects of the Kinect's invention demonstrate ingenuity. It began with the setting of a difficult problem; a sensor that can reliably track the players' body without requiring too much processing power:

"Sometimes in programming you don't even know that it's possible to begin with. [The Kinect] has to work in real time which we normally think of as 30 or 60 frames per second. But you're not allowed to use 100% of the [Xbox's processing power], you're only allowed to use 10% of the Xbox... so we're talking up to 600 frames per second. Nothing has been reported in the academic literature at all that has the performance we want, and the best methods are 1000 times too slow."

The team at Microsoft in charge of the Xbox approached Fitzgibbon and other vision experts at Microsoft Research:

"So the Xbox chaps come to Microsoft Research and say 'Can we do this?' and we first say 'No you can't — don't even try!'."

But when their initial incredulity passed, the team reflected that one of Fitzgibbon's colleagues happened to have developed a technology with some similarities; a very fast method of identifying objects, such as sky, grass or sheep from pixels. Applying his skills from one domain (image recognition) to another (tracking), the team were able to supply the Kinect with the functionality it required. Using the transferred image recognition technology to identify the location of the hands, head and torso, it became possible to extrapolate the whole body's position:

> *"So the big innovation in the Kinect was that Jamie Shotton said 'Right well I'm just going to treat this as a recognition problem, I'm going to train it so that the hands are 'horses', and the elbows are 'cows'", and because the whole thing is trained from examples, it just learned these new labels. Of course they were never labels; hands were one, and elbows were two..."*

Larry Wall, inventor of the Perl programming language, maintained laziness, impatience and hubris were essential qualities of a good programmer. These characteristics give some insight into what programmers might consider an engaging objective. Fitzgibbon concurs that a reluctance to wait can motivate him:

> *"I don't understand why televisions still take 10 seconds to start up. They did when I was a kid because the little dot had to come out [from the centre of the screen], but they still take 10 seconds which I don't understand — so yeah, impatience! You know it's like 'No we're not going to wait a second every time a new high score [in a computer game] comes in — that's insane because we don't have to!'."*

He also agrees that a tendency to distrust others' solutions can determine what motivates programmers:

> *"[Programmers say] 'I'm going to do this differently from the way other people have done it before'. Why? 'Because I believe that they — the world — have not bothered to try to do it properly before. I believe that everybody else is happy with [the way things are]'. I wonder how many different ways programmers have tried to tie their shoelaces? You know, because there are a few ways — there's one where you end with two loops and you pull them out, then there's a more careful way and you might care about whether you get a reef knot or a sheep bend in the actual tying bit. I think not just programmers, but inventors, think 'there must be a better way to do this'."*

Interview Three: Glyn David & Survival

Glyn David has a broad background in *"what happens when things go wrong"*. His career involves spells in army and navy as well as flying helicopters over the North Sea, Papua New Guinean jungles and South African Bush. Trained in underwater and helicopter escape, fire-fighting, NBC (nuclear bacterial chemical) warfare and with experience of mountain rescue, police work and disaster relief all over the world, he now teaches others as a survival instructor at Trueways Survival School.

David describes his approach as *"facilitating people arriving at the knowledge, skills and attitudes that are necessary to cope in a survival situation (which means something threatening to human life) regardless of what that may be"*. Rather than teach specific techniques that are only relevant in some situations, David teaches principles:

"My specialism is in breaking down to the bare bones what it is that [people] require in any situation, and giving them principles which they can apply in any environment in the world. The environment becomes the resources available to them. And they should apply the principles, coupled with the resources they have to achieve that basic survival aim which is bodily integrity, bodily temperature and fuel."

David tells the story of a British special forces patrol, injured in the jungle during the Malaysian crisis. Though their colleagues were searching for them in helicopters, hostile forces were also looking for them on the ground, preventing them from signalling their location by lighting a fire — the standard response.

"Somebody came up with the idea that they would climb up the trees of the jungle and use their clothes and sticks to make a box kite and tether that to the top of this tree. Because the jungle is a complete solid canopy in many places, that would then [show only the British forces their location], but who came up with idea is a mystery and why — but it got them found."

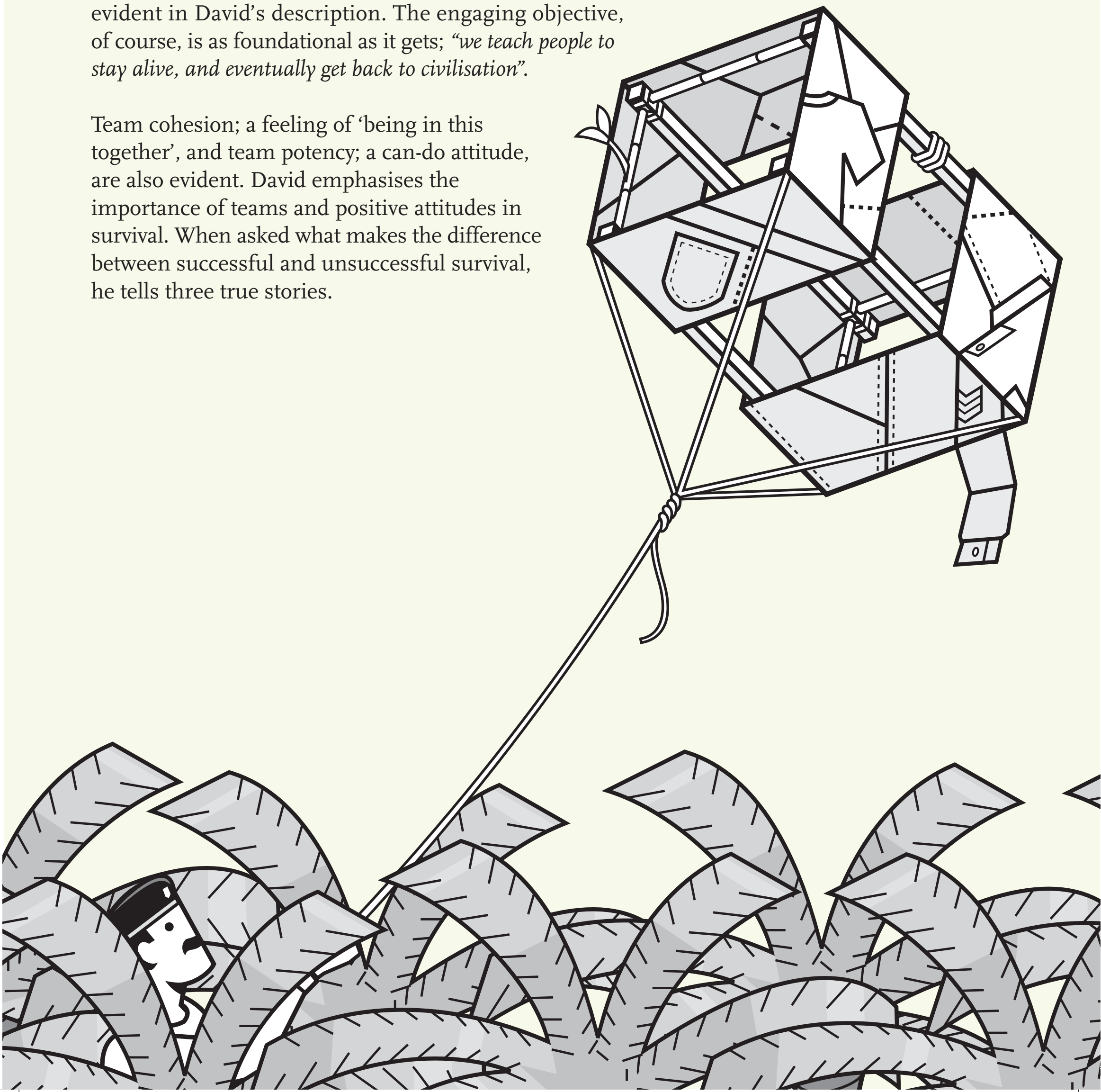
David is less explicit than other interviewees on what causes ingenious solutions to spring to mind, but his description of students' approaches to learning gives some indication. Some students only require information on a handout which they are happy to learn by rote, but others prefer to inquire more deeply:

"They want to build these relationships, see patterns develop, mesh things together, and say 'Well if that's the case then is this the case?' and we call those deep processors or deep learners. The surface is not good enough for them — they want to build the system for themselves — and I think that it's that sort of mindset which is more likely to come up with ingenious solutions."

The suspicion that those that construct mental models become more ingenious seems to align with the *Geneplore* model, one of the bounded approaches to creativity cited by Hoegl[46].

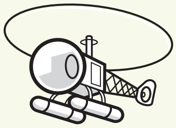
Other examples of Hoegl's principles at work are also evident in David's description. The engaging objective, of course, is as foundational as it gets; *"we teach people to stay alive, and eventually get back to civilisation"*.

Team cohesion; a feeling of 'being in this together', and team potency; a can-do attitude, are also evident. David emphasises the importance of teams and positive attitudes in survival. When asked what makes the difference between successful and unsuccessful survival, he tells three true stories.



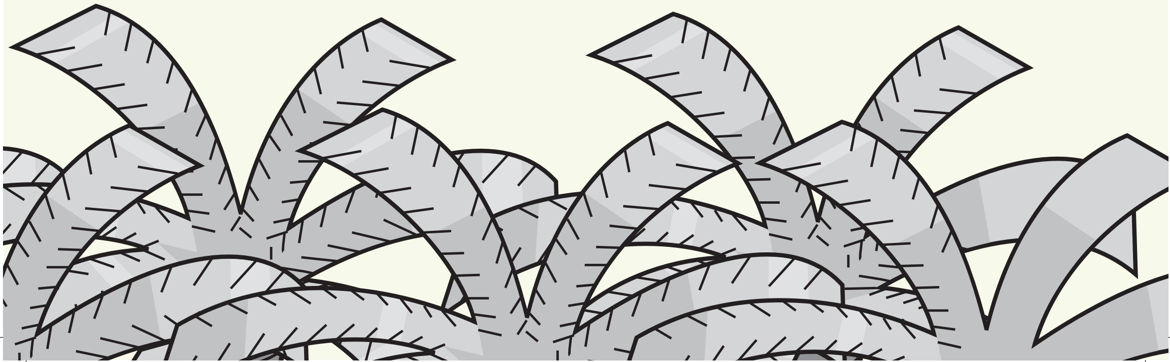
46 The *Geneplore* model is discussed in more detail below.

In the first, a Father, son and two daughters encounter trouble during a sailing trip. Abandoning their boat, they row their skiff to land. Knowing there is an emergency hut nearby, the father leaves both daughters, wrapped in a sail for warmth, and sets off with the son to get provisions and use the hut's radio. The temperatures are low, freezing during the day and -10 at night, and the landscape is difficult, steep hills covered in dense forest and deep snow. After some days, they arrive at the hut frost-nipped and in poor condition, and decide to warm up and eat before returning to the girls. When recovered they make the return journey:



"When they reached the beach on which they'd originally left the two girls, the father said to the son 'Stay here I'll go and see them'. It was 13 days later. He left the son behind because he didn't want the son to see what the result was almost certainly going to be, and as he crunched across the shingle beach, the sail cloth sat up and basically said 'Where the heck have you been!'."

Though starved, the girls had taken on water by eating snow, and kept their spirits up by making plans for the banquet they would have when back home. Though they were cold, hungry and thought their father and brother were taking a long time, the thought of dying had not crossed their minds.



The second story is of Joe Simpson (recorded in *Touching the Void*), who climbed Siula Grande in the Peruvian Andes with his friend Simon Yates. A near-fatal accident separates the two and leads Yates to become convinced that Simpson is dead. Finding himself on his own and seriously injured, Simpson has no other option than to crawl down the mountain, causing him excruciating agony and black-outs. After two days he finds himself at the bottom, miraculously just in time to catch Yates as he prepared to leave their camp.

The third story is of an American air force pilot, flying from Europe to the States at the end of the second world war. Unusually for the times, the American air force trained their pilots in survival, and the plane was well-equipped with raft, flare pistol, stove, food, water and clothing suitable for low temperatures. The plane's engines stopped over Newfoundland, and putting out a mayday call, but unsure whether it had been heard, he landed on snow.

Three days later, rescuers arrived at the crash site and found a set of footprints leading away from the plane. The footprints made a wide circle of the plane and returned to it. They found the pilot in the plane:

> *"He was sitting in the aircraft, with none of the survival equipment in use. On top of the instrument coving (like the top of a dashboard in a car) a stubbed out cigar. His personal weapon, a pistol was on the floor between his feet and a bullet was in his head. [The rescuers] assumed that [after examining the area] he had said: 'There is nothing here, and I will die horribly'."*

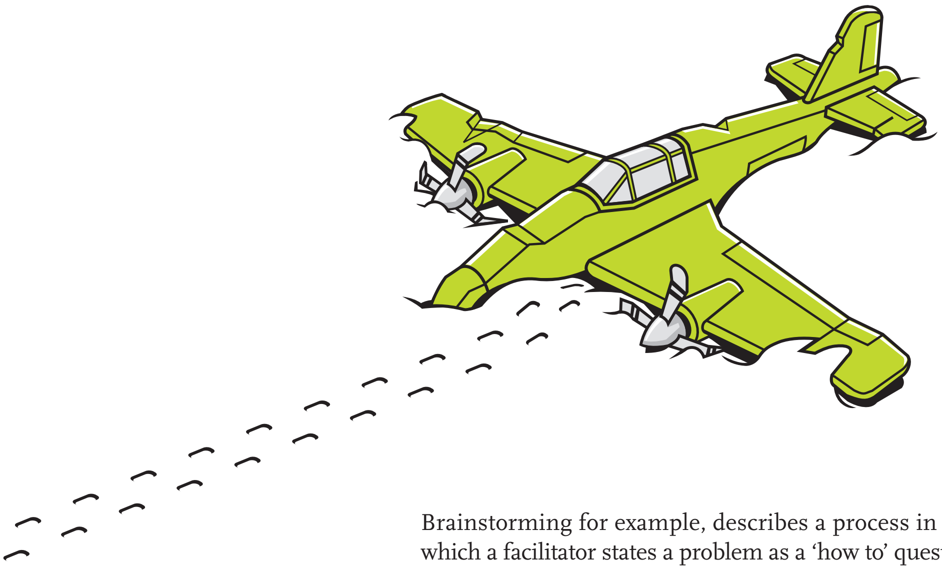
David's point from all three stories is that in each, the most important factor in their survival was their attitude — more so than their knowledge, skills or equipment:

> *"What makes people good survivors and poor survivors? It's their attitude towards the situation. If their attitude to the situation is positive, then they may well be ingenious. They may well come up with interesting ways to achieve things. The guys who were stuck in the jungle unable to signal for help came up with an ingenious method. But they could have sat their on their arses. Two of them were full of bullets, and one climbed a tree. They could have taken the attitude 'Guess we'll just light a fire and hope they find us' or they could take the attitude 'Sod this, I'm going to climb a 300 foot tree on my own and fly a kite off it'."*

Bounded Approaches to Creativity

While most of the principles advanced by Martin Hoegl are straightforward, his suggestion that bounded rather than open methods of creativity are more suitable may need some explanation. The below paragraphs outline these approaches, but much more could be written than is within scope of the present document.

From Edward de Bono's *Lateral Thinking* through Alex Osborn's *Brainstorming* to William Gordon's *Synectics*, numerous (so called) pragmatic methods of enhancing creativity have been developed. Many of these favour generating as many ideas as possible, before sorting the creative from the unfeasible: "unbounded randomness is beneficial ... in order to find one good idea, hundreds, if not thousands of ideas are needed"[47] as Hoegl puts it.



Brainstorming for example, describes a process in which a facilitator states a problem as a 'how to' question, and a team respond with ideas, while observing simple rules such as "no criticism of ideas" and "encourage wild and exaggerated ideas". Alex Osborn, the advertising executive who developed the practice supposedly said "it is easier to tone down a wild idea than to think up a new one".

47 Hoegl, M., Gibbert, M. Mazursky, D., 2008, *Financial constraints in innovation projects: When is less more?*, Research Policy, Volume 37, 1382-1391

In contrast to the idea that quantity begets quality, bounded approaches to creativity take a complementary view. Creativity researchers Ronald Finke, Thomas Ward and Steven Smith assert that "limited resources force one to think in more creative and less conventional ways"[48] and their *Geneplore* model of creative cognition takes this into account, advocating two phases, each of which take constraints into account.

The first phase involves generating 'pre-inventive structures'; visual patterns, symbols, metaphors or mental models that represent the problem under consideration. The second phase entails exploring the various properties of these structures, ideally resulting in a new creative product. One example of a pre-inventive structure has already been mentioned — the mental models created by the more ingenious of Glyn David's survival students.

Another bounded approach to creativity was developed by Russian engineer Genrich Altshuller. Analysing a database of over 200,000 patents, he noticed emerging patterns and extracted rules, forming principles of problem solving and invention. The resulting *Theory for Inventive Problem Solving* (Теория Решения Изобретательских Задач), or *TRIZ* (ТРИЗ), is now widely used by engineers, but has also been applied to social problems.

Jacob Goldberg and David Mazursky of the Hebrew University of Jerusalem adapted TRIZ into a set of five generic innovation patterns. Using their system to develop a new product, for example, they advocate starting with the current solution rather than a blank page. The physical components, attributes and environment of the product are first listed, then one of the five patterns are used to manipulate these elements. The five patterns are[49]:

1. Subtraction; rather than improving a product by adding features, try taking them away, ideally those seen as indispensable. For example, Philips designers found they were able to remove all but one control button from their DVD players.

"The things we come up with in the design studio are obvious in retrospect. We work in teams of technologists and designers: people who can't understand each other. We have a period of what we call material exploration... it's all about getting your hands dirty. So if it's data, it's getting all that data into a database and making ways to understand it... We force people to describe it to each other, and what happens is they end up inventing a new language to describe the particular things [that are characteristic] of that project. We call it Dutch — it sounds exactly like English, but if you listen closely you can't make out a word — so every project evolves its own Dutch. And after a period of weeks you can [return to] the original problem and ask: 'how should we do this?' — and the solution is clear: 'what we do is this!'. And the final outcome is usually the simplest way. It's clever, it's how you should have done it in retrospect, but you have to decode it from the slightly weird language they've developed."

Matt Webb, CEO, BERG speaking at an RSA seminar on ingenuity

"TRIZ works very well at the rule-governed end [of the problem-solving spectrum], synectics works very well at the non-rule governed."

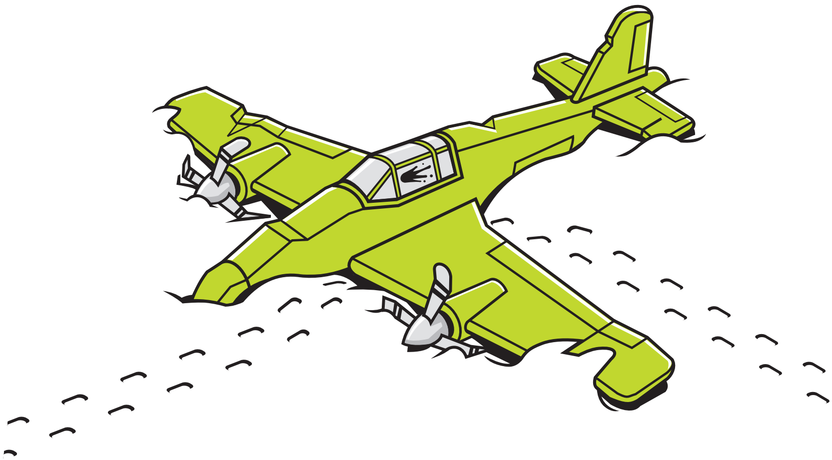
Discussion at an RSA seminar on ingenuity

2 Multiplication; duplicate elements of an existing product, but slightly change each one. For example, Gillette added an extra blade to their razors, but changed its angle, raising hairs that are subsequently cut by the second blade.

3 Division; decompose a product into its components. For example a hi-fi was once a single piece unit, but now is sold as separates, allowing enthusiastic owners to compose their own system.

4 Task unification; sometimes existing elements can be assigned new tasks. For example car windscreens' defrosting elements can be wired up to the radio, negating the need for a sole purpose antenna.

5 Attribute dependency change; relationships can be created or removed between components. For example the stiffness of a mattress is usually consistent along its length, but recent models have variable stiffness, providing support at key points.



48 Finke, R., Ward, T., Smith, S., 1992, *Creative Cognition*, MIT Press

49 Goldenberg, J., Horowitz, R., Levav, A., Mazursky, D., 2003, *Finding Your Innovation Sweet Spot*, Harvard Business Review

Although Goldberg and Mazursky use new product development to describe their approach, the principles are sufficiently generic to apply to other problems, from public service delivery to establishing new markets, to behaviour change interventions. Indeed Altshuller thought TRIZ had application beyond engineering, and several case studies indicate its success.

One local council used TRIZ to cut their costs. Buckinghamshire County Council's Legal and Democratic Services (LDS) were tasked with reducing their cost to the council. In the face of resource constraints, they used TRIZ to develop a strategy that allowed the LDS to take on external clients without compromising their internal clients. These more profitable clients; other public bodies, private clients, parish councils and charities will subsidise — eventually by 100% — the legal service provided to the council by the LDS[50].

50 Haines-Gadd, L., *TRIZ for UK Government Cost-cutting*, Oxford Creativity

FROM THEORY TO PRACTICE

With problems like reduced public spending, over-consumption of natural resources, and economic inequalities wrought by globalisation, the challenges facing the UK in the 21st Century are significant. We contend that creativity is not good enough. Problems like these call for a particular response: ingenuity.

Fostering the ability to solve practical problems by combining remarkably few resources in a surprising way, is much harder than asking people to come up with radical ideas, or incentivising them with bonuses. But our ingenious interviewees are convinced that people can improve their ingenuity. The academic literature and our own research hints at certain principles and specific tools to encourage ingenuity. This paper presents our initial understanding of these.

Constrained resources can lead to barriers that reduce a team's capability to innovate. But this barrier can be superseded if certain principles are applied. Individuals and teams that adopt bounded approaches to creativity, like improvising performers that make "the best out of what they've got", or those who use TRIZ and innovation patterns will be more naturally ingenious. Teams that can leverage domain-relevant skills, like the computer scientists and software engineers that developed the Kinect by transposing a technology from one field to another, will become ingenious when faced with constraints.

Constrained resources can also lead to barriers that reduce a team's will to innovate. As before, this barrier can be overcome by employing other principles. An engaging objective, one that a performer loves to do, or that triggers a software engineer's (self-diagnosed) impatience or hubris, will encourage ingenuity. A cohesive team, like the Comedy Store Players who love to work with each other, and a potent team, who know that they have triumphed in difficult situations in the past, will be more ingenious.

These findings are theoretical, though they may focus the minds of public sector managers, community leaders and businesses under pressure. But theory doesn't help anyone. We propose a practical project to test our assertions.

Through the RSA's existing practical projects which take place in fields as diverse as education, substance addiction, community empowerment and behaviour change, we identify real social problems every day, many of which must be solved in resource-constrained environments. Some examples are:

- Many public services address problems caused by poor relationships between distinct communities (for example groups divided by generation or race), so how could they repair and develop stronger relationships between divided groups?
- Non-scientists are often poorly equipped to make fair and accurate judgements about the application of scientific knowledge, so how could they make better judgements, supporting science that is in the public interest and challenging science that isn't?
- Students with social research skills need projects in order to complete their dissertation, and many existing third sector organisations need research capacity, so how could the two be matched in a way that satisfies each party's interests?

None of these problems are unusual, instances of them are faced by individuals and organisations across the UK and beyond. We propose three specific areas in which practical projects could realise and test the principles of ingenuity we advance, resulting in ingenious solutions to these problems and more.

Ingenious Communities

First, we propose working to foster ingenuity in communities. The RSA's Fellowship is a network of experts from a wide range of disciplines, distributed across the UK and beyond. We will offer Fellows the opportunity to form or join an ingenious team in their own neighbourhood, connecting them with 'owners' of resource-constrained problems in local communities, authorities and businesses.

Whether by helping these teams to develop bounded approaches to problem-solving (such as TRIZ), by seeding teams with individuals who posess complementary expertise, or by helping to develop their sense of cohesion and potency, we will support them to foster their ingenuity and become effective neighbourhood problem solvers.

Ingenious Incentives

Second, we propose revitalising RSA Founder William Shipley's original Premiums scheme that rewarded ingenuity. In a nod to the organisation's origins, in 2010 the RSA established *Catalyst* a fund which allows RSA Fellows with innovative solutions to social problems to apply for a grant. But prize funds have also been widely used in recent years, and we propose reviving their use at the RSA. A 21st century Premium could be one in which the ingenuity of submissions is explicitly valued.

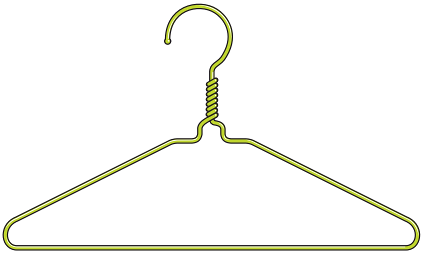
Through exemplifying the principles suggested above, the nature or amount of the prize incentive, or by implementing metrics that assess the ingenuity of submissions, we propose investigating how a 21st century Premium could be developed to reward solutions designed for resource-constrained contexts.

Ingenious Education

Third, we propose a project to explore how schools could solve more of the problems they encounter, while operating in straightened financial times. For example, how could schools continue intra-school activities and avoid becoming inward looking, when the local authority funded posts that coordinate these are to be reduced? Or how could schools ensure they receive their full allocation of the pupil premium, calculated using the numbers of children on free school meals, when many entitled children are not registered to receive them?

Whether by helping school staff solve their problems with the minimum of resources, or exploring whether ingenuity could make lessons richer and more engaging, we suggest a project to form ingenious schools.

In each of these projects, we aim to solve problems with few resources, and to spread the capability of ingenuity through our networks in communities, government and business. Through applying the principles of ingenuity advanced in this paper to real-life problems, we will complement our theoretical research with practical learning, we will help people develop their ingenious abilities, and we will encourage “works of distinguished ingenuity” that help solve the problems we face in the 21st Century.



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