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Literature Review: Enabling creativity in rural Australia

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Foreword

This publication follows and extends an earlier RIRDC publication (99/128) on Creative Research Environments (Gleeson, Russell and Woods 1999).

The report reviews the literature on creativity in a context of the appropriateness of institutional arrangements affecting rural Australia, and in particular institutional arrangements affecting innovation, and identifies five general principles to encourage creativity in the rural research community.

The report will be useful for managers in institutions that develop policy and oversee agricultural research and development, managers of natural resource management community and government agencies, as well as researchers and practitioners.

The report concludes that greater diversity is needed in institutional arrangements for innovation in rural Australia.

The project was funded from RIRDC Core Funds which are provided by the Australian Government.

This report, an addition to RIRDC's diverse range of over 1700 research publications, forms part of our Environment and Farm Management R&D program, which aims to foster agri-industry systems that have sufficient diversity, flexibility and robustness to be resilient and respond to challenges and opportunities.

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Peter O'Brien
Managing Director
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Executive Summary

What the report is about

This report reviews the literature to do with creativity in rural Australia. It is about people, what they do and their landscapes and is set in the context of the institutional arrangements applying to research and development and innovation in the farm sector.

The report opens for debate the question of whether or not existing institutional arrangements constrain appreciation of the true multifunctionality of Australian rural landscapes and identifies general principles for reforming existing institutional arrangements to enable the creative expression of a wider set of beliefs and values than currently dominates innovation in agriculture and rural Australia.

Who is the report targeted at?

The report is targeted at people with an interest in innovation and creativity in rural Australia. In particular, the literature review will prove useful for managers in institutions that develop policy and oversee agricultural research and development, managers of natural resource management community and government agencies, as well as researchers and practitioners.

Background

This literature review follows on from previous work which canvasses literature and consulted experts in creativity to find a conceptual construct that could be applied to creativity for innovation in the rural sector, finally selecting a systems construct described by Gardner (1993) and Csikszentmihalyi (1996) where:

‘Creativity lies not in the head (or hand) of the artist or in the domain of practices or in the set of judges: rather, the phenomenon of creativity can only - or, at any rate, more fully - be understood as a function of interactions among these three nodes’. This systems approach to understanding creativity is encapsulated in the definition of creativity as being any act, idea or product that changes an existing set of symbols, rules and procedures (a domain) or which transforms an existing domain into a new one.

Aims and objectives

The aim of the literature review was to discover what the literature says about creativity, especially as it relates to the agricultural research and development sector.

Methods used

Relevant literature from Australia and overseas on the relationship between the nature of innovations and the innovation systems that produced them was consulted in developing the literature review.

Key findings and implications

Key findings and implications are as follows:

- The language we use narrows our thinking about rural Australia. We use the terms agriculture, farm and rural interchangeably leading to the misperceptions that all of farm is agriculture and all of rural is farm. Hence 'problems' are found and represented in ways that limit findings that would have been enabled by broader constructs.

- The big question posed is not whether we need both insightful and non-insightful problem finding and solution but whether our current institutional arrangements enable both.

  The challenge for insightful problem solving is to see where to go whereas the challenge for non-insightful problem solving is to move successfully to a readily perceived or prescribed destination.

  These problems require differing skills, logical argument being predictive of non-insightful problem solving but not of insightful problem solving. Non-insightful problem solving places demands on the solver's ability to maintain an inner representation of the problem and the goal. However an excessive or inflexible premature prescription of a problem may limit problem representation and therefore the power of insight for it is generally accepted that insight involves a cognitive restructuring leading to a representation of the problem.

- Innovation goals and research and development processes for rural Australia are dominated by fields of gatekeepers drawn from existing industries and, from within those industries, from cohorts of people focused, rightfully from their perspectives, on improving economic productivity within existing industries. Inevitably this leads to an emphasis on non-insightful problem seeking and solution, risk adverse processes and innovation systems designed to produce incremental gains.

  Given the moderate aggregate economic performance of the agricultural sector over past decades it is questionable if this pathway alone will be sufficient to secure the future sustainability of rural landscapes and rural lifestyles.

Clearly there is a great diversity of values and of activities within the farming sector, as there is within the broader community. This diversity needs to be brought to bear on the nature of institutional arrangements for rural Australia, particularly those impacting on innovation. Given that the nature of innovation is predetermined by the design of the innovation system the way forward is to enable greater diversity in how innovation is supported and managed.

Introduction

Purpose

This report reviews the literature to do with creativity within the context of existing agricultural policies, programs and organisational arrangements in rural Australia that constrain that creativity.

The expression of creativity is largely dependent upon the capacity and willingness of the creative entity to find, represent and re-represent problems. This exploration and discovery can be limited by fixation upon a particular presentation of reality, the adverse implications being particularly potent when such presentations are based on erroneous analyses. The expression of creativity can also be constrained by structures and processes that limit intrinsic motivation and insight.

The nature of creativity

This review reflects a search of the literature to identify principles upon which to build institutional arrangements that foster the expression of creativity. These arrangements need to reflect the complexity and ambiguity of creativity yet be practical and sustainable.

Defining creativity

A review of the definitions of creativity by Repucci (1988) identified over fifty definitions of creativity and, after three decades of studying creativity, Torrance (1988) concluded that creativity defies precise definition.

It is possible, however, to find a construct for creativity that works in particular contexts and, for the purpose of this study, I have selected the systems approach best enunciated by Gardner (1993) and Csikszentmihalyi (1996).

In 1993 Gardner, from a study of creativity seen through the lives of Freud, Einstein, Picasso, Stravinsky, Eliot, Graham and Gandhi, summarised a systems approach to understanding creativity as follows:

> 'Creativity lies not in the head (or hand) of the artist or in the domain of practices or in the set of judges: rather, the phenomenon of creativity can only - or, at any rate, more fully - be understood as a function of interactions among these three nodes'.

This systems approach to understanding creativity is encapsulated in Csikszentmihalyi's definition of creativity as any act, idea or product that changes an existing set of symbols rules and procedures (a domain) or which transforms an existing domain into a new one (Csikszentmihalyi 1996).

In this systems view, creativity results from the interaction of domains of knowledge and action, fields of persons (gatekeepers) who decide whether a new idea, product or process should be included in the domain and persons whose thoughts or actions change a domain or establish a new domain.

These various definitional elements are embedded also in the understanding of creativity as the capacity to produce new or original ideas, insights, restructurings, inventions, or artistic objects which are accepted by appropriate people as being of scientific, aesthetic, social, or technological value (after Vernon 1989).

Clearly then we need to address the characteristics not only of creative people but also of the domains and fields which need to be able to encourage, recognise and diffuse new ideas arising from people acting creatively.

The creative process

Csikszentmihalyi (1996) described the creative processes leading to the generation of creative ideas or products as being preparation, incubation, insight, evaluation and elaboration. These processes may overlap in function or in time, they may proceed from varying starting points and their relative contributions to the creative process may vary among problem solvers and among environments.

Preparation

Preparation refers to the process of becoming immersed in a set of problematic issues that are interesting and arouse curiosity.

During the preparation phase the problem to be solved emerges from either personal experience, the requirement of the domain and/or the field of influence of teachers, peers, persons in industry and the community generally. Whatever may be the factors leading to an identification of the problem, creativity is unlikely to be demonstrated unless the problem solver experiences a phase of internalisation or immersion in the problem.

Really important breakthroughs in science appear to come from reformulating old problems or discovering new ones rather than by solving existing or presented problems. Consequentially one of the questions we need to address is the extent to which we foster the development of the psychic energy in the problem solver for presented problems. We need to ask whether or not an emphasis on prescribing goals, outcomes and methodological steps leads to a premature and possibly false construction of the problem, a failure in the problem solver to identify with the problem, and an inappropriate use of non-insightful procedures.

Incubation

Incubation enables ideas to churn around below the threshold of consciousness.

It is important to let problems simmer for a time below the threshold of consciousness.

Many will identify with the following comments from creative scientists as quoted by Csikszentmihalyi (1996):

> I am fooling around not doing anything, which probably means that this is a creative period, although of course you don't know until afterward. I think it is important to be idle - people who keep themselves busy all the time are generally not creative. So I am not ashamed of being idle.
>
> If you have a problem, don't sit down and try to solve it. It (the solution) will hit me maybe in the middle of the night, while I am driving my car or taking a shower or something like that.

Both cognitive and psychoanalytic accounts of what happens during incubation assume that some form of information processing keeps going on in the mind even when we are not aware of it. Cognitive theories, unlike the psychoanalytic, do not attribute any direction to this subconscious thought. However even though sub-conscious thinking may not follow rational lines it nevertheless follows patterns established during conscious learning. The knowledge of the domain and the concerns of the field have been internalised and become part of the way our minds are organised.

Insight

Insight refers to moving consciously from not knowing to knowing.

The presence and relative importance of the various facets of insight vary between problem types, people and environments. Different problems elicit or constrain varying insight processes, and problem solvers may use different processes to solve the same problem. However, it is generally accepted that insight involves a cognitive restructuring leading to a representation of the problem.

This generalisation has significant implications for the management of research for it highlights the importance of the scientist being able to reformulate the problem and hence to have undergone a process of immersion and possibly a period of incubation. It also lends support to the suggestion by Finke (1996) that techniques for generating preinventive forms (see below) and for exploring their creative possibilities might facilitate creative thinking in scientific training, a component he observes as being seldom emphasised. However, it should be noted that the representation process generally only applies to situations in which the problem solver does not know what to do to achieve the goal, that is to insight problems, and then not universally so.

Blocks to insight may be overcome by improving solving recognition or by searching for a new problem. Improving faulty recognition can come about by de-emphasising the inappropriate problem elements, by for instance delaying in order to forget, or by changing the physical or psychological context, for example by routine activities such as showering or walking. These strategies assist in removing mental obstacles to insight. Improving recognition may also be achieved by accessing more appropriate problem elements. This can occur by for instance encountering new information, by allowing cues to surface from the unconscious or by a combination of both whereby the environment may set in action unconscious retrieval processes that ultimately bring to the consciousness a cue that can prompt recognition of the solution. These concepts explain why insights occur frequently when the creator gives up on a particular problem and turns to other activities.

Simonton (1996) quotes the Nobel laureate Max Planck attributing to great scientists “a vivid intuitive imagination, for new ideas are not generated by deduction but by a creative imagination”.

Finke, Ward and Smith (1992) propose a two-stage model of divergent insight involving the generation of preinventive structures or mental representations and the exploration and interpretation of these representations.

The generative processes include a retrieval, re-association and synthesis of existing forms, an analogical transfer where there is a transfer of relationships between contexts and a categorical reduction where a familiar structure is mentally reduced to more primitive forms. The resultant preinventive structures can take the form of visual patterns, object forms, mental blends, category exemplars or mental models. Such structures promote creative insight and discovery, particularly if the following are true: they are novel, ambiguous leading to a variety of possible interpretations, possess a sense of meaningfulness or deeper significance, possess emergent features, possess incongruities or are divergent in that they may have different uses within a variety of contexts.

The exploratory processes include attribute finding, conceptual interpretation, functional inference, contextual shifting, hypothesis testing and searching for limitations.

Attribute finding refers to the systematic search for emergent features, for example the search for unusual or unexpected features in a preinventive association of ideas. Conceptual interpretation refers to the finding of a theoretical interpretation of a preinventive structure or more generally to the application of one’s knowledge to the task of creative exploration. Functional inference refers to the process of exploring the potential uses of a preinventive structure and hence is important in

evaluating and testing mental models. Contextual shifting is considering a preinventive structure in a new or different context. Preinventive structures can also be explored for their possible value in testing hypotheses or solving problems and they can be searched for limitations to provide insights into which ideas or approaches will not work.

Perkins (1996) visualises a creative system as a process of search through a space of possibilities or a "possibility space".

There are two extreme kinds of topography possessed by possibility spaces. The first is a Homing Space of a clue rich character enabling relatively easy resolution of the problem through convergent thinking by people expert enough to know the signs. The second is a Klondike Space, of vast relatively clueless regions in the midst of which occur small pockets rich with clues where rapid progress can be made. Typical earmarks of insights or more generally generative breakthrough events such as suddenness are consequences of Klondike topography and may have little to do with intelligence.

Common features of these insightful events according to Perkins are that they follow a period of preparation or search, disclose something which was previously hidden, begin with a precipitating event, and are achieved rapidly. Perkins believes there is little evidence to support the concept of incubation, the period of inactivity between preparation and insight during which progress is somehow made nevertheless. He thus dismisses the possibility of reasoning proceeding subconsciously during periods of incubation. However, the frequently cited situation where insights occur during times of distracted relaxation raises doubts about whether the role of the subconscious should be so summarily dismissed.

One feature of the search through a possibility space is that the goals may shift as the search proceeds and the aim of the search process becomes that of finding a state of the search space that satisfies the current state of the evolving goal.

Getzels and Csikszentmihalyi (1976) found sudden shifts in goals to be a hallmark of what they term problem finding, a trait related to creative productivity. Similarly the possibility space may change during the actual course of the search either from the recognition of pre-existing knowledge or the discovery of new knowledge. This evolution of the possibility space might be what underpins the evolution of research goals and the related practice of "skunking", which is progression along research pathways outside the boundaries of established programs.

Schooler, Fallshore and Fiore (1996) list the attributes they associate with the ability to find alternative approaches to problem solving as being perseverance (trying out many approaches), risk taking (the balance of low and high risk projects), playfulness (analogical and combinatory play), broad knowledge (enabling connections) and the ability to recognise analogies (they represent one of the central sources of insight).

The challenge for insightful problem solving is to see where to go whereas the challenge for non-insightful problem solving is to move successfully to a readily perceived or prescribed destination. These problems require differing skills, logical argument being predictive of non-insightful problem solving but not of insightful problem solving. Non-insightful problem solving places demands on the solver's ability to maintain an inner representation of the problem and the goal. However an excessive or inflexible premature prescription of a problem may limit problem representation and therefore the power of insight. Verbalisation can also cause an over-emphasis on reportable processes, rather than the non-reportable processes frequently associated with insightful problem solving.

Studies of simulated scientific research (in vitro) and actual scientific research (in vivo) have been conducted by Dunbar and his colleagues at McGill University, Montreal and are summarised by Dunbar (1996). These studies demonstrate that the generation of alternative hypotheses to explain

inconsistent evidence required the setting of new goals, but that such a conceptual reconstruction rarely occurred without social interaction with other scientists. Analogical reasoning, the process of reasoning from parallel cases, was an important source of knowledge and conceptual change and might arise from the same (local) domain from a similar (regional) domain, or from a different (long-distance) domain. Furthermore, the social structure of the research team was found to be crucial as to whether analogical reasoning was used. Social interactions and cognitive representations interact to produce conceptual change when surprising findings occur, when the researcher believes these findings are not due to error and when the researcher's interpretation of the findings is challenged by others. Dunbar concludes that members of a research group should have different but overlapping research backgrounds and that analogical reasoning should be encouraged in part by providing opportunities for researchers to interact and discuss their work.

Evaluation

Evaluation is deciding whether the insight is valuable and worth pursuing.

The important questions here are when the evaluation is done, by whom and for what purpose. This is the classical role of experimentation.

Elaboration

Elaboration refers to expanding and justifying the creative idea, product or process.

Again this involves experimentation and testing hypotheses in a variety of situations.

Implications

The purpose of examining at the literature was to present an understanding of the nature of creativity so as to identify principles on which to build research systems that foster the expression of creativity. Based on an understanding of creativity a general observation is that such systems need to mimic one of the defining characteristics of creative people, i.e. that they have a high tolerance for ambiguity, combined with an urge to transform chaos into organisation.

Our understanding of creativity raises several important questions as to how we might construct research (and other) environments so as to not constrain creativity, the key questions being:

- Have we selected the right domains and are they able to interact?
- Are the gatekeepers sufficiently aware of the need to enable creativity?
- Do our funding and other processes result in premature fixation?
- Do our accountability processes constrain creativity?

Enabling creativity

Integrating concepts

Three concepts, if considered together, help our understanding what drives people to be creative. They all point to the importance of the motivational state of the creative person.

The concept of intrinsic motivation (see Amabile 1982)

People will be most creative when they feel motivated primarily by the interest, enjoyment, satisfaction and challenge of the work itself rather than by external pressures.

The concept of cognitive evaluation (Deci and Ryan 1985)

The impact of an event is determined not by the objective characteristics of the event but by its psychological meaning for the individual.

The concept flow (Csikszentmihalyi 1996)

An optimal state of inner experience is achieved when consciousness is harmoniously ordered.

Intrinsic motivation

There is ample evidence to support the conclusion that people will be most creative when they are intrinsically motivated, that is, they feel motivated primarily by the interest, enjoyment, satisfaction and challenge of the work itself, not by external pressures.

It is important however to recognise that different people, or the same person in different circumstances may respond differently to the same stimuli, a phenomenon embedded in Deci and Ryan's cognitive evaluation theory, where the impact of an event is held to be determined not by the objective characteristics of the event but by its psychological meaning for the individual. Hence, for instance, the inter-personal climate between the conveyor and the recipient of a communication may be as an important determinant of effect as the message being communicated.

These concepts help explain the preferred motivational state for creativity and how it is brought about. The innate urge for creativity arises however from a person's urge to control their consciousness by being totally immersed in a cognitive or physical challenge. In these situations the activity becomes autolytic, in that it is an end in itself, and people experience, to use Csikszentmihalyi's terminology, the state of flow.

Complexity is one of the most common and prominent features of creativity. To deal with this complexity, creativity processes are usually described analogically rather than directly, for instance Perkins' exploration of various cognitive topographies (see page 4).

Complexity is not restricted to creative processes. It is evident in the pluralistic nature of the policy, institutional, funding and management arrangements for agricultural research. This plurality and complexity may lead to the misconception that there is a diversity of approaches to funding and managing of agricultural research. Last, agricultural enterprises are both variable themselves and in their capacity to relate to and adopt the findings of institutionalised research and development.

In their review 1988 review Hennessy and Amabile support the suggestion made by Lepper and Greene (1975) that the intrinsically motivated person feels freer to take risks because those risks

carry virtually no liability, save any, which is self-imposed. They conclude that motivation, broadly assessed quality of performance and creativity are reduced by surveillance, understanding the task to be a means to an end rather than an end in itself, deadlines and prior, actual and expected evaluation.

As previously reported (Gleeson, Russel and Woods 1999) the importance and the delicate state of the motivational orientation of creative people is well illustrated by a study reported by Amabile (1985). In this study creative writers were asked to write a poem after having completed one of two questionnaires about their reasons for writing, the questionnaires comprising questions all either intrinsically or extrinsically oriented. The control group was asked to write a poem without completing a questionnaire.

The writers in the control group and the intrinsic questionnaire group wrote poems judged fairly high on creativity whereas those in the extrinsic questionnaire group wrote poems judged to be much lower in creativity than the poems produced by either of the other groups. As stated by Amabile people who had been writing creatively for years and who had long-standing interests in creative writing suddenly found their creativity blocked after spending barely five minutes thinking about the extrinsic reasons for doing what they do.

As dramatic and universal as the adverse effects of extrinsic stimuli on creativity seem to be, the picture is not always a simple one. For instance, other studies by Amabile and her colleagues indicate that children at least can be trained to treat reward not as an element that detracts from intrinsic interest but as something that can add to overall motivation. These findings illustrate the cognitive evaluation theory whereby the impact of an event on motivational processes is determined not by the objective characteristics of the event but rather by its psychological meaning for the individual.

Deci and Ryan (1985) categorise external events as being informational, controlling or amotivating.

Informational events such as the provision of choice and positive feedback provide relevant information without any pressure to attain a particular outcome and they may increase or decrease intrinsic motivation. Controlling events such as rewards, deadlines and surveillance are perceived to be seeking a particular outcome or a specific behaviour, and intrinsic motivation is undermined. Amotivating events such as negative feedback lower one's assessment of being able to master certain situations, for instance through lowering self esteem, and again intrinsic motivation is undermined.

How an event will be perceived is a function of the nature of the event and of one's own sensitivities and past experiences. People who do not perceive themselves to be in a controlling situation, for instance most researchers seeking funding, will be more inclined to interpret events as controlling than will those less dependent on such funding. In designing systems to enable creativity it is necessary to reflect on Hennessy and Amabile's (1988) general conclusion that fluctuations in an individual's level of creative output must be examined in the light of environmental influences on motivation and environmental effects must be examined in the light of an individual's perceptions of these influences.

To summarise, for people to be creative they need to be intrinsically motivated and the influence of external factors on motivation may differ between individuals, depending on their psychological response to those factors. However these concepts do not address the question of what drives the motivated person to be creative. This is the urge, to use Csikszentmihalyi's terminology, to experience the state of flow.

Individuals experience flow when they are in control of their own consciousness, or at least when they understand that such control is possible. They are totally immersed in a challenge. They control the information flowing into their consciousness. The opposite state to flow is inner chaos, leading to existential dread, or the fear of there being no meaning to life.

Creative people interviewed by Csikszentmihalyi (1996) listed nine main elements to describe the flow experience. They describe clear goals every step of the way and immediate feedback to their actions. The challenges and skills required to meet the challenges are well balanced and concentration is fully focused on the activity so that action and awareness are merged. There is no worry about failure and self-consciousness disappears. In flow the sense of time becomes distorted so that the sense of how much time passes depends on what is being done. Under these circumstances the activity becomes autolytic, an end in itself.

It is not surprising that all the creative people interviewed by Csikszentmihalyi (1996), whether engineers, chemists, writers, musicians, business people, social reformers, historians, architects, sociologists or physicians, agreed that they do what they do primarily because it is fun. There is a clear message and that is if creative people do not enjoy their work, they will not be creative.

Prerequisites for problem-finding

Csikszentmihalyi and his colleagues posit that to achieve a problem-finding synthesis, the following prerequisites must be met:

- thorough knowledge of one or more symbolic domains
- thorough immersion in an endeavour that practises the domain
- focus of attention on a problematic area of the domain
- ability to internalise information relevant to the problematic area
- ability to let the relevant information interact with information from other domains at a subconscious level, where parallel processing takes place
- ability to recognise a new configuration emerging from this interaction that will help resolve the problematic situation
- evaluation and elaboration of the insight in ways that are understandable and valuable to the field.

Creative people

Gleeson, Russell and Woods (1999), drawing principally on the writings of Tardif and Sternberg (1988) and Amabile *et al* (1996) described the nature of creative people and the characteristics of work environments conducive to creativity.

In simple terms it appears that creativity will be fostered when managers give a clear idea of the desired end product, and let people set their own goals and run their own programs. However, creativity is not the only consideration. Factors such as institutional objectives and the particular circumstances of the researcher or research team also affect the design of any optimal approach to research leadership and management.

Domains and fields

The creative person-domain-field systems view of creativity has several implications for creativity, the most important being that we need to consider the influences on and the characteristics of the domain and the field, as well as those relating more directly to the creative research person.

A domain is a set of symbolic rules and procedures such as those of mathematics, music and legal systems, nested in culture, containing the symbolic knowledge shared by a particular society. Creativity is affected by the narrowness of the domain, the manner by which the domain information is sorted and accessed (for instance as words, equations, rhythm or pitch) and the breadth and depth of interest in a domain (Csikszentmihalyi 1996). Research creativity will diminish unless teachers,

industry representatives and research leaders and managers actively promote and extend existing domains and, enable new domains to emerge as needed.

A field consists of all the individuals who act as gatekeepers to the domain, including, for instance, teachers, industry people, administrators of R&D funds, journalists and other communicators, scientific editorial panels and referees. Fields can affect creativity by:

- being reactive or proactive in stimulating and supporting novelty
- being well or poorly versed in the domain
- choosing the size of the filter for new ideas, (too open or closed a filter is counter productive), and by
- being well connected (or not) to the rest of the social system from which they can channel support for their domain.

Field participants for agricultural research and development include:

- the Boards and all levels of management of Rural Research and Development Corporations and of other research funding agencies and members of advisory panels to those corporations and agencies
- organisational leaders and research and program leaders and managers in research and development organisations, professional peers and executives of professional organisations
- elected and management representatives of industry and other community organisations, and collaborators at the program and/or project level.

The struggle for recognition results in strong competition between units of information for acceptance by the field which has a limited attention and is forced to be highly selective. Field members need to recognise that they themselves need to be creative in how they execute their various gatekeeper roles.

Gardner (1993) hypothesises that creativity results from an individual's capacity to exploit or create misfits or asynchronies between him or herself, the domain and/or the field. The capacity of persons within the field to identify such asynchronies may be reduced owing to the higher order hierarchical positions normally held by these people.

Domains and fields can affect each other for the knowledge base may restrict the field, or the field may not be competent to represent the domain.

Enhancing creativity in agricultural R&D

Compared to all this complexity, the design principles of environments conducive to creativity in research are stunningly simple. One only has to ensure that the people involved are appropriately motivated and capable (Gleeson, Russel and Woods 1999).

To achieve this we need to encompass the two structural components of the creativity framework, that is, in the context of research and development, they need to be applied both to researchers and to field participants, and they need to be applied across all facets of innovation.

The five principles arising from the work of Gleeson, Russel and Woods are that creativity in Australian agricultural research and development would be enhanced by:

Setting creativity goals

Strategies which might flow from this principle could include:

- incorporating both creativity and productivity goals into organisational cultures and processes, including monitoring and evaluation procedures for researchers, managers and members of advisory panels
- ensuring field participants have an understanding of the need for and nature of creativity so that their actions inadvertently do not constrain creativity unduly
- adopting a flexible approach to the evolution of research processes to ensure that they are neither prematurely conceived nor judged.

Balancing freedom and control

Strategies which might flow from this principle include:

- actions to enable researchers to identify with the presented problem, including decentralised participatory program development forums, publication of analyses and opinions leading to selection of preferred topics for research, and recognition that the process of research planning is as potentially rewarding in terms of knowledge development as the research program so conceived
- ensuring individual researchers and research groups have research portfolios balanced for risk, organisational and personal goals and productivity and creativity goals
- (subject to adequate capability and performance) providing increasing levels of autonomy in relation to work schedules and practices, within budget expenditures and staffing guidelines.

Improving recognition of performance

Strategies which might flow from this principle include:

- research funders, organisations and clients responding meaningfully to researchers on research progress and final reports and, in due course, on the adoption or otherwise of the outputs of research
- assisting researchers and field participants to communicate with their peers and other interested and relevant individuals
- ensuring that formal recognition and remuneration processes encompass a consideration of both creativity and productivity
- improving social interaction

Social interaction

Strategies to improve social interaction might include:

- developing policies and processes which recognise the importance of face to face participation in seminars, workshops and conferences, both locally and internationally, with this participation broadly based so as to include in particular the less experienced researchers
- promoting organisational cultures which value intra and inter-organisational discussions and seminars, preferably with the active involvement of both researchers and field participants
- increased devolving of authority, with due accountability, for expenditure of project funds for the purpose of travel, communication and conference attendance
- stronger linkages between research and development and education and training.

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