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# **AC 2011-740: CREATIVITY AND INNOVATION: A COMPARATIVE ANALYSIS OF DEFINITIONS AND ASSESSMENT MEASURES**

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# Creativity and Innovation: A Comparative Analysis of Definitions and Assessment Measures

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## Introduction

The purpose of this paper is to present and discuss the misalignment and use of creativity testing for purposes of measuring innovation. Numerous definitions of creativity exist, which have spawned the development of various creativity tests. Although these tests have been based on accepted definitions of creativity – such as “a behavior that is imaginative and inventive” (Guilford, pp. 444, 1950)<sup>4</sup> – these definitions have historically been applicable to domains separate from Technology and Engineering, focusing rather on the arts and psychology. Creativity as it pertains to technology and engineering is a subcomponent of innovation. Because creativity is only a part of innovation, we believe that creativity tests should not be used to evaluate or assess innovation.

We believe that innovation is distinctly different than creativity. Innovation is structured creativity focused on producing an innovative product, service, or system. In essence it is a “practical creativity.” Although related, creativity and innovation are distinct and different. Consequently they should use distinct and different assessments. Paradoxically, most efforts to measure innovation are based on creativity definitions and tests, or only focus on production. This paper compares and contrasts the definitions, assessments, and instructional practices of creativity and innovation, in an effort to further clarify how and what should be taught regarding innovation, and how it might be more effectively measured.

## Innovation Defined

Although there are many definitions of innovation, the literature suggests that innovation is a novel and useful product, system, and or service. Novelty is defined as being unique, original, and new. Usefulness is defined as how beneficial the product is to people. Innovation is defined as structured creativity focused on producing a high in usefulness and novelty product, system, or service. Innovation has often been inappropriately used to define a person or thing that is simply *creative*. To be creative, does not mean, to be innovative. Creativity is a subcomponent of innovation. Innovation is a process that involves moving from divergent ideas to a convergent solution. In this definition creativity is a measure that can be applied to divergence. Figure 1.1 further clarifies the divergence to convergence relationship. In this figure the stars in the first phase of the innovation process represent the idea “sparks” of creativity. The imagery is

supposed to represent the need and opportunity for many idea sparks. We believe when more ideas (sparks) are created, the likelihood of seizing upon the appropriate and “best” solution is increased. In the second part of the figure “Convergence” the “best” ideas (sparks) then go through the idea defining and idea refining stages, up until the less effective ideas are filtered out, and the single “best” idea is finalized and produced.

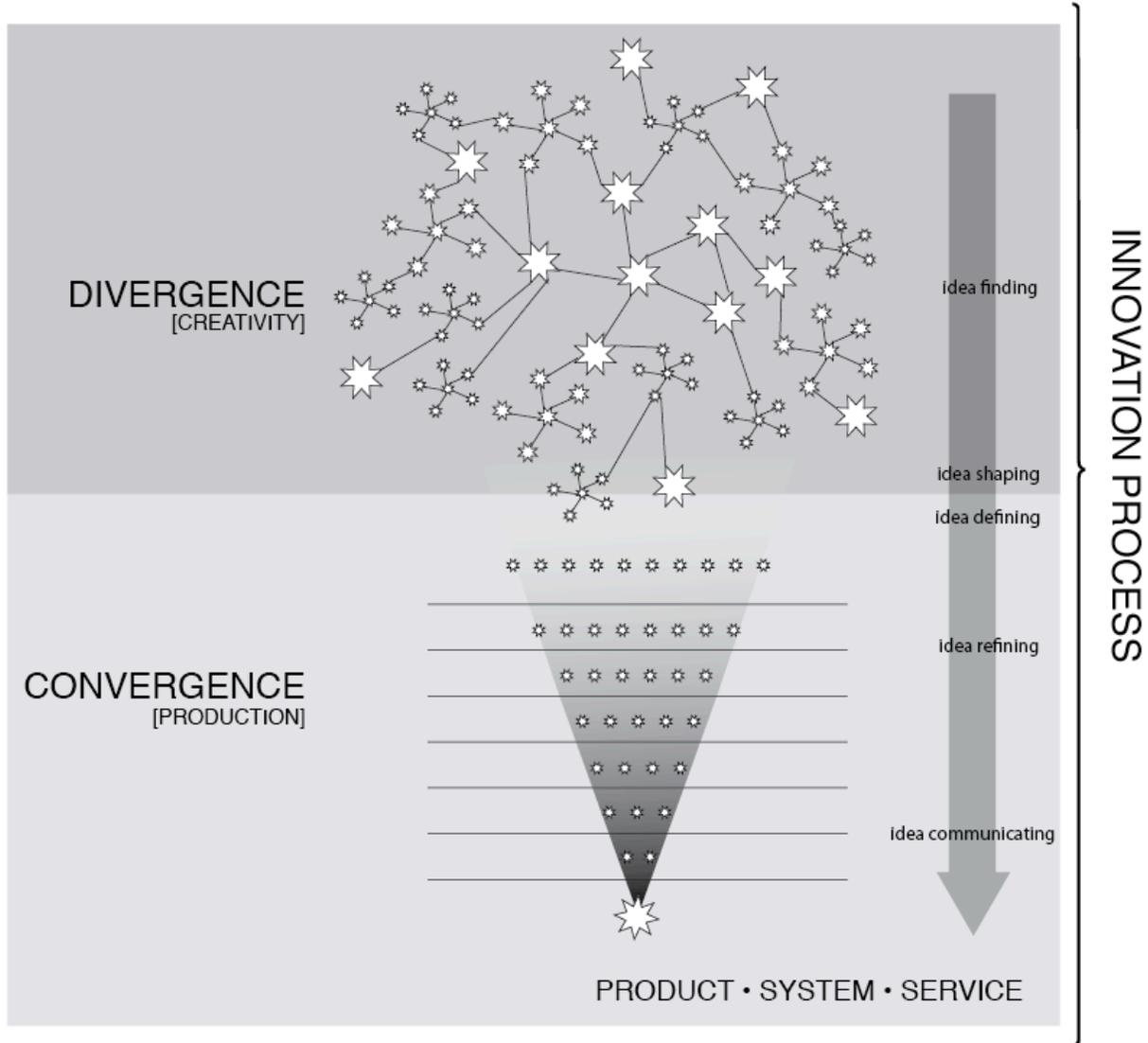


Figure 1.1: Innovation Process – Moving from Divergence to Convergence.

A secondary trait of innovation that helps distinguish it from its subcomponent (creativity) is how innovation can be measured. Innovation can be measured as a highly useful and novel new product, system, or service. Figure 1.2 compares the domain of innovation (as per. products, systems, and services) with the domain of expressive/scientific products, systems, and services – where innovation is often inappropriately assigned. In the expressive/scientific domain innovation should not be used to define something that only has limited usefulness, but has high novelty. For example, an expressive piece of art might be assessed as being highly novel, however, its usefulness is not as readily apparent. A similar definition can be seen in the

scientific realm, where much of the scientific research is exploratory, and therefore can be assessed as being high in novelty; however, because the research is not readily useful to the general public its measure of usefulness is assessed as being low.

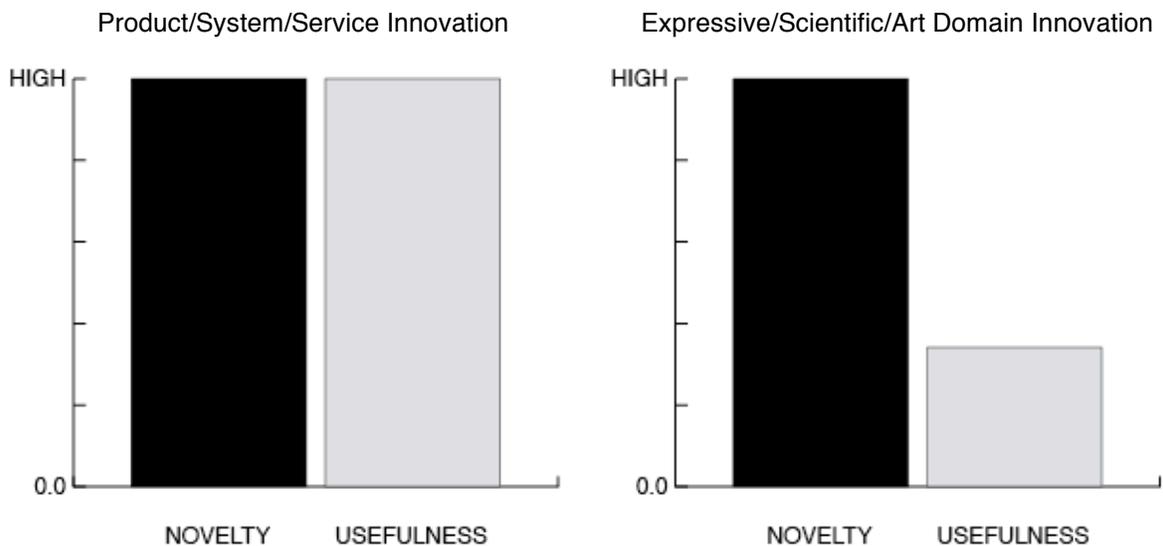


Figure 1.2: Innovation Measures of Novelty and Usefulness.

Although some might argue that scientific breakthroughs are useful in that they spawn further research, for us the value of innovation is not “potential usefulness”, but rather “actual usefulness.” What this suggests is that usefulness is measured in number of people who are immediately impacted by the new development. A good example is found in the development, marketing, and immediate use of mp3 players. As soon as mp3 devices became readily available, millions of people immediately digitized their music and were carrying around, using, and listening to mp3 devices.

Central to understanding innovation is knowing that innovation is a process that is both linear and nonlinear. Linear in that those involved in the process need to be moving from divergent ideas to a convergent solution, and nonlinear in that the linear movement towards a solution is embedded in an environment that is often cyclical, and hinges on various environmental influences, such as: organic leadership, ability to fail early and fail often, ability to defer judgment, intrinsic motivation, ability and willingness to prototype and iterate, willingness to flexibility to change roles and grow a diversity of ideas, and collaborative autonomy (ability to work both collectively and as an individual. Being able to bring individual ideas and connect them with the ideas of others). Finally, the process can be viewed as both linear and non-linear because although there should be movement from divergent ideas to a convergent solution, the innovation process steps can (and should) often be revisited to ensure the best solution(s) are being developed. Figure 1.3 diagrams the flow. Although the diagram is presented in linear format, the process needs to be interpreted as being cyclical – in that idea finding, idea shaping, idea defining, idea refining, and idea communication can and should be continuously revisited while working towards the convergent solution. The purpose of revisiting the various phases is to

ensure the proper questions are being asked, and that the *best* direction is being established and followed.

PROCESS of INNOVATION | a semi-linear process of movement, embedded in a non-linear innovative environment.

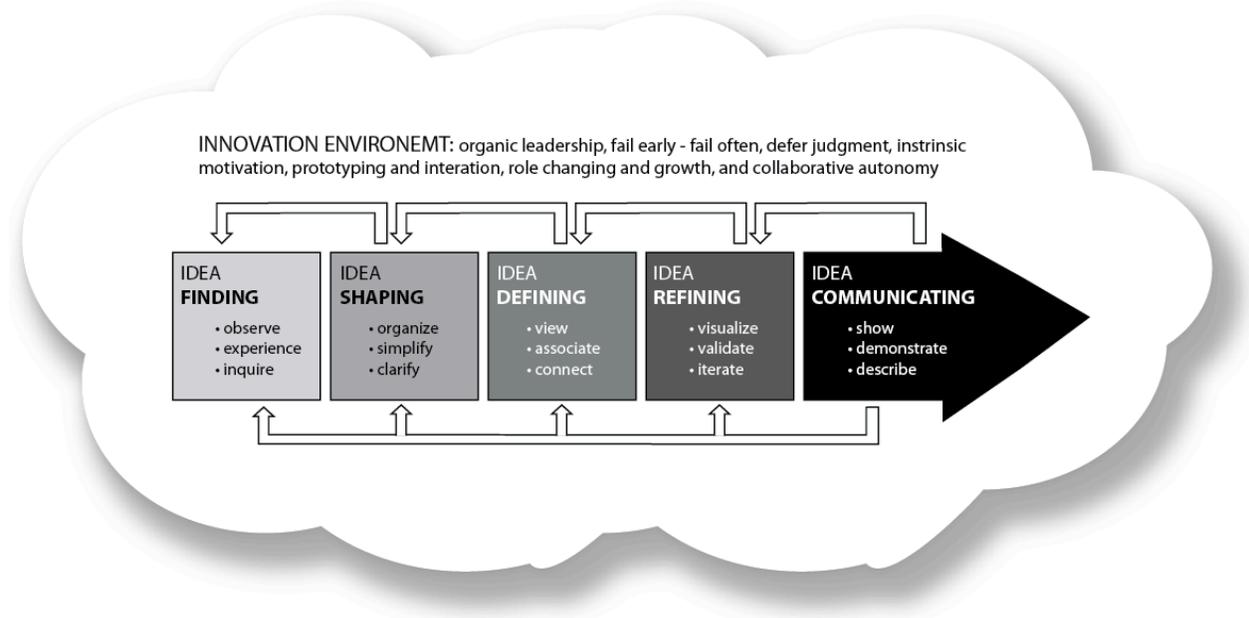


Figure 1.3: Innovation Process.

### Creativity and Innovation Measures

A thorough literature review revealed that both creativity and innovation assessments do exist (Cropley, 2000<sup>2</sup>; Hocevar & Bachelor, 1989<sup>5</sup>; Kaltsounis & Honeywell, 1980<sup>6</sup>; Torrance & Goff, 1989<sup>8</sup>), however, we did not discover any assessments that tested for both creativity and innovation. In analyzing the types of questions in the innovation tests, we discovered that most of the questions were asking questions about creativity – not innovation. In our literature review we did not find any tests that assessed both creativity and innovation. However, as we analyzed the purpose, scope and type of questions asked in the assessments we discovered the assessments focused on two primary – yet distinctly different – domains. The creativity assessments focused on divergence, while the innovation assessments focused on quantity of products. For example, the Torrance Test of Creative thinking (TTCT) asks questions focused on measuring divergent ideas. In the TTCT, participants are asked to sketch and explain different objects in response to visual stimuli presented in the test (e.g., circles, lines, abstract drawings) within restricted time limits. Developed from Torrance’s research on creativity and previous theoretical work by Guilford (1967)<sup>4</sup>, the TTCT measures the following components of creativity: (1) fluency, the ability to generate large numbers of meaningful ideas, (2) originality, the ability to produce ideas that are statistically infrequent in the normative population (used less than 5 percent of the time), (3) elaboration, the ability to add details to one’s ideas, (4) resistance to premature closure, the ability to maintain an open and flexible mindset, and (5) abstractness of titles, the ability to think abstractly about concepts. The TTCT also assesses other minor aspects of creativity, such as unusual visualization, storytelling articulateness, and fantastical imagery. These minor aspects

are called *creative strengths*. A human scorer scores the five components of creativity and creative strengths in a participant's test according to detailed instructions and after receiving proper training. Other creativity tests such as Guilford's Alternative Uses Task equally ask questions focused on the area of divergence by asking questions like "Name all the uses for a brick." Although focusing on the area of divergence is helpful, it is only one part of the 2-part definition of innovation, and therefore any claims that the TTCT or other creativity tests are valid measures of innovation are inaccurate.

Cropley's (2000)<sup>2</sup> more recent study examined a smaller number of creativity tests than the previously mentioned researchers. These tests were limited to paper-and-pencil tests - since those "are the most widely used in education and research" (p. 2). He also limited the number of tests discussed to those developed during the modern creativity era introduced by Guilford (1950)<sup>4</sup>. Cropley's study organized creativity tests into four categories. These categories focused on products, processes, motivation, and personality/abilities (pp. 17-19). In analyzing the tests Cropley categorized, we discovered that the tests he grouped into the products and processes categories seemed to be slightly more innovation centric, asking questions related to product development. These tests might measure a product's usefulness and novelty but do not assess the innovation process as a whole. This finding proves interesting because what Cropley was actually testing was innovation, not creativity. One such test is the Creative Product Semantic Scale (CPSS) developed by Besemer and O'Quin (1987)<sup>1</sup>. The CPSS is based on three dimensions: novelty, resolution, and elaboration and synthesis. Another test is called the Consensual Assessment Technique (CAT). This assessment asks participants to create a product, which is then rated by two or more experts in the field. The criterion for the CAT is appropriateness as evaluated by a community. Product creativity tests, as exemplified by the CPSS and CAT, focus on the end result. In contrast, the tests he grouped in the motivation and personality categories had more to do with creative thinking, which asked questions that had to do with divergence, and which typically used questions much like those identified on the TTCT. For example several of the creativity centric tests required participants to draw as many ideas in a specified amount of time. This type of task tests fluency – which is a measure of divergence.

The literature review showed that although both creativity and innovation assessments exist, the innovation assessments are typically found within business contexts, centered on *the end product*. For example, Europe uses the Community Innovation Survey (CIS) to assess national innovation performance. This survey measures innovation in terms of input and output (Godin, 2002)<sup>3</sup>. Salazar and Holbrook (2004)<sup>7</sup> critique the CIS and suggest that innovation needs to be studied as an activity and not as an end result (pp. 263). An instance in the CIS where this is evident is in the quantification questions regarding the number of how many new products have been developed, and in how much time, and how many new products will be developed, again in a measured amount of time. In addition the CIS also asks other questions regarding end results: Did your enterprise introduce new or significantly improved goods? Were any of your goods and service innovations new to your market? Did your enterprise introduce new or significantly improved methods of manufacturing or producing goods or services? Did your enterprise engage in the following innovation activities (research and development, acquisition of machinery or software, etc.)? Table 1.1 compares the more common creativity measures previously mentioned and the innovation measures from the CIS.

		Creativity Assessments	Innovation Assessments (CIS)	
Personality/Ability	Active Imagination	X		
	Flexibility	X		
	Curiosity	X		
	Independence	X		
	Acceptance of Own Differentness	X		
	Tolerance for Ambiguity	X		
	Trust in Own Senses	X		
	Openness to Sub-conscious Material	X		
	Ability to Work on Several Ideas Simultaneously	X		
	Ability to Restructure Problems	X		
	Ability to Abstract from the Concrete	X		
	Process	Uncensored Perception and Encoding of Information	X	
		Fluency of Ideas	X	
Problem Recognition and Construction		X		
Unusual Combinations of Ideas		X		
Construction of Broad Categories		X		
Recognizing Solutions		X X		
Transformation and Restructuring of Ideas		X X		
Seeing Implications		X		
Elaborating and Expanding Ideas		X X		
Self-directed Evaluation of Ideas		X		
Product	Originality	X X		
	Relevance	X		
	Germinality	X		
	Complexity	X		
	Usefulness	X		
	Pleasingness	X		
	Elegance/Well-Craftedness	X		
	Understandability	X		
	Goal-Directedness	X		
Motivation	Fascination for a Task or Area	X		
	Resistance to Premature Closure	X		
	Risk-Taking	X		
	Preference for Asymmetry	X		
	Preference for Complexity	X		
	Willingness to Ask Many (unusual) Questions	X		
	Willingness to Display Results	X		
	Willingness to Consult Other People	X X		
	Desire to Go Beyond the Conventional	X		
Innovation	Research & Development	X		
	Acquisition of machinery, equipment, and software	X		
	Acquisition of Knowledge	X		
	Training	X		
	Patent Application, Trademark, Copyright	X		
	Marketing	X		
	Education	X		
Funding	X			

Table 1.1: Innovation to Creativity Comparison.

## Conclusion

This paper proposed an innovation process, discussed product domain and expressive/scientific domain innovation, and summarized research in “creativity and innovation assessments tools. Our research suggests that creativity is a subcomponent of the innovation process, and is focused on divergent ideas. Whereas the purpose of innovation is to use divergent ideas towards a convergent solution that is both highly novel and useful. Usefulness can be defined as the number of people that will benefit from the product, system, or service. Novelty is defined as being a highly unique, fresh, original and new product, system or service.

In the second part of the paper, innovation is defined as a process of creativity leading to something useful. Although it is important to measure the outcomes, meaning the quantification of new ideas, we believe that a company who simply produces X number of widgets in X amount of time does not mean the company is highly innovative. Therefore, the argument remains that measurements of innovation that combine issues of divergence and innovation must be developed. Future research will include developing an assessment that combines issues of convergence and divergence; therefore ensuring both creativity and innovation is being assessed.

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