J PROD INNOV MANAG 2016;33(1):19–35

DOI: 10.1111/jpim.12250

# The Relationship of Individual Capabilities and Environmental Support with Different Facets of Designers' Innovative Behavior

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*Theoretical perspectives on employee creativity have tended to focus on an individual's capability to generate original and potentially useful ideas, whereas definitions of innovation also include the process of putting those new ideas into practice. This field study therefore set out to test how theoretically distinct types of individual knowledge and skills are related to different aspects of employees' innovative behavior in terms of both their new idea generation and idea implementation. Using a sample of design engineers (*n = *169) in a multinational engineering company, measures were taken of different aspects of innovative work behavior (patent submission, real-time idea submission, idea implementation) and a range of individual capabilities (creativity-relevant skills, job expertise, operational skills, contextual knowledge, and motivation) and environmental features (job control, departmental support for innovation). Analyses showed that creativity-relevant skills were positively related to indices of idea generation but not to idea implementation. Instead, employees' job expertise, operational skills, and motivation to innovate demonstrated a stronger role in idea implementation. In terms of environmental factors, job control showed no positive relationship with innovative work behavior while departmental support for innovation was related to employees' idea generation but not idea implementation. The theoretical perspective that correlates of idea generation differ in certain aspects to those for idea implementation are confirmed by the study. Practical implications for organizations wishing to improve their innovativeness are discussed in terms of tailored training, development, motivational, and environmental interventions designed to improve the capabilities of individuals to engage in all parts of the innovation process.*

## Introduction

The increasingly dynamic and competitive market conditions of the 21st century are raising the need for organizations to develop new products and services more frequently and more effectively, consequently also stimulating an upsurge of research interest in the topic (e.g., Dul and Ceylan, 2011; Evanschitsky, Eisend, Calantone, and Jiang, 2012; George, 2007; Pearsall, Ellis, and Evans, 2008; Shalley and Gilson, 2004). This desire for greater innovation, defined as the intentional generation and introduction of potentially useful new ideas, products, services, and ways of working into roles, groups, organizations, and society, is an international concern and one that can provide a significant edge (Amabile, 1988; West and Farr, 1989). For example, Birdi, Leach, and Magadley (2012) report in their evaluation study how a creativity training program led to new ideas generated by participants that then had a major impact on organizational performance, in one case saving the company over £120 million. To achieve the vision of exemplary innovation, organizations need more innovative employees in new product development and other functions, yet it is still unclear which types of capabilities are best to develop in individuals to fit this purpose (Anderson, Potočnik, and Zhou, 2014; Klijn and Tomic, 2010). In particular, recent reviews of the literature have concluded that past research has failed to adequately identify which types of employee knowledge and skills are most important for different stages of the innovation process (Anderson et al., 2014; Mumford, Medeiros, and Partlow, 2012). The aim of this field study is therefore to investigate how theoretically identified and malleable individual knowledge, skill, and motivational attributes, together with environmental support, relate to different aspects of design engineers' innovative work behavior. The theoretical basis of the study is to extend and test the different facets of the widely used Amabile (1983) componential model of creativity in organizations.

With regard to investigating employees' innovative work behavior in this study, Potočnik, Anderson

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and Latorre's (in press) definition that "individual-level innovative job performance . . . comprises the generation of novel and useful ideas in the first stage (also called creativity) and their implementation in the second stage" (p. 3) is taken. Although researchers have advocated that it is theoretically important to separate an individual's generation of new ideas from the implementation of those ideas, this has been insufficiently done in past studies (Amabile, 1988; Anderson et al., 2014; Birkinshaw, Hamel, and Mol, 2008). Idea generation concerns the mental formulation and overt expression of new ideas to others; this can take the form of simple verbal suggestions to written comments to formalized documents (e.g., patents) and often reflects the conception of employee creativity. Idea implementation, on the other hand, is where these new ideas are put into practice, resulting in actual, tangible changes to products, services, processes, or other aspects of organizational functioning. To date, though, the majority of studies have tended to focus solely on employee creativity through examining the quantity and quality of idea generation only (e.g., Dewett, 2007; Somaya, Williamson, and Zhang, 2007). However, in order to innovate, ideas have to be put into practice and research has indicated that different factors can influence the generation of ideas compared to their implementation (Choi and Chang, 2009; Urbach, Fay, and Goral, 2010). For example, Axtell et al. (2000) in a study of shop floor workers found that individual factors were stronger correlates of idea suggestion and group/organizational factors were more strongly related to idea implementation. The perspective of the current study is therefore that innovative employees should not only demonstrate greater quantities and quality (e.g., originality, usefulness) of idea generation at work but also greater implementation of those ideas. This counters the critiques of De Jong and Den Hartog (2010) and Hammond, Neff, Farr, Schwall, and Zhao (2011) of past studies which have tended to simply use unidimensional assessments of innovative work behavior when a multidimensional approach would be more informative. By examining these facets separately, this article aims to contribute to the theoretical understanding of how various factors can relate to different aspects of the innovation process. Klijn and Tomic (2010) concluded in their review of the topic "A final necessary step is to move from creativity toward innovation, because creativity alone is not enough to produce an innovative organization" (p. 337). Furthermore, since Amabile and Mueller (2007) stress the need for researchers to use a variety of methodologies to assess creativity in the workplace in order to triangulate findings and aid generalizability, multiple indices of innovative behavior (objective idea submission, expert ratings of ideas, and self-report) will be used.

Recent years have seen a burgeoning literature attempting to identify the different types of factors influencing employee creativity (Egan, 2005; George, 2007; Runco, 2004; Shalley and Gilson, 2004). Studies have addressed individual-focused variables such as mood (George and Zhou, 2007), motivation (Collins and Amabile, 1999), cognitive abilities and skills (Basadur, Wakabayashi, and Graen, 1990; Dietrich, 2007), personality (George and Zhou, 2001; Kim, Hon, and Crant, 2009), perceived time pressure (Baer and Oldham, 2006), and contextual features such as group composition and processes (Anderson and West, 1996; Choi, 2007), supervisor supportiveness (Amabile, Schatzel, Moneta, and Kramer, 2004; Janssen, 2005), peer support (Zhou, 2003), and organizational climate (Mathisen and Einarsen, 2004). Many of these studies partially draw on a small number of individual-level theories which have been put forward to describe the factors influencing individual innovation at work and which typically advocate a mixture of individual and environmental factors (e.g., Oldham and Cummings, 1996; Sternberg and Lubart, 1996; Woodman, Sawyer, and Griffin, 1993). However, examination of the literature shows that field testing of the more complete forms of these theories is relatively rare (Amabile and Mueller, 2007; Birdi, 2007). The aim of this study is therefore to test Amabile's (1983) well-

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regarded componential model of creativity (Anderson et al., 2014) but with more focus on identifying the key knowledge and skills required for greater innovative behavior by designers in an engineering context. A theoretical extension is to apply the model to the idea implementation as well as the idea generation phase.

The Amabile (1983) componential theory states that an employee's creative performance (the production of novel and useful ideas) is influenced by three intra-individual components and one external component—the social environment. The model argues that all three individual components must be present for creativity to result. First, *creativity relevant skills/processes* can be defined as an individual's generalizable capability to think divergently around an issue to generate new and original ideas and also to be able to analyze the quality of solutions generated. Amabile and Pillemer (2012) further detail this component as including "flexible cognitive style, personality traits such as openness to experience, skill in using creative-thinking heuristics, and persistent work style" (p. 10). Second, *domain-relevant knowledge/skills* are defined as "expertise, technical skill, and innate talent in the relevant domain(s) of endeavour" (Amabile and Pillemer, 2012, p. 10); they are important for creative endeavors since they allow an individual to understand where creative contributions are needed and how they can be made in a particular context. Third, a person's *intrinsic task motivation* is defined as arising from the individual's perceived value of engaging in the task itself (e.g., finding it interesting and enjoyable) (Amabile, 1988). This is as opposed to extrinsic motivation which comes from outside sources (e.g., promise of rewards). The componential theory argues that intrinsic task motivation is the crucial aspect that drives employees to actually expend the effort on creative activities; without this effort, individuals will fail to utilize their aforementioned capabilities in the workplace. Beyond these three individual dimensions, Amabile (1983) also posits the importance of the *work environment* (e.g., social support and autonomy for innovative activities) as providing an additional influence on employees' innovative work behavior through provision of time and resources or social support for engaging in creative activities.

Empirical support for the theory has come from several studies that demonstrate individuals are more creative when higher levels of the components are present (Amabile and Mueller, 2007; Amabile and Pillemer, 2012). However, many of these studies were limited in terms of being conducted with student samples in laboratory conditions (Conti, Coon, and Amabile, 1996; Ruscio, Whitney, and Amabile, 1998) or with organizational samples only focusing on certain aspects of the model (e.g., Amabile, Conti, Coon, Lazenby, and Herron, 1996). Indeed, the recent review by Anderson et al. (2014) of the innovation literature concluded that the Amabile (1983) model has received some empirical support in terms of the role of motivation and the work environment but that other components have not received as much research attention. More specifically, they state "Knowledge is a key component for creativity . . . But empirical studies on how knowledge affects employee creativity and innovation in the workplace have been rare" (p. 15).

The factors of interest chosen for this study will therefore be discussed within the Amabile (1983) theoretical framework, but the range of knowledge and skill factors investigated will be more detailed than in past research. The model will be further extended by discussing design engineers' innovative behavior in terms of idea implementation as well as the more traditionally examined idea generation. This study follows much of the past research on this framework by focusing on individual-level innovation i.e., the role of the employee in generating their own ideas and then playing a part in implementing those ideas. The following sections will discuss each of the four components of Amabile's (1983) model (creativity-relevant skills, domain-relevant knowledge and skills, intrinsic motivation, and work environment) and specify the factors within each component that will be investigated in this study.

### *Creativity-Relevant Skills/Processes*

Although the traits of personality and persistent work styles are discussed by Amabile and Pillemer (2012) as belonging under this first component, the focus of this study is on the major aspect of creative thinking skills due to an interest in investigating the relatively neglected aspect of knowledge and skills in the componential theory. The work of Basadur and colleagues (e.g., Basadur, Graen, and Green, 1982) on cognitive approaches to solving problems (defined by the Oxford English Dictionary as "a matter or situation regarded as unwelcome or harmful and needing to be dealt with and overcome") has outlined how creativity-relevant skills comprise both divergent and convergent thinking capabilities. Divergent thinking is defined as an individual's ability to generate multiple alternative solutions or perspectives as opposed to one correct solution (Scott, Leritz, and Mumford, 2004). However, convergent thinking is where analytical, judgmental capabilities are used to evaluate the worth of an idea or for identifying the causes of problems in the first place (Basadur and Finkbeiner, 1985; Grohman, Wodniecka, and Klusak, 2006). Both sets of capabilities are needed for generating novel and potentially useful ideas. Basadur and others (Basadur et al., 1982, 1990; Rose and Lin, 1984; Scott et al., 2004) have shown that individuals' creative thinking skills are malleable since they can be improved through creative problem-solving training. However, as is argued in the upcoming sections, these creativity-relevant skills should be more influential for the idea generation phase compared to the implementation phase (Birdi, 2007). Although new ideas can be generated by the cognitive processes outlined above, putting those ideas into practice requires different capabilities such as communication and negotiation skills to persuade others as to the worth of an idea (Sternberg and Lubart, 1996). Hence:

*H1: Creativity-relevant skills will be significantly positively related to idea generation but not to idea implementation.*

## *Domain-Relevant Knowledge and Skills*

Amabile and Mueller (2007) consider that domain-relevant skills include "knowledge, expertise, technical skills, intelligence and talent in the particular domain in which the problem-solver is working" (p. 35). Much of the previous research on individual innovation has simply used educational qualifications or experience as an indicator of job expertise to assess the domain-relevant skills component (e.g., see the Hammond et al., 2011, meta-analysis). However, as well as job expertise, with this study it is argued that there is a need to investigate two further domain factors which have been suggested by previous research as also being additionally important for innovative work behavior: operational skills and contextual knowledge. To the authors' knowledge, no previous studies have examined these dimensions concurrently in the same study to ascertain their relative importance to different stages of the innovation process.

First, although there is some debate as to whether "too much knowledge is a bad thing," it is generally considered important to have some level of job knowledge or technical expertise about a domain in order to innovate in it (Kristensson and Magnusson, 2010; Weisberg, 1999). Mumford et al.'s (2012) theoretical review of creative thinking argued that expertise provides mental models and knowledge of errors and constraints that can help in different stages of the creative process. Greater understanding of underlying principles and strategies can help in identifying areas for innovation, uncovering the causes of problems, aid idea generation and evaluation, and aid the implementation of solutions since expert employees should have a better approach to making ideas work in practice (Leach, Wall, and Jackson, 2003; Patterson, 2002). In support of this, Anderson, Hülsheger, and Salgado (2010) (cited in Potočnik et al., in press) report meta-analytic findings showing that general mental ability is only weakly related to innovative job performance (corrected $r = .05$) but that job knowledge is much more strongly correlated (corrected $r = .40$). Furthermore, Wu, Cheng, Ip, and McBride-Chang (2005) found that domain knowledge enhances one's performance in knowledge-rich creativity tasks, whereas functional fixedness may occur in knowledge-lean tasks. Since this study is examining contextualized creativity for a sample of design engineers (a knowledge-intensive role), it would be expected that their job expertise would be positively related to their innovativeness. Hence:

*H2: Job expertise will be significantly positively related to both idea generation and idea implementation.*

Second, having greater understanding of a topic will result in limited impact if an individual is not also competent in putting ideas into practice. Operational skills are therefore defined as those organizational and interpersonal capabilities required for successful project or change management. Sternberg and Lubart (1996) in their confluence theory pointed out the importance of operational skills such as planning and time management in the context of innovation. Furthermore, since innovations are frequently challenging to the status quo, resistance from others is often encountered. Skills such as communication and influencing are therefore also needed to reduce resistance and help implement ideas (Ford, Ford, and D'Amelio, 2008; Howell and Boies, 2004). It is therefore proposed that individuals possessing better operational skills would demonstrate better implementation of their ideas, but these types of skills would not relate to levels of idea generation since they do not relate to divergent and convergent thinking capabilities. Hence:

*H3: Operational skills will be significantly positively related to the implementation of ideas but not to idea generation.*

Third, innovation efforts should be aided by having greater contextual knowledge of the environment (Sternberg and Lubart, 1996). Dutton, Ashford, O'Neill, and Lawrence (2001) defined contextual knowledge as understanding of how decisions are made within the organization and who are the key players who can make things happen. This is distinct from job expertise, which covers a person's technical knowledge and skills in the

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topic. The authors showed in their qualitative study the importance of this type of knowledge for managers selling issues within organizational change initiatives. Better understanding of normative procedures and individuals' status should help individuals to more effectively present their ideas to the organization and translate them into practice. In their study of innovation champions, Howell and Boies (2004) demonstrated that contextual knowledge was positively related to the better packaging of ideas for promotion (thus aiding implementation) but nonsignificant when it came to idea generation itself. The emphasis from the literature here is therefore on contextual knowledge aiding the putting of ideas into practice rather than influencing the quantity of ideas generated. Hence:

*H4: Contextual knowledge will be significantly positively related to the implementation of ideas but not to the generation of ideas.*

## *Intrinsic Motivation to Innovate*

Regardless of skills and capabilities, if an individual is not motivated to engage in creative efforts, then little innovation will occur. In particular, Amabile (1988) flags up the importance of an individual's intrinsic desire to innovate. Extrinsic motivation concerns a person's decision to exert effort on a task in order to receive external rewards or avoid punishments, while intrinsic motivation is where a person exerts effort for internal reasons such as enjoyment or curiosity. The willingness to put in extra effort to creative activities without explicit reward is considered to result in better generation i.e., since more time is spent on coming up with ideas, more ideas will be produced and also, by the law of averages, more likelihood that original ideas will surface. Empirical studies have supported this direct positive relationship between intrinsic motivation and employee creativity (e.g., Amabile and Pillemer, 2012; Shin and Zhou, 2003; Tierney, Farmer and Graen, 1999). Looking at the other part of the innovation process, the implementation of ideas at work is often an effortful, time-consuming process which may involve overcoming many obstacles and therefore dissuade employees from taking their ideas forward. It can be argued that those with higher intrinsic motivation to innovate would be more likely to keep going in the face of resistance when others would give up. Intrinsic task motivation should therefore be directly important for all aspects of employees' innovative behavior, from the initial willingness to identify opportunities for innovation to the effort to generate multiple ideas to the persistence required to implement them. Hence:

*H5: Intrinsic motivation to innovate will be significantly positively related to both idea suggestion and idea implementation.*

## *Environmental Support*

The Amabile (1983) componential theory states that the external social environment is an additional source of influence on employee creativity beyond the three sets of intra-individual factors. Many studies have indeed shown that the environment in which employees work is a crucial influence on their innovativeness (Choi, Sung, Lee, and Cho, 2011; Cokpekin and Knudsen, 2012; Hutterman and Boerner, 2011; Mathisen and Einarsen, 2004; Oldham and Cummings, 1996; Unsworth and Clegg, 2010). For this study, two of the environmental factors (job autonomy and departmental support for innovation) most commonly examined in relation to workplace creativity and innovation (see Hammond et al., 2011) are drawn on in order to cover the fourth component of Amabile's (1983) model and provide a substantive enough situational comparison to the aforementioned individual factors.

Environmental favorability can be reflected in the extent to which there is practical support for innovation in terms of providing employees with the time and resources to explore and develop innovative ideas. A potentially important factor therefore is the autonomy the individual has in their work since greater job control (the extent to which the individual can define for themselves how they work) should give individuals more time to explore, develop and, in particular, apply new ideas (Amabile et al., 1996; Unsworth, Wall, and Carter, 2005; Urbach et al., 2010). Although increased job control may give employees more time to generate ideas, a stronger relationship should be found with implementation since it requires a much greater time commitment. Indeed, Axtell et al. (2000) found this to be the case in their study of shop floor workers. Hence:

*H6: Job control will be more strongly positively related to the implementation of ideas compared to the generation of ideas.*

The environment also provides strong social cues to employees, and perceived departmental support for innovation (which can be defined as the extent to which the participant feels the other people in their department actively encourage and engage in innovative work behavior [Birdi, 2007]) is the second external factor to focus on. Madjar (2008) indicated the importance of emotional and informational support from work colleagues for creativity. Tierney et al. (1999) showed that quality of leader–member exchange was a significant predictor of R&D staff innovation, and other studies have found that employees with more supportive managers were more likely to have their ideas implemented (Choi and Chang, 2009; Tierney et al., 1999). At a more general level, Ekvall and Ryhammar (1999) found that environmental support and resources exerted the strongest influence on creative outcomes in their study of university teachers. Furthermore, a recent meta-analysis showed that both senior management support and organizational climate significantly predicted new product success (Evanschitsky et al., 2012). Such verbal encouragement from others and instrumental provision of time and resources can therefore both encourage employees to come up with new ideas and also help them put those ideas into practice. Hence:

*H7: Departmental support will be significantly positively related to both idea generation and idea implementation.*

In summary, this study makes several important contributions by testing and extending Amabile's (1983) well-regarded componential theory of creativity. First, theoretically, employees' innovative work behavior is separated into the two distinct dimensions of idea generation and idea implementation, whereas the Amabile (1983) model focuses primarily on how its components influence the creativity (i.e., idea generation) of employees only. The theory is therefore extended to make hypotheses regarding how the proposed components would differentially relate to idea generation versus implementation. Recent reviews (e.g., Gong, Zhou, and Chang, 2013; Mumford et al., 2012) have concluded this has not been undertaken nearly enough in previous studies, and indeed Anderson et al. (2014) state "Akin to two siblings who fell out at a family gathering in their distant past, the subfields of idea generation and idea implementation remain doggedly disconnected from one another." Second, all four of the Amabile (1983) theory components are tested concurrently. In doing this, the study readdresses the balance of past research which has focused in the main on intrinsic motivation and work environment components only but neglected to detail factors underlying the knowledge/skill components (see Anderson et al., 2014). There is therefore a particular focus on expanding the domain-relevant knowledge/skill component to propose and test how the three potential antecedents of job expertise, operational skills, and contextual knowledge relate to the two innovation phases. No other studies have gone to this level of detail in investigating the knowledge and skills components. Third, the study investigates how well the extended componential model works in accounting for innovative work behavior in the real-world context of design engineers working in a multinational company. The population is highly qualified and with a strong requirement to innovate in their jobs. A final point is that since Robinson-Morral, Reiter-Palmon, and Kaufman (2013) stress the need for future research to investigate whether the same predictors work across different measures of creative performance, both self-report and objective measures of innovative work behavior are used.

## Method

### *Procedure and Participants*

The study was conducted within a major international engineering firm (Company X) that manufactures power systems and services for use on land, sea, and air with an average timescale of four years from initial design to initial production. It has sites in several countries including the United States and the United Kingdom. The researchers were allowed by the Design Engineering function of the company to undertake a quantitative study of the factors influencing the innovativeness of their employees. The main function of these staff was to improve the design, manufacture, and performance of engines and their components, e.g., looking for ways to reduce engine weight, improve engine power, or make the production process more efficient. After initial testing of the measures with a pilot sample of 111 design engineers, an online survey was sent out to design engineers across its main business units in four countries. Out of 496 surveys sent out, 219 were returned (a response rate of 44%). Out of that sample, 169 participants provided the required data for the analyses reported in this paper. The average age of participants was 41.28, average organizational tenure was 13.57 years, 27% had some form of supervisory role, and 33% had a post-graduate qualification.

### *Measures*

Unless indicated otherwise, all responses were on a 5-point scale from 1 "strongly disagree" to 5 "strongly agree." Details of all the measures are provided in the Appendix. As noted above, an initial pilot study was conducted within the company to test the robustness of the scale measures (reliability and construct validity) before the final of version of the survey was sent out.

*Idea generation measures.* Patent submission. A discrete measure of idea generation at work for design engineers concerns the extent to which they have submitted patents based on their ideas, i.e., they were named on the patent application (Park, Lubinski, and Benbow, 2007). This was considered to represent a formalized measure of idea suggestion as patents only constitute ideas with the potential to make a significant contribution to project objectives. The process of patent application, being a focused and intense activity, is therefore likely to be recalled accurately. The company confirmed the view that an individual being named on a patent meant that they had contributed significantly to the generation of the idea, even though others may also be included in the application. Respondents were asked how many patents they had applied for in each of the last three years. Given the non-normal, skewed nature of the distribution (65% stated they had submitted no patents), this variable was dichotomized so that 0 = no patent applications submitted and 1 = at least one patent application submitted in the past three years (Tabachnik and Fidell, 2001).

Real-time idea submission. To assess participants' capacity for idea generation more objectively, respondents were directly asked in the questionnaire to offer their ideas for dealing with an important work-related challenge, a method used by other researchers (e.g., Binnewies, Ohly, and Niessen, 2008; Robinson-Morral et al., 2013). A senior company contact was asked to identify a salient issue for the organization where they would welcome new ideas from employees, resulting in the choice of dealing with climate change issues. This presented good face validity for this measure of idea generation since it was something design engineers could contribute to and that was valued by the organization (since power systems can potentially affect climate change). At the end of the questionnaire, the following question was posed: "To help Company X develop its innovation strategy, could you suggest ways in which Company X products, technology, or expertise could be used as part of a solution to climate change?" If respondents answered this question, they were coded as 1 on actual idea generation and 0 if they submitted no relevant response (this dichotomous scoring was more appropriate than simply looking at number of ideas submitted since 75% of the sample did not submit any ideas). Sullivan and Ford (2010) recently highlighted the importance of measuring different aspects of creative ideas in order to assess idea quality as well as quantity. The consensual assessment technique developed by Amabile (1983) has been widely used in the creativity literature as a means of more objectively assessing a person's level of idea generation (Amabile and Pillemer, 2012). Therefore, for the subsample that had submitted at least one idea ($n = 44$), three experts in the company were asked to rate the quantity and quality of the ideas submitted. The experts were chosen on the basis of them being senior design engineers who had a substantial number of years' experience working in the company and would therefore be able to more accurately judge the originality and value of the climate change ideas. Each of the raters were therefore asked to independently assess the *number of ideas* that a person had submitted and the average quality of a person's ideas (from 1 "very low" to 5 "very high") along each of three dimensions: *originality*, *usefulness* (i.e., in terms of dealing with climate change), and *persuasiveness* (i.e., the strength of the arguments put forward). Originality is fundamental to judging the novelty of ideas, but innovation requires ideas to be implemented, hence judgments of the utility of those ideas were also requested (Binnewies et al., 2008). Furthermore, since Sternberg and Lubart's (1996) theory of creativity explicitly states that intellectual skills for persuading others as to the value of one's ideas are important, it was also thought important to assess how persuasively argued the ideas were. Intra-class correlation coefficients (ICC) were calculated for each of these four criteria using a two-way random effects model and using an absolute agreement type of analysis (i.e., examining averaging across raters) (Giberson, Resick, and Dickson, 2005). Results indicated statistically significant levels of agreement for the criteria (number of ideas: ICC [2] = .93, $F = 15.29$, $p < .001$; originality: ICC [2] = .64, $F = 3.84$, $p < .001$; usefulness: ICC [2] = .55, $F = 2.46$, $p < .01$; and persuasiveness: ICC [2] = .54, $F = 2.43$, $p < .01$) so ratings for each of the four criteria were averaged across the three raters.

*Idea implementation measure.* To capture both outputs of the patent process and more modest suggestions, it was decided it would be appropriate to develop a contextualized idea implementation measure, as recommended by innovation researchers (e.g., De Jong and Den Hartog, 2010). A company expert (the Head of Research and Technology for Design Engineers) was briefed on the aims of the study and asked to indicate in writing the areas in which the design engineers could be expected to innovate in their jobs. This resulted in a 5-item scale reflecting where innovative changes to power systems were likely to be focused: (1) weight reduction, (2) unit cost reduction, (3) other product improvement, (4) manufacturing improvement, and (5) local process improvement. Respondents were asked to indicate to what extent their ideas about the five aforementioned areas had been put into practice over the last three months. Responses were on a 5-point scale from 1 "not at all" to 5 "to a very great extent" ($\alpha = .81$).

In order to test the construct validity of the above innovation measures, the two idea generation measures (patent submission and real-time idea submission) and five idea implementation items were entered into a factor analysis. The two idea generation measures clearly loaded onto one factor and the five implementation items loaded on to another factor, together explaining 59% of variance in the data.

*Individual and environmental factors.* Examination of the extant literature showed a lack of an adequate instrument that assessed the full range of competencies that were proposed to group into creative problem-solving and operational skills, and hence a new set of measures were developed. Amabile's (1983, 1988) creative performance process (task presentation, preparation, response generation, response validation, and outcome) was taken as a starting point to identify the different skill sets that would be required for each stage of the process. Existing measures of innovative work behavior (e.g., Janssen, 2005; Zhou and George, 2001; Tierney et al., 1999) were also examined to identify underlying skills that would contribute to the performance of the behavior. For example, Janssen's (2005) measure of innovative work behavior contained the behavioral items "Acquiring approval for innovative ideas" and "Evaluating the utility of innovative ideas," which were then turned into the skill items "Getting management support for your decisions" and "Being able to pick out the best option from a number of solutions." Seventeen items were therefore created to describe the skills thought to be required for generating and evaluating new ideas (divergent and convergent thinking skills) and for implementing them in the workplace (operational skills). Respondents were asked to rate how skilled they were now in each of the 17 activities, using a response scale from 1 "not skilled at all" to 5 "highly skilled, i.e., can coach others in this." Factor analyses indicated, as expected, a two-factor solution which accounted for a cumulative variance of 60%. The first factor, *creativity-relevant skills*, contained seven items covering idea generation and evaluation skills such as "Thinking up new ways of doing things" and "Being able to pick the best option from a number of solutions to a problem" ($\alpha = .90$). This theoretically related to the divergent and convergent thinking skills referred to by Basadur et al. (1982). The second factor, *operational skills*, contained seven items covering tasks such as "planning tasks and activities," "influencing others," and "managing projects" ($\alpha = .86$).

The other individual and environmental attribute measures were taken from other studies or adapted from the literature as follows (plus an initial test of the measures was conducted in a pilot sample). *Job expertise* was assessed by developing a new 4-item scale based on a qualitative study by Leach et al. (2003). A sample item was "I would be considered an expert in my area of work" ($\alpha = .76$). *Contextual knowledge* was assessed by developing a new 4-item scale which covered the relational and normative aspects described in the qualitative study by Dutton et al. (2001). A sample item was "I have a good awareness of how things are usually done around here" ($\alpha = .87$). Intrinsic *motivation to innovate* was assessed by taking the 2-item scale from Birdi (2007) and adding in two additional items to reflect enjoyment of innovation (e.g., "I enjoy engaging in tasks that require creative thinking") ($\alpha = .79$). *Job control* was assessed using a 3-item scale from Jackson, Wall, Martin, and Davids (1993). A sample item was "I decide how to go about getting my job done" ($\alpha = .79$). *Departmental support for innovation* was assessed using a 4-item scale from Birdi (2007). A sample item was "Members of this Department provide and share resources to help in the application of new ideas" ($\alpha = .83$). Three demographic variables were assessed to act as controls. Organization *tenure* was measured in years, *supervisor* status was dichotomized as 1 "Yes" and 2 "No," and *site* at which respondent was based was recoded into dummy variables.

In order to test the construct validity of the above individual and environmental measures, the job expertise, contextual knowledge, intrinsic motivation to innovate, job control, and departmental support for innovation items were entered into a factor analysis. The results clearly showed the relevant items loading on to each of the appropriate scales, together explaining 68% of variance in the data.

## Results

Table 1 shows the means, standard deviations, and correlations between the study variables. In regard to idea generation, 35% of designers had submitted at least one patent in the previous three years, and 25% of the sample submitted at least one climate change idea when prompted to do so. Idea implementation was not particularly high (mean = 2.02). Although some of the zero-order correlations in Table 1 were not significant, partial correlations controlling for demographics showed that the three employee innovation variables were nearly all significantly interrelated, suggesting they were tapping into the same types of construct (patent submission–actual idea submission, $r = .16$, $p < .05$; patent-submission–idea implementation, $r = .12$, $p = .06$; actual idea submission–idea implementation, $r = .16$, $p < .05$).

## *Individual and Environmental Variables and Innovation Measures*

Table 1 shows zero-order correlations for reference purposes. In order to test H1 to H7, a series of multiple linear and logistic regressions were undertaken where each of the three main indicators of employees' innovative behavior (patent submission, real-time idea generation, idea implementation) were regressed onto the same posited individual and environmental variables. Logistic regressions were used for patent submission and real-time idea submission since both variables showed very skewed distributions (i.e., non-normal), and hence the appropriate approach was to dichotomize the data for regression analyses (Tabachnik and Fidell, 2001). Multiple linear regression was used for the idea implementation measure since the data were not adversely affected by skewness issues and showed acceptable normality. All analyses controlled for site, supervisor status, and tenure to remove any variance attributable to demographic factors and one-tailed significance tests were used since hypotheses were directional (Rogelberg, Leach, Warr, and Burnfield, 2006).

Table 2 shows the results of these analyses. Controlling for demographics, the findings indicate that creativity-relevant skills positively predicted patent and real-time idea submission but not idea implementation, therefore supporting H1. Job expertise ($\beta = .19$, $p < .05$) and operational skills ($\beta = .20$, $p < .05$) only predicted idea implementation, providing partial support for H2 and support for H3, respectively. No support for H4 or H6 was found, as the proposed relationships of contextual knowledge and job control with the innovation measures were not supported. Curiously, job control was negatively related to patent submission ($B = -.58$, $S.E. = .36$, $p < .05$). However, H5 received partial support as motivation to innovate positively predicted idea implementation ($\beta = .25$, $p < .01$) but not the two idea generation measures. Finally, H7 was partially supported as departmental support for innovation positively and independently predicted the two idea generation measures ($B = .74$, $p < .05$ for patent submissions and $B = .77$, $p < .05$ for real-time idea submission) but not idea implementation.

The idea generation measures discussed so far utilized simple yes/no categorizations of patent submission and climate change idea submission. In order to also independently assess the *quality* of idea generation, the suggestions for climate change products/services submitted by respondents were independently rated by three organizational experts for number of discrete ideas generated and their overall levels of originality, usefulness, and persuasiveness. Since only 44 respondents submitted climate change ideas and thus restricted the sample size for analyses (Tabachnik and Fidell, 2001), Table 3 shows the results of partial correlations between the expert rating criteria and the individual and environmental factors, controlling for the demographics of supervisory status, tenure, and site. Interestingly, creativity-relevant skills

**Table 1. Correlations between Study Variables ($n = 169$)**

| | Mean | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Supervisor | 1.73 | .44 | | | | | | | | | | | |
| 2. Tenure | 13.57 | 10.48 | −.12 | | | | | | | | | | |
| 3. Creativity-relevant skills | 3.72 | .65 | −.21** | .06 | | | | | | | | | |
| 4. Expertise | 3.81 | .62 | −.12 | .15 | .52*** | | | | | | | | |
| 5. Operational skills | 3.52 | .60 | −.30*** | −.03 | .53*** | .39*** | | | | | | | |
| 6. Contextual knowledge | 3.83 | .60 | −.30** | .07 | .31*** | .47*** | .37*** | | | | | | |
| 7. Motivation to innovate | 3.74 | .66 | .02 | −.07 | .56*** | .30*** | .14 | .19* | | | | | |
| 8. Job control | 3.98 | .62 | −.26** | .08 | .21** | .49*** | .28*** | .36*** | .16* | | | | |
| 9. Departmental support | 3.76 | .66 | −.07 | .08 | .26** | .32*** | .17* | .32*** | .40*** | .36*** | | | |
| 10. Patent submission | .35 | .48 | −.06 | .08 | .20** | .05 | −.02 | .05 | .22** | −.05 | .20* | | |
| 11. Real-time idea submission | .25 | .44 | .11 | −.03 | .12 | −.04 | .07 | −.02 | .10 | −.07 | .15 | .14 | |
| 12. Idea implementation | 2.02 | .86 | −.05 | −.09 | .42*** | .38*** | .34*** | .22** | .41*** | .15 | .28*** | .11 | .13 |

* $p < .05$; ** $p < .01$; *** $p < .001$.
Note: Two-tailed significance levels shown.

**Table 2. Multiple and Logistic Regressions of Employee Innovative Behavior Indicators on Individual and Environmental Variables, Controlling for Site, Supervisor, Tenure ($n = 169$)**

| | Patent Submission $B$ | Real-Time Idea Submission $B$ | Idea Implementation $\beta$ |
|---|---|---|---|
| Supervision | − .40 (.44) | .88 (.51)* | − .01 |
| Tenure | .01 (.02) | − .01 (.02) | − .07 |
| Site 1 dummy | − .10 (.63) | .05 (.66) | .06 |
| Site 2 dummy | 1.01 (.73) | − .68 (.87) | .10 |
| Site 3 dummy | − .02 (.61) | − .68 (.67) | .23 |
| Creativity-relevant skills | .81 (.43)* | .80 (.47)* | .06 |
| Job expertise | − .09 (.42) | − .51 (.46) | .19* |
| Operational skills | − .56 (.38) | .31 (.42) | .20* |
| Contextual knowledge | − .03 (.36) | − .17 (.38) | .01 |
| Motivation to innovate | .28 (.36) | − .24 (.39) | .25** |
| Job control | − .58 (.36)* | − .35 (.38) | − .08 |
| Departmental support for innovation | .74 (.34)* | .77 (.36)* | .11 |
| $R^2$ | | | .33*** |
| $\chi$ 2 (df) | 17.56 (12) | 24.71 (12)* | |
| Nagelkerke$R^2$ | .15 | .19 | |

* $p < .05$, ** $p < .01$, *** $p < .001$.
Note: One-tailed tests for individual and environmental factors, two-tailed tests for demographics (supervision, tenure, site dummies).

were positively related to both quantity and originality of ideas generated ($r = .26$, $p < .05$ and $r = .36$, $p < .05$, respectively) but not their rated usefulness or persuasiveness of argument, again providing some support for H1. Job expertise was related to originality of ideas and their persuasiveness ($r = .38$, $p < .01$ and $r = .34$, $p < .05$, respectively), providing partial support for H2. Operational skills were not related to any of the four idea generation criteria, supporting the relevant part of H3. However, greater contextual knowledge did turn out to be correlated with a larger number of ideas generated and more persuasive arguments ($r = .38$, $p < .01$ and $r = .34$, $p < .05$, respectively), therefore not supporting H4. H5 received more support with motivation to innovate being related to number of ideas generated ($r = .28$, $p < .05$), originality ($r = .44$, $p < .01$), and usefulness ($r = .26$, $p = .05$). As with the other innovation indicators, job control showed no significant positive relationships (supporting H6, which stated control would show weaker relationships with idea generation compared to implementation). Finally, in line with the other analyses, departmental support for innovation was significantly correlated with all four expert ratings of idea quantity and quality, supporting H7.

## Discussion

This study showed support for the perspective that individual and environmental factors relate differentially to separate aspects of the innovation process. In the study sample of design engineers, creativity-relevant skills were positively associated with idea generation but

**Table 3. Partial Correlations between Real-Time Idea Submission Criteria as Rated by Experts and Individual and Environmental Factors ($n = 44$)**

| | No. of Ideas | Originality of Ideas | Usefulness of Ideas | Persuasiveness of Ideas |
|---|---|---|---|---|
| Creativity-relevant skills | .26* | .36* | − .02 | .12 |
| Job expertise | .17 | .38** | .16 | .34* |
| Operational skills | .13 | .14 | − .07 | .07 |
| Contextual knowledge | .27* | .21 | .19 | .34* |
| Motivation to innovate | .28* | .44** | .26**** | .11 |
| Job control | .23 | .15 | .09 | .19 |
| Departmental support | .38** | .34* | .32* | .38** |

* $p < .05$; ** $p < .01$; *** $p < .001$; **** $p = .05$.
Notes: One-tailed tests, controlling for supervisor, tenure, and site. Log of idea criteria used due to skewness of variables.

employees' operational skills and job expertise, along with motivation to innovate, were more strongly related to idea implementation. Furthermore, a consistent finding was the positive association between departmental support for innovation and all the metrics for assessing the quality and quantity of employee idea generation, although surprisingly, there was no significant relationship to implementation. The implications of these findings will be discussed.

### *Theoretical and Research Implications*

The componential theory of creativity (Amabile, 1983) proposes that a variety of individual components and environmental factors dictate an individual's creative output. This study contributed theoretically by extending Amabile's (1983) model from one focusing just on creativity (i.e., the generation of ideas) to one covering innovation (i.e., the generation and implementation of ideas) and demonstrating that the model components are not all equally weighted in their relationship with different facets of innovative work behavior.

The first component of creativity-relevant skills had, as hypothesized, by far the most consistent relationship with the idea generation measures. Designers who considered themselves more skilled at finding opportunities for innovation, defining problems, generating multiple solutions, and evaluating those solutions reported greater levels of patents submission, as well as having a greater quantity and originality of ideas as rated by experts. On the other hand, the level of creativity-relevant skills was weakly related to levels of self-reported idea implementation. The findings support the theoretical view that the individual capabilities required for better idea generation are separate to those needed for better idea implementation, i.e., the most creative employees are not necessarily the most innovative. This echoes the findings of Birdi (2007), which found self-rated creative ability more strongly related to idea suggestion than implementation. There is therefore a clear indication that although in the Amabile (1983) model the divergent and convergent creativity-relevant skills do influence idea generation, if the model is theoretically extended to look at idea implementation, then that component becomes less important compared to other domain-relevant individual knowledge and skill attributes.

Hence, the second component of Amabile's (1983) model is domain-relevant knowledge and skills and three factors (job expertise, operational skills, and contextual knowledge) were examined under this heading; these had not been examined before together in the literature. Based on past research, it was expected that job expertise would be related to both idea generation and implementation. This was proven to be true for implementation and for only some aspects of idea generation (rated originality of real-time ideas submitted and persuasiveness of those ideas). The results for idea generation make sense in that the patent and real-time idea submission indicators used in Table 2 were a measure of quantity of ideas whereas originality and persuasiveness were a measure of quality of ideas. It could therefore be the case that expertise brings with it the capacity to recognize originality and value of ideas, rather than simply producing a larger quantity. The Amabile (1983) model does not distinguish between quantity and quality of idea generation, but the study findings suggest that there may be more differentiated relationships between components and these two indices of creative output.

However, in addition to expertise, an individual's operational skills in planning, communicating, and influencing others were significantly and uniquely related to idea implementation, even though there was no relationship with idea generation. These types of operational skills are ostensibly ill-defined in the Amabile (1983) theory of employee creativity, but if this is to be extended to a theory of employee innovation, then these capabilities should be added to the domain-relevant knowledge and skills component.

Contradictory to the hypothesis, contextual knowledge showed no significant relationship with implementation in this study. It could be that in this engineering context, there are quite clear formal processes and procedures to go through in order to get new ideas implemented; hence using informal routes has minimal impact. Alternately, since the measure of contextual knowledge used was quite brief, more detailed measures in future studies (e.g., distinguishing between knowledge of strategic aims versus normative procedures) may provide more nuanced relationships with other indices. Interestingly, though, participants' contextual knowledge was positively related to two indices of idea generation (the number of real-time ideas submitted and how persuasively ideas were argued). This makes sense in that greater awareness of an organization's needs and procedures can help an individual formulate a more potent argument and also provide a specific focus for generating more ideas (Dutton et al., 2001). The initial hypothesis would therefore be revised in the light of the study findings to suggest that contextual knowledge would be related to idea generation also.

Most past research has simply focused on job expertise as an indicator of domain-relevant skills and knowledge but it has been shown here how operational skills can aid implementation and contextual knowledge has some relationship with idea generation.

The third component of the Amabile (1983) model, intrinsic motivation to innovate, showed mixed relationships with the idea generation indices. Although there was no significant relationship with the patent submission measure or whether a climate change idea had been suggested at all, expert ratings showed that more intrinsically motivated participants in the study subsample suggested more ideas and more original ideas. This is surprising as past research has tended to show intrinsic motivation as a strong predictor of idea generation (Anderson et al., 2014). For example, Hammond et al. (2011) in their meta-analysis on individual innovation, showed that intrinsic motivation was a stronger positive correlate of innovation than personality factors. One contextual theoretical insight from this study could relate to the nature of the population studied. Design engineers by their very nature are tasked with coming up with new ways of improving products, and hence the career should attract people with a good level of intrinsic motivation already (the mean score for this variable was a moderately high 3.74 out of 5). Hence, intrinsic motivation might not be so important for patent submissions as that could be expected as part of the job. On the other hand, the study did show that intrinsic motivation to innovate was positively and uniquely related to idea implementation. No matter how skilled or knowledgeable an individual, he/she needs to have the willingness to engage in the innovation process if change is to occur in the workplace. The communicating and selling of ideas together with planning to put them into practice takes much more time than simply coming up with ideas and hence higher intrinsic motivation at this stage can ensure individuals put in enough effort to ensure things are followed through. This study used a simple overall measure of motivation to innovate, but future studies could differentiate the various facets of motivation (e.g., motivation to generate ideas, motivation to suggest ideas, motivation to implement ideas) and test their relationships with the different facets of the innovation process more specifically.

A further theoretical extension to this study would be to investigate how the knowledge, skill, and motivational individual characteristics relate to the radicalness of the innovations proposed. Most of the employee innovative behaviors assessed simply focused on the quantity or frequency of idea suggestion in the workplace. Where the expert-rated quality of climate change ideas were rated, some interesting differential relationships were hinted at. Job expertise was not related to the number of ideas generated but was to their rated novelty; contextual knowledge was associated with the number of ideas but not their novelty; motivation to innovate was more strongly related to the originality of ideas (perhaps because more enthusiastic individuals put more effort into generating unique perspectives) than the number generated. If radical versus incremental innovation could be investigated within the workplace in a bigger sample, then these relationships could be more rigorously tested as well as new ones posited. For example, contextual knowledge and operational skills might be more important in selling radical ideas which are more likely to upset the status quo compared to selling incremental ideas which are much less disruptive.

The final part of the Amabile (1983) model outlines the importance of the work environment and out of the two situational factors examined, one demonstrated more robust relationships than the other. Job control failed to show any significant positive associations with innovative behavior, even though this has been shown in other studies (Axtell et al., 2000; Unsworth et al., 2005). This may be because the sample of design engineers had a good amount of control in their jobs (the mean score for this scale was 3.98 out of 5), and hence autonomy to suggest and implement ideas was not such an issue, as well as this restricting the range of the measure.

The strongest finding in this study was the fact that departmental support was positively and uniquely related to all the idea generation indices, which supports the componential theory of creativity and findings of other studies showing organizational climate as an influence on creativity (Ruiz-Moreno, García-Morales, and Llorens-Montes, 2008). The organizational environment plays an important role in providing cues as to the appropriateness of creative behavior in a particular context as well as providing opportunities and resources to do so. Interestingly, social support was not found to be significantly related to idea implementation after taking into account the individual variables. Innovation is very much a social phenomenon in that the efforts of others are often required to put ideas into practice (Van de Ven, Angle, and Poole, 1989) and hence being in an environment where time, resources, and guidance are devoted to creative activities should make the implementation process easier for individuals. Past studies have shown that group and organizational factors are stronger predictors of implementation of ideas compared to individual factors (e.g., Axtell et al., 2000). In this study, departmental support may have had an indirect effect on implementation through its influence on intrinsic task motivation rather than directly. Alternately, the lack of significance with implementation in the study may have been because broad assessment of departmental support for innovation was used, so future studies need to examine the effect of different aspects of support (Cokpekin and Knudsen, 2012). For example, is support from managers (the gatekeepers of time, resources, and authority for employees) more influential than that of peers (the referent group with which the employee should identify most closely), and do different dimensions of organizational climate relate to the different phases of idea generation and implementation (Mathisen and Einarsen, 2004)?

### Managerial Implications

If organizations want to develop more innovative employees, a number of important individual knowledge, skill, and affective dimensions have been highlighted for practical interventions. First, research has shown that creativity-relevant skills and attitudes to innovation can be enhanced by training initiatives (Scott et al., 2004). However, if training is to lead to better implementation as well as generation, then this study suggests that courses also need to cover the operational skills required for developing and putting ideas into practice, i.e., *innovation training* rather than just creativity training. These types of courses would therefore develop: analytic skills for identifying problem causes and assessing the quality of ideas, creative thinking skills to generate more novel ideas, marketing and negotiation skills to encourage commitment from key stakeholders, and planning and project management skills to help systematically implement the innovation. Second, job expertise is evidenced by educational qualifications but instituting an ethos of continuing professional development and knowledge sharing can also be helpful. Annual development reviews for employees should highlight their future learning needs, and organizations must provide resources for individuals to update their knowledge and skills through a variety of means (e.g., subsidizing college courses or e-learning provision). Bonuses could be provided for the attainment of professional qualifications or certain competency levels. Furthermore, regular knowledge-sharing events should be introduced. These could take the form of monthly seminars presented by different internal and external groups on the latest thinking on topic areas.

Third, contextual knowledge showed some relationship with the quantity and persuasiveness of actual ideas generated in the study, and this could be improved in employees through job rotation, site visits, and better organizational communication. Mentoring schemes are also good for less experienced employees to learn from more senior colleagues how to navigate organizational channels more successfully (Allen, Eby, Poteet, Lentz, and Lima, 2004). Fourth, motivation to innovate was shown to be significant for idea implementation and could be developed through outlining the value of innovation efforts to employees (Vroom, 1964), setting goals for new product or process initiatives (Latham and Locke, 2006), and introducing suitable rewards or support for creative efforts (Eisenberger and Aselage, 2009). For example, organizations could provide a percentage of the financial gain from successful patents to contributing employees. Finally, environmental support for innovation was shown in this study to be consistently related to better idea generation. Organizations therefore need to ensure that they inculcate a positive innovation climate through strategies such as training managers in how to support innovation in others and providing time, resources, and opportunities for initiating and developing ideas (Mathisen and Einarsen, 2004). There is also now a trend for companies to shape the physical work environment to encourage more creative thinking (Moultrie et al., 2007). For example, the company studied in this paper created special rooms where design engineers could go to be inspired. Within the rooms were pictures of various stimuli, books, and magazines, a box with toys demonstrating different engineering principles (engineers were supposed to pull these out randomly to see if they could spark off any ideas regarding the problem they were looking at), and facilities for relaxing. Without sufficient environmental support, there is a danger that employees' creative potential will not be fulfilled.

### Limitations

A common approach to the examination of innovative behavior is to ask participants to report both the number of ideas submitted and implemented (Amabile and Mueller, 2007). Reliance on self-report measures of innovative behavior in this way can be problematic in regard to issues related to common method variance (CMV) (Podsakoff, MacKenzie, Lee, and Podsakoff, 2003), and a number of steps were taken to address this concern. To reduce the likelihood of such problems (e.g., an inflated relationship between idea generation and implementation), data were collected via various means, namely reported patents (i.e., count data) and real-time idea generation (i.e., count data and expert ratings of idea quality), as well as traditional ratings using a low to high response scale. Furthermore, factor analyses did not show one underlying factor (which might be expected if CMV was a significant issue) but instead demonstrated distinct sets of factors along the lines that would have been expected. Respondent anonymity was ensured to decrease socially desirable responses. Finally, Krishnan, Martin, and Noorderhaven (2006) used tenure as a marker variable for controlling for shared variance in their study and that was included as a control variable in the analyses. Tenure made little difference to the results, suggesting common method bias was not a serious issue in this study.

The findings, though, should be tempered with regard to some research limitations. First, a larger sample size for the rating of climate change ideas would also have allowed more complex multivariate analysis. Second, the participants in this study were design engineers who were already required to have a level of creativity in their jobs, and hence there is a need to identify if the relationships found here are replicated in other types of jobs. Also, since this study was conducted within one organization (albeit with multiple sites), there may have been some restriction on the range of some measures so the generalizability of findings needs to be tested in other contexts. Third, although a number of individual factors were examined in this study, only a broad measure of the environment was taken in order to keep the questionnaire an acceptable length. Therefore, future studies should collect data on more differentiated aspects of the work environment such as resources, pressures, peer/supervisor support, and organizational impediments to creativity (Amabile et al., 1996; Cokpekin and Knudsen, 2012; Rahim, 2014), as well as the individual dimensions outlined here. Fourth, participants rated their own levels of skills and knowledge with the concomitant risk of some bias, so using supervisor/peer ratings or more objective indices of these and innovative behavior would help provide additional support for the study findings.

## Conclusions

Gong et al. (2013) recently stated "a comprehensive theory of creativity must fully take into consideration both creation and implementation and reconcile potential tensions between the two. Such a theory indicates the need for research that goes beyond the focus on idea generation and includes the identification of factors promoting both idea generation and implementation" (p. 71). The current study has attempted to do this by expanding the focus of Amabile's (1983) widely used componential theory from solely creativity to innovation (covering both the generation and implementation of ideas). A series of theoretical propositions on how these components would relate differentially to the facets of idea generation and implementation were created based on past research and tested in a real-world organizational context. The findings supported the differential influence view. Generally, creativity-relevant skills and departmental support for innovation were most important for idea generation, but employees' job expertise, operational skills, and intrinsic motivation were more strongly related to the implementation of ideas. These are all factors that can be actively enhanced by appropriate learning opportunities and management practices, and therefore provide an indication to organizations how they can raise the innovativeness of their employees to meet the challenging demands of the 21st-century market.

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## Appendix. Scales Used in the Study Analyses

Unless indicated otherwise, the scales below used the following response options:
1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree

### *A. Creativity-Relevant Skills ($\alpha = .90$)*

"How skilled are you in the following activities?"

1. Thinking up new ways of doing things
2. Coming up with new ideas
3. Finding new areas for improvement
4. Finding new opportunities for innovation
5. Generating more than one solution to a problem
6. Finding out the root cause of a problem
7. Being able to pick the best option from a number of solutions to a problem

*Response scale: 1 = Not skilled at all, 2 = Some basic skill, 3 = Moderately skilled, 4 = Fairly well skilled, 5 = Highly skilled*

### *B. Domain-Relevant Knowledge and Skills*

Job expertise ($\alpha = .76$)

1. I can do my job well
2. I can deal with just about any problem in my job

3. I feel better off than most people at tackling job difficulties
4. I would be considered an expert in my area of work

Operational skills ($\alpha = .86$)
"How skilled are you in the following activities?"

1. Planning tasks and activities
2. Managing projects
3. Influencing others
4. Time management
5. Verbally communicating with others
6. Getting management support for your decisions
7. Negotiating with colleagues

*Response scale: 1 = Not skilled at all, 2 = Some basic skill, 3 = Moderately skilled, 4 = Fairly well skilled, 5 = Highly skilled*

Contextual knowledge ($\alpha = .87$)

1. I know who to go to get things done around here
2. I know who makes the key decisions around here
3. I have a good awareness of how things are usually done around here
4. I am familiar with how decisions are made in this department

### C. Intrinsic Motivation to Innovate ($\alpha = .79$)

1. I put a lot of energy into coming up with new ideas at work
2. I always try to come up with new ways of dealing with problems
3. I am always trying to do things differently from before
4. I enjoy engaging in tasks that require creative thinking

### D. Environmental Support

Job control ($\alpha = .79$)

1. I plan my own work
2. I decide how to go about getting my job done
3. I can choose the methods to use in carrying out my work

Departmental support for innovation ($\alpha = .83$)

1. This Department is always moving towards the development of new answers
2. People in my Department are always searching for fresh, new ways of looking at problems
3. People in my Department co-operate in order to help develop and apply new ideas
4. Members of this Department provide and share resources to help in the application of new ideas

### E. Idea Generation

#### *Patent Submission*

Participants stated the number of patents they had submitted based on their ideas (i.e., they were named on them) in the past three years. Due to the highly skewed nature of the responses, this variable was dichotomized to 0 = no patents submitted and 1 = at least one patent submitted.

#### *Real-Time Idea Submission*

At the end of the questionnaire, participants were asked to respond to the following question: "To help Company X develop its innovation strategy, could you suggest ways in which Company X products, technology or expertise could be used as part of a solution to climate change?"

The number of ideas submitted were counted and due to the skewed nature of responses, this variable was dichotomized to 0 = no ideas submitted and 1 = at least one idea submitted.

For the subsample of respondents who submitted at least one idea, a panel of three experts rated the *number of ideas* that a person had submitted and rated the average quality of a person's ideas along three dimensions: *originality*, *usefulness* (i.e., in terms of dealing with climate change) and *persuasiveness* (i.e., the strength of the arguments put forward). Each of the three quality dimensions was rated from 1 "Very low" to 5 "Very high."

### F. Idea Implementation ($\alpha = .81$)

"To what extent have your ideas about the following areas been put into practice over the last three months?"

1. Manufacturing improvement
2. Unit cost reduction
3. Other product improvement
4. Local process improvement
5. Weight reduction

*Response scale: 1 = Not at all, 2 = To a small extent, 3 = To a fair extent, 4 = To a great extent, 5 = To a very great extent*