Applying Impact Based Incentives for Idea Generation in R&D Projects

by

Rafael Holzhacker

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Signature of Author_____

Rafael Holzhacker
System Design and Management Program
June 2005

Certified by_____

Dan Ariely
Thesis Supervisor
Luis Alvarez Renta Professor of Behavioral Economics

Para Liane

ABSTRACT

Innovation is a key factor for sustainable competitiveness, and idea generation in Research and Development is an essential part of it.

In the present study, we focus on a specific process that intends to inhibit some dysfunctional behaviors occuring in team work schemes for idea generation – namely free ride, evaluation apprehension and production blocking.

To that effect, we follow a twofold approach: a literature review of some aspects pertaining to creativity, reward systems and team work; and the application of an anonymous and asynchronous idea-generation system with incentives based on impact (IDEATION) in real-world situations of an R&D department.

The outcomes of the proposed IDEATION process are analyzed and compared to the estimated results for verbal brainstorming, thus allowing conclusions about the effectiveness of the former.

1) INTRODUCTION

A. OBJECTIVE AND HYPOTHESES

The present study aims at addressing some of the aspects inherent to idea generation in groups at an R&D department of a technology company. Specifically, the object of this study is an asynchronous and anonymous idea generation process – IDEATION – in which participants' rewards are based on their respective performance.

IDEATION has been proposed (Toubia, 2004) as an answer to observations indicating that in verbal idea generation processes carried out in teams, we find several dysfunctional behaviors– namely, free ride, evaluation apprehension and production blocking. Such phenomena are so significant that further observation indicated that verbal brainstorming is a less effective process than the consolidation of ideas of team members working alone (Pinsonneault et al., 1999).

In this context, our preliminary hypothesis is that IDEATION would lead to higher productivity than the usual verbal brainstorming processes. This study will review the literature on creativity and reward separately, so as to build a foundation on which to ground its analysis of the relation between the two topics (Chapters 2 and 3). Additionally, we will study team work to verify and understand the above mentioned behavioral dysfunctions (i.e., free rides, evaluation apprehension and production blocking).

The current study will also focus on:

- Suggesting a context in which idea generation occurs in an R&D department;
- Applying the proposed process of idea generation with reward based on performance (IDEATION), assessing results and understanding some of the reasons behind them;

- Suggesting and implementing changes to the proposed IDEATION process.

B. APPROACH

In this study, research will be mostly conducted through literature review and experiments. A web-based idea generation system will be deployed and experiments will be run in an R&D department and other areas of a company.

Three topics related to R&D projects will be selected. Suppliers, external consultants, clients and employees will be invited to participate in teams of 10 people to generate ideas on such topics via IDEATION. The system will allow participants to remain anonymous, disclosing nicknames or other alternative identities only.

Points will be awarded according to the impact of each idea, measured by the number of ideas generated based on the original one. Thus, it is expected that participants will contribute with a large number of impactful ideas.

The outcomes of the proposed IDEATION process will be analyzed and compared to estimated results of verbal brainstorming to allow for conclusions about its effectiveness in inhibiting free ride, evaluation apprehension and production blocking.

2) CREATIVITY IN THE R&D CONTEXT

This chapter presents some of the factors that influence creative work in an R&D department. During the course of our review and observation, we have perceived that participant intrinsic motivation is a key factor for creativity (Amabile, 1997); its relation with reward will be addressed in Chapter 3.

A. IDEA GENERATION IN R&D

Idea generation occurs in R&D as a manifestation of creativity. To ensure creativity results in impactful and meaningful ideas for the department, some characteristics of the idea generation process and the generated ideas themselves must be identified and addressed.

Firstly, those ideas generated should be in line with the problem and/or opportunity at hand. Bizarre thoughts that are disconnected from the problem or reality are unlikely to have a significant impact to R&D work.

Secondly, idea generation must be within the scope of specific R&D goals. To ensure developers are aware of the scope of ideas they may bring forward, objectives and issues must be presented very clearly.

Thirdly, besides their generation, ideas must be communicated. An idea generation process that does not include communication prevents the results of creativity to be used.

And finally, idea generation must be coherently inserted into the innovation process – i.e., the successful implementation of novel ideas (Amabile, 1997). An effective idea evaluation system and the availability of resources to implement prototypes are determinant to the level of impact resulting from the idea generation process.

An idea generation process (IDEATION) similar to the one used in the present study addresses at least two of the conditions previously stated. In Chapter 6, on the analysis of results, we will see that new (and old) ideas came out when the question was clearly and objectively presented, and a communication channel was available.

B. COMPONENTS OF CREATIVITY

According to the componential theory of creativity, while everyone is capable of being creative, the level and frequency of creativivity are influenced by both individual and work environment factors (Amabile, 1997).

INDIVIDUAL FACTORS INFLUENCING CREATIVITY

The componential theory identifies three major individual components of creativity: expertise, creative thinking skills and intrinsic motivation (Amabile, 1997).

Expertise:

- Expertise includes memory for factual knowledge, technical proficiency and familiarity with the problem.

Creative thinking skills:

- Individual behavior favorable to taking new perspectives on problems, applying techniques for creativity, and having persistence and enthusiasm;
- Personality traits related to independence, self discipline, orientation towards risk taking, tolerance for ambiguity, perseverance in the face of frustration, and lack of concern for social approval;
- Ability to concentrate and abandon unproductive strategies.

Intrinsic motivation:

- Determination of what the person will actually do, in spite of his/her ability to do it as a result of skills and expertise;
- Potential to be driven by curiosity or personal sense of challenge, enthusiasm and pride;

EXTERNAL FACTORS INFLUENCING CREATIVITY

External elements can positively influence intrinsic motivation and creativity but can also create obstacles to new ideas and creative behavior:

- Positive challenge – Sense of having to work hard on challenging and important tasks;
- Organizational encouragement – Fair and constructive judgment of new ideas, recognition of creative work, mechanisms for developing new ideas, shared vision of what the group is trying to do, implementation of people's ideas (Amabile, 1996);
- Work group support – Good communication among people, as well as an open mind to new ideas, trust, and the feeling of commitment;
- Organizational impediments – Criticism of new ideas, avoidance of risk, lack of resources;
- Workload pressure – Deadlines and time pressure, unrealistic expectations for productivity;
- Freedom – Sense of control over the work; individual discretion over his/her own research (Muhlemeyer, 1992);

- Supervision – Incentive to creativity when supervision is characterized by planning and feedback, good communication, support for the work of the individuals and the team;

Some of the factors mentioned above will be reviewed during the analysis of IDEATION results, since this process addresses both individual and external factors that influence creativity.

It should also be stressed that the work environment strongly influences the motivation aspect – a critical component of creativity.

3) REWARD AND MOTIVATION

The idea generation system analyzed in this study proposes rewards based on the individual performance. Such a reward scheme intends to reduce free rides while stimulating participant creativity.

So as to better understand the results observed during the experiment, this chapter presents some aspects of reward systems and their relation to motivation. The importance of motivation for creativity has already been explored in Chapter 2.

First, we identify some characteristics of reward systems to then address extrinsic and intrinsic factors of reward and motivation. Finally, we explore some of the findings regarding the relationship between reward and motivation.

A. REWARD SYSTEM

Reward systems should have clear criteria to maintain equity. Frustrations are more often related to lack of clear standards and transparency than to the size of the reward. It has also been noted that uniform and undifferentiated reward distribution reduces its expected impact (Muhlemeyer, 1992).

As with other aspects pertaining to a reward system, no specific criterion is clearly more appropriate to maintain equity, for its adequacy depends on the alignment with the company's culture, strategy, structure and work type (Heneman, 2001).

Criteria may be related to the analysis of job or person, behavior or results, as well as to whether the analysis is conducted at individual or team level (Heneman, 2001). These aspects are discussed below.

ANALYSIS UNIT – JOB OR PERSON

The job evaluation criterion defines individual reward as being limited by job scope and responsibilities, while the person evaluation criterion considers reward as based on those skills and abilities the individual employs to perform his or her job.

In view of the above, job-based criterion may not fully take into account the technical development of R&D professionals, thus stimulating them to seek management positions (Beer & Walton, 1989). Person-based criterion, on the other hand, involves a higher level of subjectivity that renders its implementation not only more complex, but also more likely to generate feelings of unfairness.

BEHAVIOR OR PERFORMANCE METRICS

Behaviors measure what the person does, whereas performance measure what the person accomplishes (Heneman, 2001).

Findings show that a performance-based reward is appropriate because it generates desired behaviors, attracts result-oriented professionals, and retain good performers, while discouraging poor ones. It should be noted, however, that a result-oriented focus may be unfavorable for uncertain, risk-prone activities carried out in the longer term – i.e., those inherent to R&D activities.

Whenever performance-based reward is adopted, care must be taken to ensure individuals have both control and a comprehensive understanding of the impact their work has on measured results. Therefore, there must be a causal relation between the individual's effort, his/her performance, and the final result (Beer & Walton, 1989).

Behavior-based reward requires metrics that substantially represent desired behavior. For instance, punctuality and work hours may not be the appropriate

metrics to measure the individual's commitment – the behavior we in fact wish to assess.

LEVEL OF ANALYSIS – INDIVIDUAL OR TEAM

The reward system may favor individual or team performance.

An analysis that exclusively focuses on team performance may lead to apathy, free rides, and lack of motivation. A reward system based on individual performance only, on the other hand, does not foster cooperation and team work.

The ideal weight to be put on individual and team analyses will depend on company culture and work type.

SENIORITY

Seniority is an alternative equity criterion that establishes higher reward levels to more experienced individuals. Such a criterion may be particularly applicable to situations in which individual effectiveness relies on tenure and experience.

Typical seniority cases would include, for instance, a sales manager that has established a personal relationship with his/her clients over the years, or an R&D professional that has participated in several developments and acquired an expertise that cannot be learnt in schools.

Based on the author's experience – even in those cases in which all other criteria to maintain the equity of the reward system are clear – R&D professionals also expect to be rewarded according to seniority. In other words, more experienced professionals expect to have higher reward than more junior ones, regardless of their performance or behavior.

The complexity of measuring job, capability and performance aspects requires intrusive and subjective analyses of behavior; those in turn presuppose strong

interpersonal skills and a sound relationship between leader and employee (Beer & Walton, 1989).

B. EXTRINSIC / HYGIENIC FACTORS

Extrinsic factors – also known as dissatisfaction or hygienic factors – are external to individuals. Company processes and policies, supervision, peer pressure, work environment, compensation, status and stability illustrate some of these factors (Herzberg, 1968).

Although extrinsic factors do not generate motivation, if inadequate, they lead to dissatisfaction. Furthermore, it has been observed that they may improve the performance of intrinsically motivated individuals (Wiersma, 1992).

Although extrinsic factors may lead to action and the fulfillment of tasks, they do not motivate. They should be continuously renewed to ensure action is maintained (Herzberg, 1968). Over time, extrinsic reward starts to be perceived as an acquired right, rather than recognition (Herzberg, 1968; Muhlemeyer, 1992). Alternatively, fear of extrinsic reward discontinuity may be enough to lead to action and task fulfillment (Herzberg, 1968).

Such factors should be enough to compensate individuals for performance costs – i.e., fatigue, physical and emotional distress. According to the "effort net return model" (Grant, 1999), individuals will operate at the performance level that yields the maximum satisfaction for them, maximizing the spread between extrinsic reward and performance cost. Thus, less hygienic work environments may generate the need of substantially higher extrinsic rewards.

Maximizing the spread between extrinsic reward and performance cost is not enough to prevent individual dissatisfaction. A gap between expectations generated by skills, behavior and performance, and what is really obtained in terms of extrinsic reward may cause dissatisfaction (Beer & Walton, 1989).

Dissatisfaction may also result from comparisons with other individuals. This is often a problem, since people tend to overestimate their own strengths while underestimating the performance of others – generating unrealistic self assessments and distorted comparisons. As a consequence, to avoid demotivation, good performers must receive significantly higher compensation levels than their less-performing peers (Beer & Walton, 1989).

C. INTRINSIC FACTORS

Intrinsic factors relate to fulfillment potential, leading to feelings of usefulness and pride for the contribution made. The opportunity to take on responsibility, employ and be able to use one's individual skills are intrinsic motivational factors. Additionally, intrinsic reward occurs in situations that allow individuals to learn, face challenges, and develop (Herzberg, 1968).

Reward systems cannot generate intrinsic reward, but should foster a work environment that does (Beer & Walton, 1989). Avoiding those conditions that cause dissatisfaction and reduce creativity is easier and more effective than creating mechanisms to increase intrinsic motivation and creativity (*Amabile, 1983*).

In this context, job enrichment is one of the ways to act on the environment. This requires eliminating controls and increasing accountability; granting individuals complete work units that allow them to perceive their contribution; promoting direct feedback to foster learning and alignment around expectations; and finally giving them opportunities to perform challenging tasks within their areas of interest and capabilities (Herzberg, 1968).

D. REWARD AND MOTIVATION

Research shows that the way through which extrinsic reward is used and perceived determines its effect on motivation. Extrinsic reward may reduce motivation if withdrawn or understood as a controlling agent by the recipient; alternatively, it may enhance motivation if signaling competency of information, growth, or the possibility of a more in-depth involvement with work (Wiersma, 1992; Amabile, 1997).

Based on such findings, extrinsic reward tied to and dependent on performance may reduce intrinsic motivation, and thus creativity. Individuals would question whether their performance results from their own decision or extrinsic reward. The implication is that motivation would be reduced if behavior is perceived as a consequence of external factors, since people feel more motivated when they believe to be the actual source of their own behavior (Wiersma, 1992).

Some extrinsic rewards may be synergic with intrinsic ones, substantially enhancing motivation and creativity. However, such situations mainly occur when there has been previous motivation and the potential for intrinsic reward deriving from work (Amabile, 1997).

E. REWARDING TEAMS

Individual reward systems may be inadequate and contradictory in organizations that aim at fostering team work. Evidence shows that when an individual reward system is employed for suggestions, for instance, individuals hold back ideas during team brainstorming sessions, so that they may be remunerated later by their individual contributions (Kerrin, 2002).

In view of that, the reward system must reinforce and recognize high performers while fostering team work. To that effect, a coherent combination of group and individual reward should be employed (Kerrin, 2002).

An option to that would be to reward individual contributions towards team performance. In other words, individuals would be rewarded based on team results and their specific contributions to the final outcome. Such reward should be noticeable to ensure team work is stimulated, with substantial differences between rewards awarded to high and low performers, so that the high performers are widely recognized and continue in their efforts (Heneman, 1995; Guthrie et al. 2004).

Following the process as suggested by Heneman (1995), team members should participate in the definition of goal and assessment of individual contributions. In the author's experience, however, similar processes in companies result in informal agreements among team members, without significant reward differentials for high performers.

Other difficulties are also associated to rewards based on team performance. One such problem is that members may not fully understand how individual effort contributes to team results upon which reward is based (Heneman 1995). Competition and lack of cooperation between different teams are also observed, with incentives for each team to focus on its own performance at the expense of the performance of other teams within the same organization (Kerrin, 2002).

The degree to which individual performance should be recognized, as well as the incentive given to team work, varies according to some factors – i.e., organizational culture and interdependence of tasks to be performed. If individuals work by themselves and simply combine final results, it is possible to increase the focus on individual reward. In other cases, when there are intense interaction and interdependence of tasks and results, stronger focus should be given to team performance (Kerrin, 2002; Guthrie et al. 2004).

4) TEAM WORK IN IDEA GENERATION

IDEATION, the asynchronous and anonymous idea generation process in which the reward of each participant is based on his/her performance, intends to reduce some dysfunctional behaviors of team work – namely free ride, evaluation apprehension and production blocking.

In order to explore the reasons behind the results of our experiment, as well as suggest changes to the process originally proposed, we make a few comments about some idea generation processes and their inherent gains and losses. The characteristics considered to analyze process gains and losses refer to whether the idea generation process occurs in teams or individually, and with disclosed or anonymous identities. Such findings help clarify the impact dysfunctional behaviors and processes themselves have on the idea generation outcome.

A. IDEA GENERATION IN TEAMS

Idea generation team members can interact with each other in several ways, depending, for instance, on when and how the ideas are integrated and on whether the process is asynchronous and allows anonymity.

The nominal process refers to the individual generation of ideas that are later integrated to a team output, without any interaction among team members during the process.

On the one hand, verbal brainstorming presupposes intense interaction among team members. Its rules establish that the largest possible number of ideas should be given, including wild and unconventional ones, and that ideas from members should be altered by others without criticism (Gallupe et al., 1992). Verbal brainstorming is therefore a synchronous, non-anonymous, team work process.

Anonymity and asynchronism may be implemented in electronic brainstorming, which uses computer networks as technological infrastructure. Each member types in his/her ideas, which are collectively read on screen. Ideas can be posted at any given moment – which constitutes the asynchronous nature of the process; the author's identity may or may not be indicated before each idea, thus allowing for anonymity if desired.

All idea generation processes – be them nominal, verbal or electronic – require subsequent stages to organize and consolidate ideas, a task usually performed by a facilitator or other stakeholder. Such later stages allow for a cost-benefit analysis and decision making (Gallupe et al., 1992).

Team brainstorming – either verbal or electronic – has some advantages over the nominal process. Redundancy is limited, and synergies are increased, since all members have access to those ideas presented by others. Non-anonymous team work also generates social recognition and a group identity that may foster good performance (Pinsonneault et al., 1999). Additionally, such dynamics enables team members to learn from and level with high performers. Electronic brainstorming also allows team members in dispersed locations to interact and collectively generate ideas (Gallupe et al., 1992).

In spite of such advantages, experiments show that people tend to generate fewer and less creative ideas in verbal brainstorming than in nominal ones. Dysfunctional behaviors and process losses inherent to team work compromise productivity in idea generation. Therefore, final results should be seen as a function of team work's gains and losses (Pinsonneault et al., 1999), which stress the importance of understanding the process to minimize its losses– one of the goals of the proposed idea generation process.

B. DYSFUNCTIONS AND PROCESS LOSSES

People who work in teams usually present some dysfunctional behaviors that negatively impact team results. Additional losses associated to the idea generation process in teams are also observed.

Losses related to behavioral dysfunctions are more impactful in non-anonymous processes, such as verbal and some electronic brainstorming (Pinsonneault et al., 1999). Anonymity is therefore proposed to reduce the impact of such dysfunctions (Toubia, 2004):

- Fear of conflict – People fear different ideas may generate conflicts, usually perceived as undesirable in work environments (Lencioni);
- Evaluation apprehension – Fear of being evaluated and punished by ideas presented, which inhibits participans to present ideas that go against those put forward by higher tenure participants. Observation shows that teams generate fewer ideas when authority figures are present (Pinsonneault et al., 1999);
- Pressure for uniformity and conformity – Observation shows that there is some pressure in team sessions towards conforming to social rules (e.g., creativity levels and suggestion types);
- Social influence – Few team members (opinion makers) tend to exert considerable influence on the rest of the group;
- Negative productivity matching - Comparison and adjustment of individual productivity to a baseline level.

The more sensitive and controversial the issue, the higher the motivation of team members, and the greater the evaluation apprehension and pressure for conformity (Pinsonneault et al., 1999).

No evidence was found that anonymous contributions minimize the importance of absence of trust (Lencioni) vis-à-vis the intentions of other team members, the fear of exposing their own weaknesses, and the personalization of issues – which is an excessive association of ideas and opinions with personal matters. Some techniques – i.e., meeting check-ins – have been developed to deal with this kind of dysfunction.

Diminished accountability and individual participation are some of the dysfunctions present in team brainstorming, be it verbal or electronic. Due to its individual nature, nominal brainstorming is not affected by these dysfunctional behaviors:

- Free rides – Employees withdraw their individual efforts because they rely on other team members to reach the proposed goal. Lack of clear individual accountability and commitment, as well as a perception that individual contributions are unnecessary to collective success help explain such behavior;

  Free rides usually occur when team members place their own individual goals above those of the group. Peer pressure and reward based on individual performance – as proposed by IDEATION – aim at reducing free ride impact.

Some of the process losses in idea generation are inherent to team work:

- Cognitive interference –Ideas generated by other team members interfere in the individual process of idea generation.

  Such interference can be manifested in two ways: distraction, with individual members focusing on the ideas of others rather than on their own output; and a quest for originality, when team members excessively focus on the ideas of others for fear of replicating what has already been said.

Verbal brainstorming has some specific losses, usually due to the synchronous nature of the process:

- Production blocking – Members are prevented from expressing their ideas at the time they occur. Ideas are then discarded during the brainstorming session – because they are either forgotten or irrelevant and out of scope. IDEATION's asynchronism aims at reducing such losses;

- Attentional production blocking – The focus on generating ideas is reduced because members must concurrently pay attention to the ideas of others (Pinsonneault et al., 1999);

- Cognitive dispersion – Trains of thoughts continuously alternate due to interruptions from other members. Differently from nominal or electronic brainstorming, it is difficult to maintain the focus on specific issues and conduct in-depth analyses (Pinsonneault et al., 1999).

Electronic brainstorming aims at minimizing some of the losses that exist in the verbal process; however, it does introduce other disadvantages, specially caused by the use of technology:

- Cognitive complexity of the process – Electronic brainstorming requires a higher number of cognitive activities than verbal brainstorming, slowing down the process of idea generation. Typing, for instance, is a slower and less complete task than speech (Pinsonneault et al., 1999; Gallupe et al., 1992).

Nominal brainstorming, essentially an individual activity, is neither fostered nor hindered by the characteristics of team work. Losses are nevertheless also associated to individual processes of idea generation:

- Redundancy – Double work often occurs because individual members are unaware of results and ideas generated by others (Gallupe et al.,

1992). Lack of stimulus may also lead to narrow lines of reasoning, reducing originality and the novelty in ideas.

Team history and size, among other elements, modulate the level of influence each dysfunction and process loss may have (Pinsonneault et al., 1999; Gallupe et al., 1992).

Problems inherent to team work tend to be reduced if members are already acquainted, communicate effectively with each other, and develop norms to be followed during team work.

Similarly, small teams show fewer dysfunctions and process losses, which tend to grow with the size of the group. In verbal brainstorming, individual marginal contributions are reduced as the team increases, whereas in electronic formats, they tend to remain constant. For small, non-anonymous teams, verbal and electronic brainstorming show similar productivity levels (Gallupe et al., 1992).

C. WHY VERBAL BRAINSTORMING IS SO POPULAR?

By analyzing dysfunctions and process losses, it is possible to explain the poorer results observed in verbal brainstorming when compared to the nominal process. In spite of such results, enthusiasm for the nominal process is lower than for verbal brainstorming. In other words, people are more enthusiastic about the process that yields poorer results (Pinsonneault et al., 1999).

Findings show that people prefer working in teams, regardless of their productivity levels. Teams are also used for different purposes, such as consensus building, understanding and commitment of members towards shared goals (Pinsonneault et al., 1999).

The perception of productivity is higher in team work than in individual sessions due to the increased total number of ideas being generated – which is known

as baseline fallacy. Team members take ownership of a larger number of ideas than those really produced by them (Pinsonneault et al., 1999).

Team work also allows for productivity comparisons. Individuals compare their performance with that of other members, a situation that is perceived as more comfortable than working alone.

5) EXPERIMENTAL APPROACH

A. GOAL

This experiment aims at assessing how free ride, evaluation apprehension and production blocking are affected by the proposed process of idea generation.

To this effect, we intend to reduce free ride by implementing a reward system based on the impact of individual contributions. The impact of individual contribution will be measured by the number of ideas generated by other team members that are built on the original idea[1], resulting in points to be assigned to their respective authors. Final results will therefore depend on both individual performance and the participation of the whole group.

The anonymous nature of participants' contributions should inhibit the evaluation apprehension during this process, while the system's asynchronicity should reduce production blocking and enable participants to read and include ideas at any given time.

The experiment also aims at observing other aspects that influence the idea generation process, as well as propose improvements so that it may be used in a real R&D environment.

An anonymous survey will be answered by the participants to allow the comparison between the proposed process and verbal brainstorming, as well as to provide input for the identification of some other aspects that influence results.

B. DESIGN OF THE EXPERIMENT

IDEATION is an asynchronous, internet-based idea generation system that automatically scores participants' points based on the impact of their ideas. It is

[1] Bibliometric research suggests that the number of citations received by a participant should be a good measure of his or her impact (Toubia, 2004).

adapted from the system created by Olivier Toubia for his PhD dissertation (Toubia, 2004).

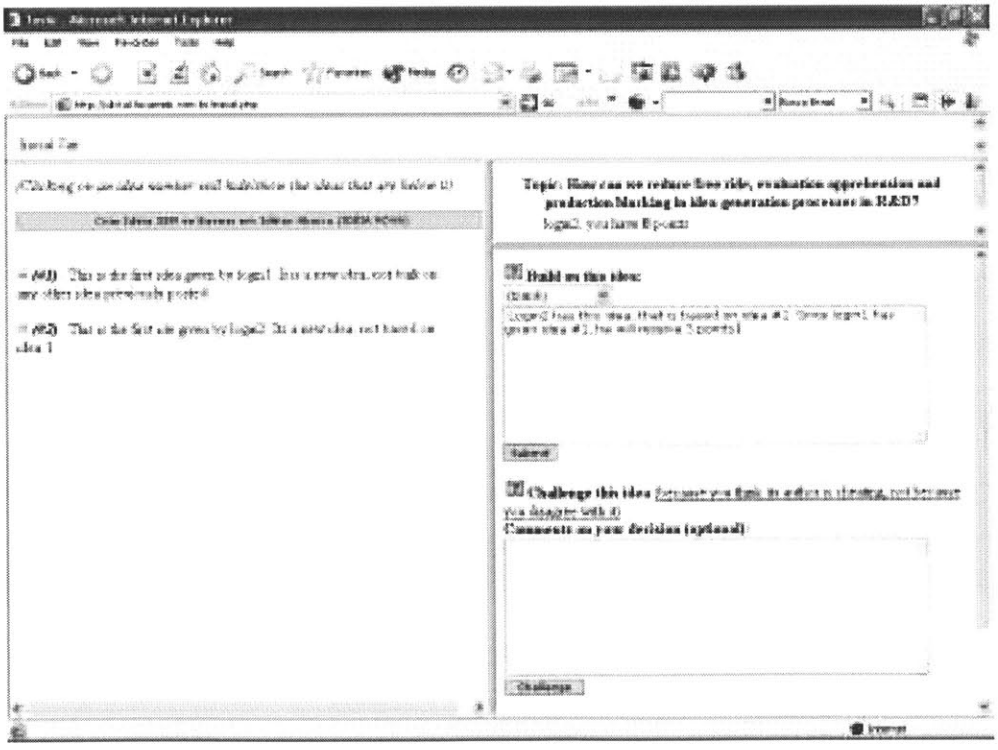
For the experiment, three topics related to R&D projects have been selected. Suppliers, external consultants, clients and employees are invited to participate in teams of 10 people to generate ideas on such topics via IDEATION. The system will allow participants to remain anonymous, disclosing nicknames or other alternative identities only.

The system will be open for contributions during five consecutive days, from 4pm to 7pm, while the reading of previous contributions will be allowed full time.

Points will be awarded according to the impact of each idea, measured by the number of subsequent ideas generated based on the original one. Thus, we expect participants to contribute with a large number of impactful ideas.

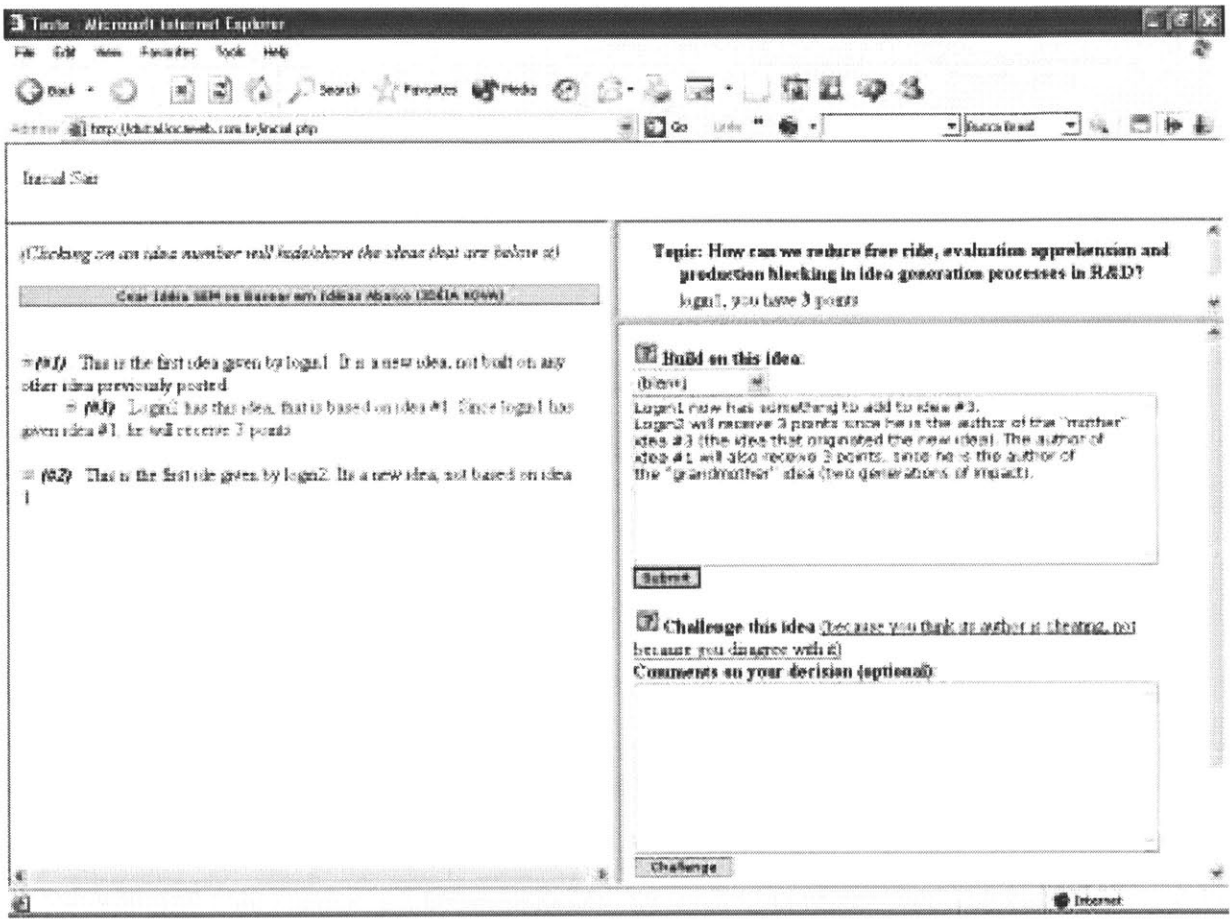
IDEATION example:

1. Login2 generates an idea based on Idea #1.

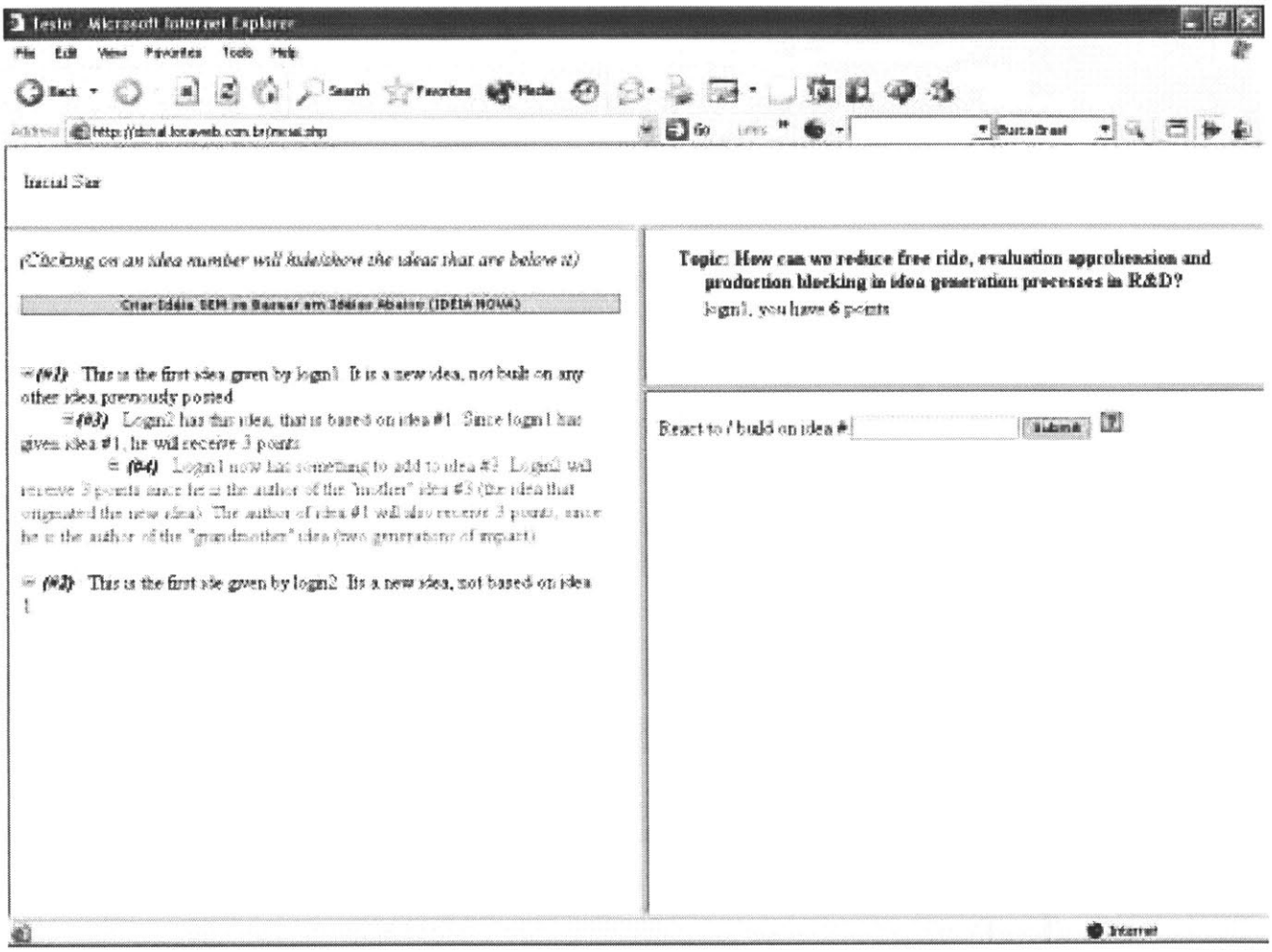


2. Login1, the original author of Idea #1, scores 3 points, since Idea # 3 is based on his/her idea. Thus participants score only when their original ideas generate “descendants”.

Login1 proposes another idea, based on Idea #3.



3. This time, Login2 scores 3 points for authoring Idea #3, while Login1 also gets 3 points for being the original creator of Idea #1 (Idea #4 was based on idea #1).



Since the system automaticaly awards points to participants based on the impact of their ideas, they could cheat by posting irrelevant ideas under ideas based on their own production. In the example above, for instance, Login 1 is the author of Idea #4 but also receives points for this idea since he/she is the author of Idea #1.

The system prevents cheating by mutual monitoring and relational contract (Toubia, 2004). Participants will be able to "challenge" the ideas of others should they believe a participant is cheating. A moderator will analyze the challenged ideas and, whenever he judges that the cheating occurred, the frauding party will lose, with the complaining party scoring 30 points. If the challenge is unjustified, the complaining party will lose 30 points. Participants will have access to their scores at all times and receive information about their overall rating at the end of each session.

The top half of participants with higher scores will receive prizes according to their total points. Suggested prizes are whiskies or the equivalent in credits to be spent in virtual stores.

IDEATION rules:

- Identity of participants will remain confidential;
- Participants will be awarded 3 points whenever someone posts an idea based on his/her original idea (both for second and third generation of ideas);
- Each idea can yield a maximum of 30 points;
- Participants cannot give ideas based on their own ones;
- Participants who cheat lose 30 points, whereas the one who challenges is awarded 30 points. Alternatively, if cheating is judged inexistent, the denouncing party loses 30 points;
- Prizes are awarded to participants with a minimum of 50 points.

C. SURVEY

The effectiveness of the proposed IDEATION process of idea generation vis-à-vis the verbal brainstorming usually held at the R&D department will be assessed through a survey to be answered by participants. This survey will analyze individual performance and the occurrence of free ride, evaluation apprehension and production blocking, as well as other factors that might have influenced the results of the experiment.

Answers will be consolidated by an administrative assistant to ensure anonymity and confidentiality are enforced.

SURVEY

Instructions: Please fill out the following survey comparing IDEATION with the usual verbal brainstorming process held in the company. Check the statement that best describes how you feel in the situations given (1 to 18). For questions 1 to 4, please estimate the number of ideas. Other comments are welcome, and should be entered in the appropriate space at the bottom of this page. To ensure confidentiality is kept, please send your answered survey to [assistant name], who will consolidate the answers.		Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	HOW MANY?
1	You gave more ideas than you would normally give in verbal brainstorming meetings because the points were assigned for the impact of each idea.						
2	You did not give some ideas because it would give points to another player.						
3	You had thought about some of the ideas given but have never told about them before in verbal brainstorming meetings.						
4	Many ideas did not make sense and would be criticized by you in verbal brainstorming meetings.						
5	You put more effort than you would normally do because the manager has proposed the IDEATION process						
6	The ideas generated in IDEATION are more creative than ideas generated in verbal brainstorming meetings						
7	You usually give more ideas in verbal brainstorming meetings, in which you do not receive points per idea						
8	You give more creative ideas in verbal brainstorming meetings, in which you do not receive points for the impact of your idea						
9	You gave more creative and non-conventional ideas because you were anonymous						
10	You give more ideas when your identity is known						
11	You were confident that your ideas were anonymous						
12	You were able to identify who gave each idea						
13	You gave all ideas that you had, including the most creative and non-conventional ones						
14	You prefer the IDEATION process instead of verbal brainstorming meetings						
15	You learned more from others than you usually do in verbal brainstorming meetings						
16	It was easy to use the on-line system and navigate throughout the ideas given						
17	The IDEATION process caused an increase of internal competition among peers						
18	You were extremely compelled by the topic discussed						

Other comments:

D. EXPERIMENTAL LIMITATION

On the one hand, applying the IDEATION process in a real work environment posed some limitations to this study. On the other, it enriched results, since most reviewed work was conducted in artificial conditions. According to Guthrie (2004), caution should be taken when generalizing results from studies conducted with business students to the workplace. Actual incentives in organizations exist in a more complex environment than the experiments can emulate.

Using cash as a reward was considered too controversial, since it is not foreseen in the official company compensation scheme. The adopted solution was therefore to offer bottles of whisky or credits for virtual shopping. However, such prizes may not have the same value for all participants. The option of awarding points to participants has been chosen to allow them to compare their performance with each other's.

Having the manager to propose the system may have an either positive or negative impact on participation. Employees who wish to stand out of the crowd may use it as an opportunity, while those wanting to stress the fact they are overworked may reduce their participation.

Running such an experiment in an R&D department also limits the choices of topics and the number of participants. The results of all applications of IDEATION will be added and analyzed as a whole. There will not be enough data to explore the reasons behind the differences in performance among the different applications of IDEATION.

Additionally, the results of this experiment will not be compared to those of a control group, but to an estimate given by the participants themselves, who will assess the system's efficiency based on their extensive previous experiences with verbal brainstorming. Such a comparison is considered acceptable since verbal brainstorming is applied very often in the department.

Although additional evaluation and classification of ideas could provide data for complementatry findings, in order to limit the scope and complexity of the experiment, we will consider only the impact of ideas – measured by the number of ideas generated by other team members that are built on the original idea – for participants' scores.

6) RESULTS

This chapter focuses on the experiment and survey results. Here, we describe observed behaviors and comments made by some participants, followed by an interpretation and analysis of outcomes.

A. EXPERIMENT

The experiment resulted in the following:

- Thirty seven people (i.e., company employees, clients, consultants and suppliers) were invited to participate in IDEATION. Of this group, 29 created a log-in and password to take part of the experiment; The participants did not know that they were part of a study on reward and idea generation, and each one focused on only one instance of IDEATION;

- Four participants did not contribute with any ideas, despite having logged into the system;

- Participants had an average company tenure of 5 years;

- IDEATION was applied three times, each time with a different group and topic;

- IDEATION was open for participation during 3 hours for five consecutive days; the system was also open full time for participants to read the ideas posted;

- Four challenges were generated by repeated ideas, which should have been regarded as descendants but were posted as original ones;

- There were seven comments that were clearly descentant ideas of the original ideas commented;

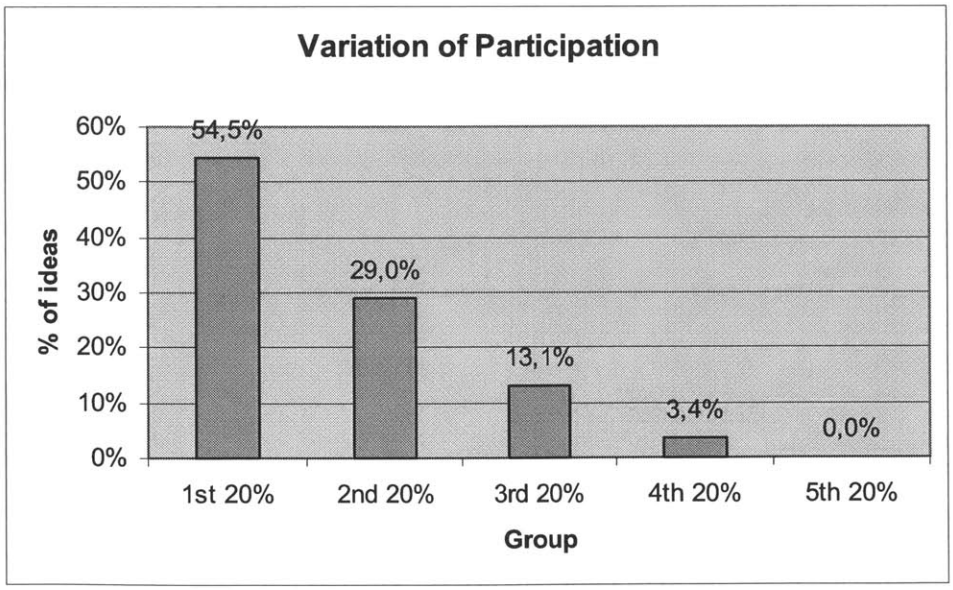
- Nearly 50% of ideas were proposed as new ones (level 1).

Additional findings are presented in the tables and figures below:

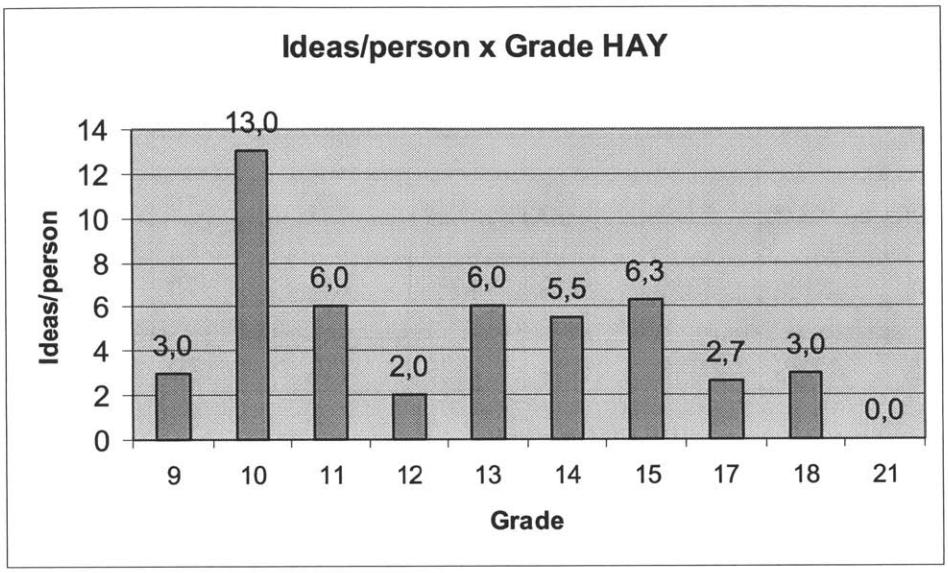
	Number of ideas	Ideas in Level 0	Ideas in Level 1	Ideas in Level 2	Ideas in Level 3	Ideas in Level 4+	Number of Participants	Average Tenure (years)
IDEATION 1	45	67%	20%	11%	2%	0%	9	6.4
IDEATION 2	19	68%	21%	11%	0%	0%	10	4
IDEATION 3	81	31%	33%	19%	12%	5%	10	4.9
Total	**145**	**47%**	**28%**	**15%**	**8%**	**3%**	**29**	**5.07**

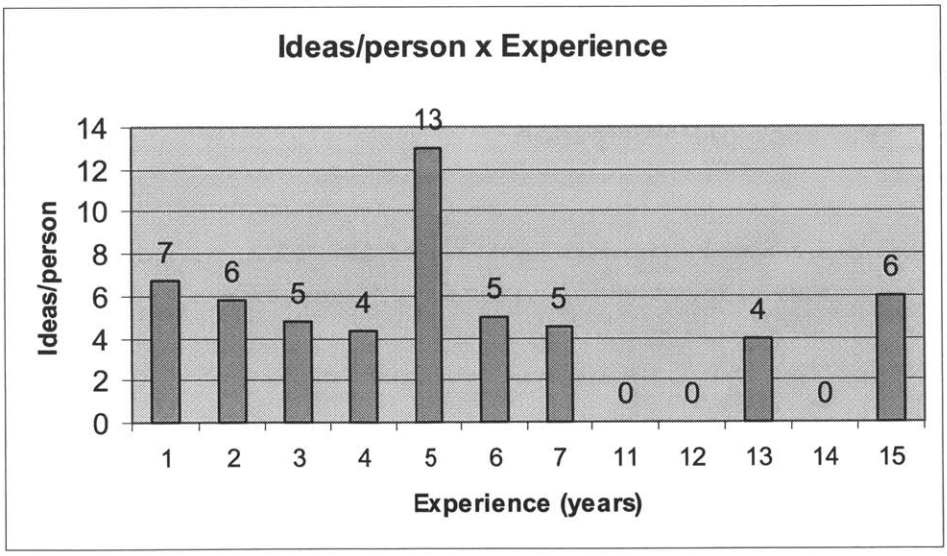
IDEATION results

Participation in IDEATION was not homogeneous: 20% of participants who contributed the most accounted for over 50% of ideas, while the 20% who contributed the least put forward no idea at all (see "Variation of Participacion" graph bellow).



The HAY®[2] methodology and participants' tenure were employed as expertise indicators. Performance (measured as the number of ideas generated) was plotted against the expertise criteria employed (see "Ideas/person x Grade HAY" and "Ideas/person x Experience" graphs bellow).





[2] HAY® methodology values a job according to the know-how required to perform it (specialized, managerial and human relations skills), problem solving skills (thinking environment and challenge) and accountability (freedom to act and impact on the results)

Participants were asked to comment on their contributions and on the IDEATION process. Major ideas presented in the comments are summarized below:

- Six comments justified participants' limited contributions due to the workload with "real projects" (mostly during IDEATION 2);
- Some participants strongly reacted against scores and the competititon generated by the IDEATION reward system;
- A few thanked for being invited to participate, and pointed out others were hurt for not being included in the IDEATION;
- At the end of the experiment, some participants stated that no brand new or creative ideas had been posted;
- Participants commented that several ideas were repeated within the IDEATION system itself: ideas from the first day were repeated in days 3 and 4;
- Some declared that searching for new ideas and reading the contribution of others enabled them to view different dimensions of the problem – for them, IDEATION is a key learning tool.

B. SURVEY

An assistant received the surveys and consolidated the answers, thus ensuring full confidentiality. Results were grouped by topics for analysis purposes.

All survey questions compared IDEATION aspects to verbal brainstorming ones – the method most often used in the organization.

FREE RIDE and PERFORMANCE

Participants assessed their performance in IDEATION vis-à-vis both the number of ideas they put forward and their level of creativity. We tried to identify the effect individual reward had on performance, so as to estimate its influence on free ride. Additionally, we observed whether individual reward reduced the group's performance based on the total number of ideas generated.

A quarter of participants agreed the reward system proposed by IDEATION resulted in more ideas than usual – an increase estimated at 23 additional ideas, or 18% above the average production of ideas in a non-reward system.

A smaller share of participants (17%), on the other hand, stated individual reward based on the impact of one's contribution led to a decrease in the total number of ideas generated.

For 33% of participants, IDEATION has led to an increase in creativity due to the impact-based reward, while 17% stated verbal brainstorming – in which there is no reward – yields more creative ideas.

Only 4% of participants declared they refrained from contributing ideas because they would benefit other people. According to their estimates, the number of ideas generated would have been 3% higher if rewards were based on group rather than individual performance.

	FREE RIDE and PERFORMANCE NUMBER OF IDEAS and CREATIVITY caused by the impact-based incentive	TOTAL DISAGREEMENTS	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	
1	You gave more ideas than you would normally give in verbal brainstorming meetings because the points were assigned for the impact of each idea.	63%	42%	21%	13%	21%	4%	25%
7	You usually give more ideas in verbal brainstorming meetings, in which you do not receive points per idea	50%	29%	21%	33%	13%	4%	17%
6	The ideas generated in IDEATION are more creative than ideas generated in verbal brainstorming meetings	58%	21%	38%	8%	29%	4%	33%
8	You give more creative ideas in verbal brainstorming meetings, in which you do not receive points for the impact of your idea	42%	29%	13%	42%	17%	0%	17%
2	You did not give some ideas because it would give points to another player.	83%	58%	25%	13%	4%	0%	4%

EVALUATION APPREHENSION

Participants were asked whether they would have criticized others' ideas in a verbal brainstorming session – an indication that evaluation apprehension would occur in those situations.

Since IDEATION proposes anonymous contributions to counteract evaluation apprehension, the survey checked both if the scheme had been successful and if anonymity led to more creative ideas.

The vast majority of participants – 83% – indicated they would have criticized some of the ideas in verbal brainstorming situations, a clear sign that evaluation apprehension would have occurred. According to participants' estimates in

question 4 of the survey, there would have been 52 criticisms, which corresponds to 36% of the ideas generated.

Of the total number of participants, 79% stated they were able to identify the authors of ideas through their use of language, opinions and informal conversations; not surprisingly, 63% felt unsure their ideas were really anonymous.

Only 25% of participants considered they produced more creative and unconventional ideas as a result of being anonymous. Half of the group disagreed anonymity had any positive effect; however, no one indicated anonymity is deleterious to creative performance.

	Impact of EVALUATION APREHENSION	TOTAL DISAGREEMENTS	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	
4	Many ideas did not make sense and would be criticized by you in verbal brainstorming meetings.	4%	0%	4%	13%	46%	38%	83%
11	You were confident that your ideas were anonymous	63%	42%	21%	13%	17%	8%	25%
12	You were able to identify who gave each idea	8%	0%	8%	13%	50%	29%	79%
9	You gave more creative and non-conventional ideas because you were anonymous	50%	42%	8%	25%	25%	0%	25%
10	You give more ideas when your identity is known	75%	38%	38%	25%	0%	0%	0%

PRODUCTION BLOCKING

IDEATION's asynchronous nature aims at reducing production blocking. To assess results, participants were asked to estimate their blocked production – i.e., ideas that came to mind but were not put forward – in verbal brainstorming processes and indicate if the same occurred in IDEATION.

Sixty three percent of participants stated they had ideas not previously communicated – evidence that verbal brainstorming usually leads to substantial production blocking and is ineffective as a communication channel in an R&D environment. Of the total number of ideas, 12% were known but had not been previously communicated – a result in line with comments from participants during IDEATION sessions.

IDEATION's effectiveness in reducing production blocking can be verified by the number of participants (71%) that declared having entered all the ideas they had on the proposed topic.

PRODUCTION BLOCKING		TOTAL DISAGREEMENTS	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	
3	You had thought about some of the ideas given but have never told about them before in verbal brainstorming meetings.	33%	8%	25%	4%	54%	8%	63%
13	You gave all ideas that you had, including the most creative and non-conventional ones	17%	0%	17%	13%	33%	38%	71%

COGNITIVE COMPLEXITY

IDEATION's cognitive complexity – a result of technological limitations – presents a potential loss vis-à-vis verbal brainstorming processes.

Although all participants work daily with computers, we have decided to assess whether implementing IDEATION implies an additional level of complexity. In this respect, 13% believed the system was rather easy to use, whereas 67% disagreed, indicating increased complexity when compared to verbal brainstorming sessions.

COGNITIVE COMPLEXITY		TOTAL DISAGREEMENTS	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	
16	It was easy to use the on-line system and navigate throughout the ideas given	67%	42%	25%	21%	8%	4%	13%

OTHER FACTORS

Besides reward, asynchronism, anonymity and technology, other factors influence participants' performance in this idea-generation system. The survey addresses such issues to evaluate their influence on actual performance.

The fact that the experiment was proposed by the R&D manager, to whom several participants report, did not seem to influence participation: 88% of survey respondents declared not to have been influenced by it.

Participants' low performance could also be explained by an inadequate reward system, evaluation apprehension, and production blocking, or else simply by lack of interest in the proposed topic. However, 88% of participants stated the latter did not negatively influence their performance.

Activities that allow for growth and learning are sources of intrinsic reward, an important factor to boost creativity. Nearly half of participants commented that IDEATION improved learning, whereas a similar share disagreed with such statement. No clear conclusion was therefore possible in this respect.

Competition in the work environment was identified as a source of dissatisfaction (hygienic factor). Since prizes were awarded solely for the top performers (50% of the group), the experiment could have enhanced competition and led to greater dissatisfaction and lower performance levels. Such a hypothesis proved wrong – 75% of survey respondents did not notice increased competition in the work environment.

	Impact of OTHER MOTIVATORS on results	TOTAL DISAGREEMENTS	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	
5	You put more effort than you would normally do because the manager has proposed the IDEATION process	46%	38%	8%	42%	13%	0%	13%
18	You were extremely compelled by the topic discussed	13%	0%	13%	17%	46%	25%	71%
15	You learned more from others than you usually do in verbal brainstorming meetings	46%	13%	33%	8%	42%	4%	46%
17	The IDEATION process caused an increase of internal competition among peers	50%	25%	25%	25%	25%	0%	25%

Ideas derived from others that were not posted under their original sources, as well as the prevalence of new ideas (47%) may have been caused by the added cognitive complexity of the system or participants' competitiveness - which would stimulate participants to withhold their contributions to prevent others from scoring. According to survey comments, however, competitiveness hardly contributed to that.

GENERAL PREFERENCE

A literature review showed people prefer some processes, regardless of their performance (Pinsonneault et al., 1999). To test this possibility, participants were asked how they perceived IDEATION's overall results, and whether they preferred such a system over verbal brainstorming sessions.

Although IDEATION showed positive results when compared to verbal brainstorming, no clear preference was indicated.

PREFERENCE		TOTAL DISAGREEMENTS	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	
14	You prefer the IDEATION process instead of verbal brainstorming meetings	42%	4%	38%	29%	29%	0%	29%

7) CONCLUSION

In this chapter, based on the experiment and survey results, we consolidate our findings regarding IDEATION's effectiveness in reducing free ride, evaluation apprehension and production blocking.

We also include here observations and recommendations to idea generation processes carried out in R&D departments, as well as open questions for future studies.

A. HYPOTHESES

HYPOTHESIS 1 - IDEATION reduces free ride, since reward is based on individual performance.

Substantial decrease in free ride was not observed. Although final IDEATION results improved vis-à-vis verbal brainstorming estimates, individual performance varied widely. The 40% with lower participation levels contributed with only 16.5% of ideas, which indicates they put much less effort than the high performers.

In IDEATION, free ride is influenced by the individual reward system and prizes given to high performers. Such mechanisms aim at generating a competitive environment that foster individual performance. Survey results nevertheless indicated competitiveness was only marginally increased, and that reward was not strongly regarded as an incentive to higher participation. These strongly indicated free ride was not significantly reduced with IDEATION.

Some alternative explanations for the wide range of performance levels may be discarded. First, participants have similar experiences with both the software and interfaces employed, thus minimizing the impact cognitive difficulties derived from IDEATION could have had on performance. Second, since all participants were involved in high priority company projects, the high work load argument cannot be used to explain differences in performance. Last, survey

results presented evidence that having IDEATION be suggested as a tool by the department's manager did not significantly influence participation.

HYPOTHESIS 2 - IDEATION reduces evaluation apprehension due to its anonymous nature.

Survey results and comments indicated participants were unsure of the system's level of anonymity, and could identify the authors of ideas by their use of language, opinions, and informal conversations held during IDEATION.

Such low level of anonymity makes the system inefficient to inhibit evaluation apprehension, and does not allow us to confirm the original hypothesis.

There are evidence, however, that evaluation apprehension is more likely to occur in verbal brainstorming sessions than in IDEATION, even without full anonymity. The majority of participants (83%) stated that they would have criticized the ideas put forward in verbal brainstorming sessions. Such criticism is likely to be reduced in IDEATION because participants have to write their ideas prior to posting them, which allows them to better reflect on their thoughts beforehand.

HYPOTHESIS 3 – IDEATION reduces production blocking due to its asynchronous nature.

Most participants pointed out they were able to put forward all the ideas they had on the topic given, indicating production blocking was very limited with IDEATION. Moreover, considering that verbal brainstorming had been the only method ever employed, and that 63% of participants had ideas they withheld in such previous sessions, it is possible to infer IDEATION actually reduced production blocking.

B. OBSERVATIONS AND RECOMMENDATIONS

Both the experiment and literature reviews led to some observations and recommendations that go beyond those dimensions related to free ride, evaluation apprehension and production blocking. Rather, such observations refer to the environment in which IDEATION was run, the results obtained, and the reward system used.

ENVIRONMENT

Through IDEATION, the company attempted to boost creativity and dialogue among its employees. Thus, regardless of results, the system supported intrinsic motivation.

IDEATION also helped participants' learning and commitment. Many of them subsequently quoted ideas posted in the system, including those they had not authored.

At the end of IDEATION, however, participants showed some frustration, commenting they were unsure of the concrete use of their ideas. It should therefore be stressed that IDEATION is one of multiple stages, and ideas generated during the process will need to be consolidated, prioritized, and selected for an action plan.

FINDINGS

Participants with increased HAY® grade and expertise show marginally lower performances, which may be partly explained by a degree of skepticism from higher tenure professionals in relation to alternative idea-generation and reward methods. The criteria used to measure performance may have also influenced such results, an indication that other options should be assessed to allow for more definitive conclusions.

Overall, participants estimated the experiment yielded better results than verbal brainstorming. However, they did not clearly indicate their preference for IDEATION – as was the case with Pinsonneault (1999), who stated people do not always choose processes that lead to higher performances.

REWARD

A number of participants communicated they were too focused on actual company projects, and thus reduced their participation in IDEATION. This may be a manifestation of delayed reward (Guthrie et al., 2004), since they traded their chances of immediate rewards for recognition by top management of their commitment to critical company projects – with potential rewards in the future.

Strategies to win more points other than the posting of impactful ideas were also observed. Having performance perceived as a means to reward, instead of reward being regarded as recognition for high performance, may be a problem for systems that reward individual performance.

C. FUTURE WORK

The challenges we faced to prove our initial hypotheses raised several issues for future studies.

One of the dimensions refer to the compensation for performance. We suggest it should become a substantial share of employees' total reward in order to be effective. Future studies could identify potential thresholds for individual performance-based rewards that would reduce free ride if exceeded, and define those variables that would influence such thresholds.

Another key issue for future studies would be how to better ensure anonymity. In our experiment, participants were well acquainted and could identify the authorship of ideas – a situation that should occur in real work environments.

The amount of ideas posted also made it difficult to check for only those that were new without having to virtually review the whole text. Since cognitive

complexity is an important process loss, we believe future studies should focus on developing alternative interfaces.

Criteria for measuring the impact of ideas is an additional area that should be further analyzed. Participants' performance was determined by the impact of their ideas, according to the number of descendant ideas they had generated. Examples of alternative metrics would be the level of originality and implementability of ideas generated.

Finally, future studies may concentrate on the aspect of frequency IDEATION – or any other remunerated idea generation process - is applied to verify whether the number of ideas given in non-remunerated processes are reduced because individuals would not post their ideas without compensation for their efforts.

8) BIBLIOGRAPHY

1. Pinsonneault, Alain; Barki, Henri; Gallupe, R Brent; Hoppen, Norberto (1999), "Electronic brainstorming: The illusion of productivity", *Information Systems Research*, 10, 2, pg. 110

2. Amabile, Teresa (1997), "Motivating creativity in organizations: On doing what you love and loving what you do", *California Management Review*, 40, 1, pg. 39

3. Amabile, Teresa M; Conti, Regina; Coon, Heather; Lazenby, Jeffrey (1996), "Assessing the work environment for creativity", *Academy of Management Journal,* 39, 5, Pg 1154

4. Gallupe, R. Brent; Dennis, Alan R.; Cooper, William H.; Valacich, Joseph (1992), "Electronic Brainstorming and Group Size", *Academy of Management Journal*, 35, 2, pg. 350

5. Kerrin, Maire; Oliver, Nick (2002), "Collective and individual improvement activities: The role of reward systems", *Personnel Review*, 31, 3 pg. 320

6. Heneman, Robert L; von Hippel, Courtney (1995), "Balancing group and individual rewards: Rewarding individual contributions to the team", *Compensation and Benefits Review*, Vol.27, Iss. 4; pg. 63

7. Lencioni, P. , "Conquer Team Dysfunction"

8. Wiersma, Uco J. (1992), "The effects of extrinsic reward in intrinsic motivation: A meta-analysis", *Journal of Occupational and Organizational Psychology*, 65, 101-114

9. Guthrie, James P. ; Hollensbe, Elaine C. (2004), "Group Incentives and Performance: A Study of Spontaneous Goal Setting, Goal Choice and Commitment", *Journal of Management*, 30(2) 263–284

10. Grant, Philip C (1999), "New perspectives on incentive system design: Integrating the theory of the firm and the Theory of Individual Behavior", *The Journal of Psychology*, 133, 4, pg. 456

11. Herzberg, Frederick (1968), "One More Time: How Do You Motivate Employees?", *Harvard Business Review*

12. Muhlemeyer, Peter (1992), "R&D - Personnel Management by Incentive Management: Results of an Empirical Survey in Research & Development", *Personnel Review*, 21, 4, pg. 27

13. Heneman, Robert L. ; Dixon, Katherine E. (2001), "Reward and Organizational Systems Alignment: An Expert System", *Compensation & Benefits Review*

14. Toubia, Olivier (2004), "New Approaches to Idea Generation and Consumer Input in the Product Development Process", DOCTOR OF PHILOSOPHY AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

15. Beer, Michael; Walton, Richard (1989), "Reward System and the Role of Compensation", *Harvard Business School*