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AN INVESTIGATION OF THE EFFICIENCY OF SYNERGISTIC MULTICULTURAL TEAMS

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AN INVESTIGATION OF THE EFFICIENCY OF SYNERGISTIC
MULTICULTURAL TEAMS

A Dissertation
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy
Industrial Engineering.

by
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December 2015

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ABSTRACT

The current globalized environment has increased the prevalence of multicultural teams in the workplace. While much research has focused on the advantages of such teams, the challenges companies should anticipate when using them has not received as much attention. These difficulties, specifically communication and trust, need to be considered to ensure that the company remains competitive in an economy driven by growing client expectations. In addition, companies often have to meet tight delivery schedules in order to survive, an expectation which adds strain on production teams.

Efforts to address these issues have ranged widely, with some researchers suggesting cultural awareness training and others early and clear communication between parties to identify their responsibilities and establish issue resolution procedures. However, little research has explored strategies of team creation for mitigating the challenges associated with diverse teams. To address this need, this research focuses on investigating whether a particular approach, the Kolbe guidelines for team creation, can be used to predict the resilience of multicultural teams to time constraints.

The research was completed in two steps: the pilot study which provided evidence that the Kolbe guidelines could predict multicultural teams' performance and the main study which provided additional support for the guidelines' performance prediction capabilities but not for their potential as resilience predictor.

DEDICATION

I thank you Lord for having put all the right people, at the right time, on my path, and for having given me the exact personality traits and cognitive abilities I needed to complete this mission. I pray now that you grant me the opportunity to take all those lessons that I have learned and those wonderful friendships that I have made and light up this world with them.

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CHAPTER 1: LITERATURE REVIEW

The importance of teams

Because of the societal and technological changes that marked the second half of the twentieth century, the work environment evolved to incorporate teams of cross-trained employees to ensure that they were aware of the entire process involved in the production of goods or the delivery of services (Ilgen & Pulakos, 1999). As a further advantage, these members could pool ideas and perspectives for the benefit of the company. As corporations became more convinced that teams increased efficiency, they made every effort to integrate them into their culture, varying their authority, lifespan and scope of impact as needed.

Past research on these various teams used in the industry has resulted in their classification into four main types: work, management, parallel and project (Cohen & Bailey, 1997). Work and management teams are self-managed, meaning that members appoint a leader or decide that all members may participate equally in the decision-making process; these teams are usually stable and well-defined. Work teams, which are responsible for the production of goods or the delivery of services, are usually composed of cross-trained members (Elloy, 2005). Their primary function is to reduce operating costs while increasing productivity and quality. On the other hand, management teams operate on a broader scale than work teams, coordinating and guiding the sub-units under their supervision and being responsible for the overall performance of their organizational unit. For example, an executive management team supervises the performance of an entire organization, regulating its strategic direction (Nielsen, 2010).

Project and parallel teams, which typically have shorter lifespans than work and management ones, are often cross-functional. Since both are created to address a particular

problem and then disbanded at the end of the project, the compatibility of their members is of less concern. Project teams, which function within the bounds of the organization and can occasionally be self-managed, are not typically cohesive as they solve the problem by addressing different components simultaneously, allocating them to the appropriate team members (Cohen & Bailey, 1997). Parallel teams, on the other hand, have limited authority, only making recommendations to higher-ranked individuals (Cohen & Bailey, 1997). As their name suggests, they exist apart from the rest of the organization and may even include members from external consulting companies (Duarte & Snyder, 2011). These teams, though temporary, may have a longer lifespan than project teams.

With the rapid advancement of technology and globalization, all of these teams can be virtual, meaning members may communicate and coordinate using technology. However, traditional teams who meet face-to-face and are usually co-located are still prevalent (Cheng, Chua, Morris, & Lee, 2012; Chiang, 2011; Davidson, 2013; Watson, 2008; 2008), even though they can now be as diverse in composition as their virtual counterparts.

Multicultural teams

Diversity, sometimes referred to as multiculturalism, has multiple definitions, with Hofstede's being one of the most widely recognized. Geert Hofstede defines culture as a distinctive set of collectively held values (Hofstede, Hofstede, & Minkov, 1997). In an effort to measure these, he surveyed IBM employees from forty countries resulting in five continuums: masculinity/femininity, power distance, individualism/collectivism, uncertainty avoidance and long-term orientation (Hofstede, 1984). Other researchers have used a modified version of Hofstede's survey, for example, Lord and Maher's Global Leadership and Organizational Behavior Effectiveness (GLOBE) survey (Bajdo & Dickson, 2001; Jackson, 2005; Peterson &

Behfar, 2003). Based on this survey, culture reflects a person's judgment of how the world should be as opposed to how it really is. Differences between Hofstede's and Lord's scales include the division of Hofstede's individualism/collectivism dimension into two components: collectivism in respect to work or society in general and coherence to family and close friends. Hofstede's masculinity/femininity scale was also subdivided into two GLOBE dimensions: gender egalitarianism and assertiveness orientation.

Frequently, in industry, however, cultural differences are simply defined as demographic diversity or differences in gender, age and race. This diversity can be measured, as is often the case in teamwork research (Harrison & Klein, 2007; Richard, Kirby, & Chadwick, 2013), with Blau's index which measures variety within a group using the formula

$$\text{Eq. 1: } V = 1 - \sum [n_k(n_k - 1)/(n(n - 1))]$$

where n_k represents the number of unit members in the distinct k^{th} category with k ranging from 1 to the maximum number of possible categories and n is the unit size (Blau, 1977; Harrison & Klein, 2007). This expression is based on the original heterogeneity index developed by Simpson (1949) for sampling from an infinite population

$$\text{Eq. 2: } V = 1 - \sum p_k^2$$

where p_k is the fraction of the population in the k^{th} category.

Despite a lack of consensus on a definition for the term, diversity or multiculturalism in teams has become the norm in industry and, therefore, the focus of much research. For example, by the end of the twentieth century as women integrated the workforce in increasingly large numbers, more diverse teams were developed based on gender, with researchers becoming interested in its effect on team performance (Hoogendoorn, Oosterbeek, & Van Praag, 2013; Karakowsky & Miller, 2002). In addition, due to globalization, the modern team is constituted of

members from different backgrounds, not only technological or academic but also racial, or has to interface with teams from different nations (Bouncken & Winkler, 2010; Cheng et al., 2012; Cox & Blake, 1991; Friedemann, Pagan-Coss, & Mayorga, 2008; Govindarajan & Gupta, 2001; Nielsen, 2010). Furthermore, in search of a competitive advantage, companies often open branches in other countries, hiring a local workforce. These external branches are never totally independent and must, at some level, interface with the headquarters, creating the necessity for multicultural communication. Moreover, currently, multiculturalism can be found even in local companies due to the diversity of available employees and the trend of collaboration among departments. In 2000, for example, 10.4 percent of the population of the United States consisted of people not born in this country (Camarota, 2001). In some instances, it is even mandated by law to have a percentage of minorities represented in the company.

Though multicultural teams seem like a natural solution to understanding and responding to the current business environment, those teams face unique challenges. In fact, the multicultural composition of a team may moderate the benefits usually observed in monocultural ones. Some researchers argue, for example, that these teams delay the team-building process due to the increased difficulty in creating trust and building rapport, thereby increasing stress as well as the likelihood of conflict and negative peer evaluation (Friedemann et al., 2008; Govindarajan & Gupta, 2001; Keller, 2001; Scholz & Stein; Simkhovich, 2009). Research has also found that cross-cultural teams are more susceptible to interpersonal conflicts and show less group cohesion than teams of homogenous cultural composition (Bouncken & Winkler, 2010). These conflicts and this lack of cohesion are, in part, related to the challenge of establishing trust. Although trustworthiness and the ability to trust are important traits of an employee in any work setting, they become crucial in the context of multicultural teams (Govindarajan & Gupta, 2001). In instances where trust is low, team members are more predisposed to withhold their opinions and

judgments. On the other hand, when trust is high, members are likely to take risks and expose their vulnerability (Costa, 2003). These behaviors of team members in such an environment are typically conducive to more efficient collaboration and better conflict resolution.

In general, the performance of a multicultural team is dependent, in part, on the ability of the members to overcome culturally established barriers and work together harmoniously (Friedemann et al., 2008; E. Salas, Nichols, & Driskell, 2007; Shaw & Barrett-Power, 1998). For example, what some traditions might see as proper and as a mark of respect, others might perceive as a sign of weakness, resulting in a negative response; older members may typically be less inclined to rush into a decision, a characteristic often viewed as a weakness and even an obstacle to innovation by their younger counterparts. Failure to sensitize team members to these differences may not only result in conflict but can also impact the potential for the enhanced performance that could result from input from different perspectives. As past research has shown, teams are more likely to benefit from diversity when their members are validated by one another (Janssens & Brett, 2003; Thylefors, Persson, & Hellström, 2005). One area important for creating this validation, especially in relation to multicultural teams, is good communication, whether verbal or non-verbal, as miscommunication fosters conflict (Hinds & Bailey, 2003). While communication has been reported as one of the prime factors determining team performance (Burke et al., 2009; E. Salas et al., 2008), studies have found that communication behaviors vary depending on a person's background (Rodríguez, Hines, & Montiel, 2009; Taras, Steel, & Kirkman, 2011). This issue is magnified in the case of multicultural teams because of their diverse compositions (Ochieng & Price, 2009), with at least one member having to communicate in a language different from his/her native one. While this issue can result in misunderstandings and conflicts, they are less likely to have a significant impact if the team members trust one another and address the misunderstandings immediately.

Despite the particular challenges faced by multicultural teams, they are not simply a product of convenience and legal concerns. Research also suggests they can outperform monocultural teams in some contexts, for example increasing creativity and innovation and enhancing the learning process (Bouncken & Winkler, 2010; Mitchell, Boyle, & Nicholas, 2011; Piccoli, Powell, & Ives, 2004; Slater, Weigand, & Zwirlein, 2008; Stahl, Maznevski, Voigt, & Jonsen, 2010) precisely because of the associated cognitive diversity. Some researchers (Ye, Zhang, & Rezaee, 2010) have found, for example, that a higher female representation on a decision making team can lead to increased company economic performance. As this analysis of multicultural teams suggests, the benefits associated with diversity are mixed and dependent upon context.

Team composition: a multi-faceted issue

In addition to communication, other factors have been found to affect the performance of diverse teams, including individual personalities and behavioral and cognitive traits (Driskell, Goodwin, Salas, & O'Shea, 2006; O'Neill & Allen, 2011; Sinclair, Siemieniuch, Haslam, Henshaw, & Evans, 2012; SmithJentsch, Salas, & Baker, 1996). To address these factors, several approaches to team allocation, such as the Myers-Briggs and the Big Five tests, both of which focus on individual traits, are used in the industry. Table 1 presents a summary of those surveys:

Table 1: Tests used in the industry for team allocation

Name	Description
Big Five Personality Traits	Comprehensive assessment of personality, measures agreeableness, conscientiousness, extraversion, neuroticism and openness to experience
Enneagram	Delineates 9 basic personality types and shows relationships among them
Kolbe Method (A, B, and C Indexes)	The A Index is a self-assessment indicating the instinctive methods and approach to creative problem solving; the B Index measures self-perception of the job requirements, and the C index measures conative requirements for success in the job as described by a third party
Myers-Briggs Type Indicator (MBTI)	Identifies the preferred behavioral style of the individual; enables comparison between differing styles within a team.
Personality Research Form (PRF)	Available in 5 forms; describes personality traits relevant to a wide variety of situations; minimizes response bias due to social desirability
Wonderlic Personnel Test	50 items measuring general cognitive ability; allows estimation of IQ scores; predicts success in training programs and job performance for certain jobs

These tests, aside from the Kolbe surveys, all assess either the cognitive abilities or personalities of the respondents, which, as evidenced by research, may not be stable across time or cultures (BeVier, 1999; Wortman, Lucas, & Donnellan, 2012). In addition, there is a lack of evidence that these tests, again with the exception of the Kolbe Indices (Fitzpatrick & Askin,

2005), can be used to build high-performing teams (Gardner & Martinko, 1996; Koroutchev, Acuña, & Gómez, 2013; Kress & Schar, 2012) even though researchers agree that a mixture of personalities on teams is preferable (Zhang & Zhang, 2013).

The Kolbe Method for team allocation

The Kolbe Method, a tested set of assessments (Kolbe, Young, & Gerdes, 2008) focusing on problem-solving behaviors, identifies four primary action modes: Implementor, Fact Finder, Quick Start and Follow Thru, with a person being ranked, depending on the zone he belongs to, as Initiating, Responding or Preventive in each of these modes (Kolbe, 2004; Kolbe, 2015); in other words, a person can naturally initiate a type of behavior, respond appropriately to people demonstrating any innate tendency for this type of behavior, or counterbalance the behavior suggested by each mode.

Initiation in the Implementor mode suggests that the individual is most productive when focusing on the physical quality of the product when solving a problem, while in the Fact Finder mode, it indicates a need for details and precise information for optimal decision-making. An Initiator in the Quick Start mode, on the other hand, can be just as proficient with mere estimates but needs frequent opportunities for change to remain a top performer. The Initiating Quick Start's propensity to lose interest quickly can be misunderstood or even be found exasperating by the Initiating Follow-Thru, for whom organization is key; the Initiating Follow-Thru's most efficient contribution to the team is his natural aptitude for keeping track of and organizing everything related to a project, even establishing procedures when they are not set.

On the other end of the spectrum, a Preventive Follow-Thru supports speed of execution with his ability to create shortcuts and manage efficiently several things at once, while the Preventive Fact Finder's most valuable contribution is his capacity to isolate the crucial material

and to work efficiently with indefinite estimates. This attribute is stimulated by a Preventive Quick's Start proficiency in clarifying deadlines and establishing outside limits, limiting the options. The Preventive Implementor's skills in dealing with abstraction and creating temporary fixes are also invaluable to a team in an emergency.

As demonstrated by the earlier examples, no zone in an action mode is systematically more desirable than another. In fact, each combination of zone and mode represents a strength, the list of which can be seen in Figure 1. These Kolbe Strengths are not to be confused with skills or learning; they represent the person's instinctive behaviors when motivated to thrive. Each individual exhibits a relatively unique set of 4 of these strengths, one in each action mode. In combining differing sets, or individuals with different *modus operandi*, a team benefits in terms of resources available to utilize based on the context, increasing its flexibility and resilience.

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Figure 1: The 12 Kolbe Strengths

An important characteristic of the Kolbe approach to individual differences is that an individual's conative profile, or instinctive mode of operation, is in no way related to his or her personality, and therefore not subject to change with time and life experiences as personality often is (Boyce, Wood, & Powdthavee, 2013; Roberts, Walton, & Viechtbauer, 2006). For instance, the Initiating Fact Finder will always have the urge to collect rigorous data whether primarily through social interactions as an extrovert or with a stronger inclination for reading materials in the case of the introvert. However, the Kolbe Method acknowledges the possibility for changes in behavior, claiming that although individuals have a specific or conative profile which they use by default, they can also change to different modes, more or less easily, when the situation requires (Kolbe, 2004). For example, if Joe is Initiating both in Fact Finder and Follow-Thru modes but has depleted his Fact Finder energy for a task, he might then approach a problem by trying to classify the information already collected instead of trying to gather more data.

Using these individual conative profiles, Kolbe has established guidelines for selecting the optimum mix of people for building a successful team. Though these dimensions are not meant to be used to measure performance as intended in the industry, they define a conative mix or combination of differing individual problem-solving methods which should lead to optimal performance. The primary objective in creating teams based on these guidelines is to balance the synergy of the members' conative instincts to enhance productivity. This emphasis is supported by the developer of the Kolbe Method when she says, "without instinctive synergy in a group, you can have all your other ducks in a row, and they will just sit there" (Kolbe, 2004). As a general rule, the Kolbe guidelines recommends a distribution of 25% of the team's energy in the Initiating and Preventive zones, with a margin of +/- 5%, and 50% of its energy in the Responding zone, with the same margin of +/- 5% as seen in Figure 2.

Productivity

Productivity Chart
 Team 1

Figure 2: Example of a team's distribution of conative energy compared to the ideal scenario

If a team is constituted of too many members with the same capabilities, it may result in inertia, a condition usually associated with passivity and the incapacity for the team to move forward (Kolbe, 2004). Warewithal, the Kolbe Corp. software used to assess the mix of conative energies in teams, includes a team Productivity score which takes into account both of these potential problems.

The set of Kolbe Indices, in addition to its potential as a performance predictor (Berry & Lingard, 2001; Timmerman, Lingard, & Barnes, 2001), has been validated as an unbiased tool in regards to race and gender as well as other personal factors (Kolbe, 2004). In addition, research

has also assessed its validity for team allocation, the objective performance measures typically consisting of performance as defined by the hiring company and scores on simulated tasks and decision-making scenarios. Subjective measures of performance, on the other hand, consist primarily in self-assessments from the team. However, none of this research has addressed multicultural teams specifically nor investigated the resilience of teams built using the Kolbe guidelines.

Purpose of proposed research

In any work setting, sufficient allocation of the required proper resources is important for performance; however, since this is not always possible, employees are expected to function productively even when they are limited. One of the commonly identified stressors from the perspective of employees is the perception of insufficient time to execute their tasks. However, given the current economic climate and global competition where it benefits, even temporarily, to be the first on the market and where delivery schedules must be met for the survival of the company, time constraints are not likely to disappear. It is, thus, reasonable, when forming a team, to consider efficiency and resilience to time constraints. In some cases, such as in the context of virtuoso teams, this issue is irrelevant as strict time constraints are traditionally believed to improve their performance (Fischer & Boynton, 2005). However, the inclusion of time constraints often adds strain even to well-functioning systems.

This research proposes to investigate whether the impact of different levels of time constraints on the performance of multicultural teams can be mitigated with team allocation. Specifically, it targets the examination of team composition by assessing the relationship between the conative profile of self-managed multicultural project teams and their resilience to time constraints. This objective will be met through the two studies conducted as part of this research.

The initial study investigating the predictive validity of the Kolbe guidelines in terms of performance is described in chapter two, including both its limitations and its impact on the main study. The latter, exploring whether conative profiles can predict performance of multicultural teams even in the face of time constraints, is described in the third chapter as well the conclusions drawn from its results.

For the purposes of this research, a team will be defined as a group of people working interdependently towards the accomplishment of a shared goal (Hollenbeck, Ellis, Humphrey, Garza, & Ilgen, 2011; Ilgen & Pulakos, 1999; Monda-Amaya & Fleming, 2001; Popov et al., 2011; E. Salas, Cooke, & Rosen, 2008). As explained by Nicholson et al. (2006), on a team, the input of any one member affects the productivity of the others in such a manner that the output cannot be attributed to any single member. Furthermore, multiculturalism will be defined as it is typically in the industry, as the variance in gender, age and race, with the addition of variations in educational background. For example, a female and a male both Caucasians in engineering will constitute a multicultural team due to their difference in gender. Similarly, two Black Caribbean females, one in law and another in architecture, constitute a multicultural team due to their different educational backgrounds. This approach to multiculturalism will facilitate the application of the findings in industry because they will be based on commonly collected data.

CHAPTER 2: PILOT STUDY

Before exploring the resilience of such teams, it is necessary to determine whether a multicultural team's conative profile can predict its efficiency, an issue addressed in the following pilot study. This section describes the sample and the experimental task used as well as the relevant hypotheses and the tools used to measure the variables.

Participants

This study recruited 24 students from Clemson University over a seven-month period excluding semester breaks through emails sent to student organizations, flyers posted around campus and word of mouth. They represented a diversity of racial origins, ethnicity, gender, and educational backgrounds. Based on their demographic and academic information provided by email and their availability collected through Doodle polls, they were grouped into teams of 4, the smallest team size recommended by the Kolbe Corp.; however, complete data are available for only 5 teams for a total of 20 participants. Appendix A contains the email sent for recruitment, the consenting process and the demographic and academic data.

Although they did not necessarily have the same demographic profile, all teams were multicultural exhibiting the same Blau's Index. The maximum number of categories ($K = 23$) used to compute the Blau's Indices corresponds to the number of categories of participants recruited for the study even if some were not represented in the final teams who performed the task, allowing for the comparison of the cultural diversity of the teams based on this Index. Because each category found in a team is represented by only one member, Blau Indices are always 1, indicating that all teams are equally diverse. A summary of the team's composition can be found in Appendix B.

Task and Materials

This study used a variant of the Taggar and Seijts (2003) bridge exercise to measure performance objectively. After being provided with the same number of sheets of paper, strips of scotch tape, base boards and pens, each team was asked to build a bridge spanning as far as possible that was able to support one pound without collapsing. The one-pound weight used was a Firm exercise glove. Performance was measured using two variables: the bridge length measured in centimeters and the quantity of resources used, including time, based on the equation below:

$$\text{Eq. 3: Number of resources used} = \text{time to completion (in minutes)} + \text{number of (paper sheets and/or tape strips) used}$$

This task was expected to be a novel experience for most team members, thus limiting the possibility that their efficacy belief would be based on previous experience instead of the belief that members could collaborate to achieve high team performance (Taggar & Seijts, 2003). In addition, the nature of the task necessitated this collaboration with the contribution of each member shaping the overall performance of the team without making it possible to attribute the output to any single member.

Model and Hypotheses

The primary research question guiding this effort was whether the Kolbe guidelines can be used to predict performance in multicultural teams. Though some literature supports these recommendations, there is little evidence correlating them to efficiency in the context of multicultural teams. In addition, prior knowledge, a covariate with past research supporting its impact on objective performance, was included in this investigation to control for its expected variance among team members (Andrevski, Richard, Shaw, & Ferrier, 2014; Kwasnik, Crowston, Im, Yates, & Orlikowski, 2005; Richard et al., 2013; ZELLMER-BRUHN & GIBSON, 2013). In addition to the assessment of the validity of conative entropy, or the mix of conative profiles, as a

performance predictor for multicultural teams, this study also attempts to provide insight regarding the moderating impact of such factors as teamwork processes and subjective performance on that relationship as well as the relationship between prior knowledge and objective performance.

The model in Figure 3 is a simplified representation of these questions, with Hypothesis 1 being used to assess the primary research question of the predictive value of conative entropy for the performance of multicultural teams.

Figure 3: Research model, pilot study

Hypothesis 1: There is a positive direct relationship between the team's conative profile and its objective performance in terms of length or resources used.

Hypotheses 2 and 3 address the impact of teamwork processes and subjective performance on that relationship.

Hypothesis 2: The team's teamwork processes mediate the relationships between the conative score and both measures of objective performance.

Hypothesis 3: The team's subjective performance or collective efficacy belief mediates the relationships between a team's conative profile and its objective performance.

Similarly, Hypotheses 4 and 5 investigate the impact of teamwork processes and subjective performance on the relationship between prior knowledge and team performance.

Hypothesis 4: The team's teamwork processes partially mediate the relationships between their knowledge measures and the objective performance measures.

Hypothesis 5: The team's subjective performance or collective efficacy belief partially mediates the relationship between the members' prior knowledge and the team's objective performance.

The groupings seen in the model are acceptable as all the variables clustered into one box are expected to have the same relationships with the other variables, as indicated by their groupings and in the phrasing of the hypotheses.

Measures

Testing the hypotheses involves measuring team performance objectively, the individual perception of team performance, the team members' prior level of familiarity with one another and the task, the teamwork processes and the individual Kolbe profile and the team conative entropy. Of the various methods used to account for both synergy and inertia when building teams, the two used in this study were the Productivity score provided by the Kolbe software, Warewithal, when analyzing the team's conative profile and the modified version of the entropy scale, which has been empirically tested and is used by Seager, seen below:

$$\text{Eq. 4: } S(\text{labeled conative entropy}) = \sum_{m=1}^4 \sum_{z=1}^3 \{\ln(P_{mz}) * P_{mz}\}$$

where

{m =1 -> Fact Finder, m= 2->Follow-Thru, m=3 ->Quick Start, m=4 -> Implementor;

{z=1 ->Initiating, z=2 -> Responding, z=3 -> Preventative;

and

$$\text{Eq. 5: } P_{mz} = \frac{\text{Number of people on the team in zone z of mode m}}{\text{Total number of people on the team}}$$

Both measures were grouped in the model in the box labeled conative entropy. This study addresses the problem referred to by Kolbe as Missing Methods, when no one in the team is in a particular zone of a mode, by adding one person to each combination of zone and mode. Using this version, the ideal entropy is Modentropy = -3.64 and smaller values are preferable.

The complete list of tools used to measure the variables in the proposed model is given below:

- The individual Kolbe profiles were determined based on responses to the Kolbe Index A questionnaire. The responses to this online survey were subsequently used to determine the team's entropy.
- A team's conative entropy was computed after the input of the team members' Kolbe profiles. Both measures were taken at the team level, level 2 of data.
- Teamwork processes were measured via an adapted version of Marks, Mathieu and Zaccharo's (2001) survey at the individual level, level 1 of data (see Appendix C). The team's teamwork processes score was computed as the average of individual team members' scores.

- The individual perception of team performance was measured using a slightly modified version of Taggar and Seijts' (2003) collective efficacy index, the one question used here asking participants about their team's chances of winning the competition instead of about the contract as in Taggar's version (see Appendix D). This measure was taken at the individual level (level 1).
- The surveys used to measure individual prior knowledge in relation to other team members as well as the task can be found in Appendix E. These two concepts are grouped in the model's prior knowledge box. Prior knowledge of the task was measured at the individual level (level 1). Two measures of team familiarity were computed based on the responses to the prior knowledge of the team members survey:
 - The number of people known at least to some extent by each individual team member (labeled Number4), as determined by the number of people a team member gave a score of 4 or more on the prior knowledge survey. This score was computed at the individual level (level 1).
 - The overall level of familiarity within the team (Eq. 6) calculated as the ratio of the average familiarity scores across the team and 7, the average familiarity in a team where all members know each other very well. This score is based on the density measure used in research on social networks (Carson, Tesluk, & Marrone, 2007; Sparrowe, Liden, Wayne, & Kraimer, 2001)

$$\text{Eq. 6 Teamfamiliarity} = \text{Average actual scores} / 7$$

Since not knowing each other at all was marked as 1 instead of 0, this measure varied between 0.14 and 1, with lower scores indicating that

team members did not know one another well. This score was computed at the team level (level 2).

- Team performance was measured both objectively and subjectively, both at the team level (level 2).
 - Objective performance as identified in the model included the length of the bridge and the number of resources (paper, strips of tape and time) used as computed in Eq. 3.
 - Subjective performance was computed as the aggregation of the team members' collective efficacy scores.

Data Collection

Study Design and Procedure

This study was quasi-experimental with no control group, as team assignment was not completely random, and as such causality cannot be inferred (reduced internal validity). However, quasi-experimental research provides increased generalizability of the results because it imitates more closely natural observations (increased external validity). This research used a between-subjects design, with prior knowledge and conative profile as covariates or uncontrolled exogenous independent variables.

Through email, the participants provided their demographic profile, signed the consent form (seen in Appendix F), took the Kolbe test and indicated their availability in terms of meeting time. Based on their schedules, individuals were then allocated to teams quasi-randomly, with all being multicultural both in demographic profiles and educational backgrounds. Then, the teams' conative entropy was assessed, and they met to complete the bridge-building activity, one team at

the time due to the lack of the availability of researchers to collect data simultaneously and the participants' conflicting schedules.

At the beginning of a team session, the consenting process was completed as needed and questions related to the study were answered. Team members were then officially introduced to one another, and five minutes were allotted for them to become acquainted. The participants were subsequently given the material to complete the task, which was explained to them. The team was reminded that this was a competition and that the one with the best efficiency score would win the prize, four Amazon gift cards, each worth \$25.00. The method for computing the efficiency score was also explained as the ratio of bridge length and the number of resources used with a bonus point for optional planning information submitted by the team.

Additional questions were answered after which the researcher signaled the team to begin working and started the timer. When the team indicated that it had completed the task, the timer was stopped. Team members were asked to take the teamwork processes and the subjective performance surveys, and the reports were collected. Once they had completed the surveys, participants were given permission to leave though most wanted to know the team score. They were given the chance to see whether their bridge supported the pound without collapsing, therefore meeting the qualifying criterion, and witness the researcher assessing and reporting objective performance, i.e. the bridge length and the number of resources used. The team's bridge score, which reflected the length achieved while meeting the weight requirement as well as the resources used including time, was computed using the equation below:

$$\text{Eq. 7: Bridge score} = \frac{\text{length of bridge}}{\text{amount of resources used}}$$

Once all the teams had completed their respective sessions, their efficiency was compared across teams. In an effort to promote the utilization of all team members' conative

strengths, including Follow Thru, which might have been devalued by the nature of the task, a bonus point was awarded to teams who submitted a completed design on paper by the end of the session. This addition to the task described by Taggar and Seijts is consistent with practice in industry which typically rewards planning and usually demands reports at the completion of a project. The final team efficiency score was calculated based on the equation below:

$$\text{Eq. 8: Team efficiency score} = \text{Bridge score} + \text{Bonus point}$$

The Amazon gift cards were given to the team with the highest efficiency score, the total of the bridge score and bonus point.

Figure 4 summarizes the procedure used for this study with participants' actions labeled in orange and the researcher's in black capital letters.

Figure 4: Flow chart of the procedure of the pilot study

Study design and data analysis

After validating the measures, two methods of data analysis were used to investigate the hypotheses. Because the team's objective score was measured only at the team level, a simple regression was used to assess Hypothesis 1. On the other hand, teamwork processes and collective efficacy belief were assessed using measures collected at the individual level;

therefore, Hypotheses 2, 3, 4 and 5 were evaluated using both a mixed model analysis for the relationships between conative entropy and prior knowledge with these variables, and a simple regression for the relationships between all other variables and team objective performance. In addition, mediation effects were verified through Sobel testing. For example, the assessment of whether teamwork processes partially mediate the relationship between a team's conative profile and its objective performance as stated in Hypothesis 2 involved the steps below:

- 1) Evaluate the relationship between the conative profile and objective performance via a regression analysis
- 2) Assess the relationship between the conative profile and teamwork processes using multilevel regression analysis.
- 3) Analyze the relationship between teamwork processes and the objective performance via a simple regression.
- 4) Estimate the mediation effect via Sobel testing.

Results

The content validity of the prior knowledge surveys was assessed by presenting them to two experts, with changes being made based on their feedback. Both measures of team member prior knowledge of one another were highly correlated (Pearson Correlation = 0.78, $p = 0.00$).

Both potential measures of the team conative profile, Modentropy based on Dr. Seager's approach and Productivity included in the Kolbe Corp software Warewithal, were also correlated (Pearson Correlation = -0.73, $p = 0.00$).

All data were tested for normality using skewness and kurtosis measures (see Appendix G). Reliability was assessed for all subjective scales, except collective efficacy belief and team

familiarity with their members, using Cronbach's Alpha (Table 2). Evaluating internal consistency was not necessary for subjective performance as it was a one-item survey and for prior level of familiarity because of the nature of this measure as team members were expected to know others at varying levels.

Table 2: Cronbach's Alpha for all subscales, pilot study

Scale	Initial Cronbach's Alpha
Mission Analysis	0.844
Goal Specification	0.862
Strategy Formulation	0.462
Monitoring	0.738
Resource monitoring	0.841
Team Monitoring	0.596
Coordination	0.918
Conflict Management	0.919
Motivating and Confidence Building	0.480
Affect Management	0.831
Prior Knowledge of Task	0.636

Some of the items from the teamwork processes survey had to be removed from further analysis because of their negative and significant impact on the related subscale's reliability. For example, as illustrated in Tables 2 and 3, eliminating the third item of the Strategy Formulation subscale raised its Cronbach's Alpha from 0.46 to 0.51.

Table 3: Individual item impact on Strategy Formulation reliability

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Strategy1	10.75	7.039	.240	.142	.449
Strategy2	11.05	4.576	.474	.229	-.069 ^a
Strategy3	10.30	9.484	.184	.126	.511

In addition, the third item of the Conflict subscale was removed from analysis due to its high skewness and kurtosis (Table 4), both of which had a negative but not significant impact on the subscale's reliability (Tables 2 and 5).

Table 4: Description of the data for the Conflict items

	Mean Statistic	Std. Deviation Statistic	Skewness Statistic	Std. Error	Kurtosis Statistic	Std. Error
Conflict1	6.55	.826	-1.423	.512	.161	.992
Conflict2	6.65	.745	-1.847	.512	1.769	.992
Conflict3	6.70	.657	-2.079	.512	3.176	.992

Table 5: Individual item impact on Conflict reliability

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Conflict1	13.35	1.818	.811	.710	.915
Conflict2	13.25	1.882	.914	.838	.817
Conflict3	13.20	2.274	.808	.722	.912

After this initial screening, item ratings for each subscale were combined into an individual score to represent the relevant subscale, and these scores were tested for normality

using skewness. These subscales were also investigated in terms of reliability and internal correlations to determine if they, in fact, measured a single concept: teamwork processes (Cronbach's Alpha = 0.8).

The Intraclass Correlation Coefficients ICC1 and ICC2 could not be computed for teamwork processes and prior knowledge of the task because of a lack of variance in the related data. When calculated for collective efficacy belief, they were determined to be 0.56 and 0.83 respectively (Table 6), resulting in the conclusion that the group mean is a fair representation of the team. Agreement was evaluated using the r_{WG} index to determine whether individual measures could be aggregated at the team level (Table 6).

Table 6: Agreement indices and Intraclass Correlations, pilot study

Variable	ICC1	ICC2	r_{WG}
Collective Efficacy Belief	0.56	0.83	0.27
Number4	0.57	0.8	0.62
Prior Knowledge of Task	N/A	N/A	0.16
Teamwork Processes	N/A	N/A	0.88

Agreement indices for prior knowledge of the task and teamwork processes were high, supporting aggregation of these measures at the team level. Though the Levene test was marginally significant for collective efficacy belief (Levene Statistics = 2.63, $p = 0.059$), and not significant for Number4 (Levene Statistics = 3.36, $p = 0.038$) these variables had high ICCs (ICC1=0.6 and ICC2= 0.8). Based on these results, collective efficacy belief and Number4 were also aggregated at the team level.

Since, based on those initial assessments, there was insufficient support to justify the selection of either variable from the pairs describing the team's conative profile and team members' prior knowledge of one another, the analyses were conducted with each combination to determine the better fit with the proposed model. Because of insufficient variance in the data, while using Teamfamiliarity as the measure of team members' prior knowledge of one another, the regressions could not be computed, resulting in no conclusions in regard to the model.

Alternatively, when using Number4 as the measure of team members' prior knowledge of one another, simple regressions with all the predictors showed that they predicted both length and Resources used (Tables 7 through 10).

Table 7: Regression with Productivity measuring team's conative profile and Length as the DV

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	106784.420	5	21356.884	200.178	.000 ^b
	Residual	1920.413	18	106.690		
	Total	108704.833	23			

a. Dependent Variable: LENGTH

b. Predictors: (Constant), Teamwork Processes, Collective Efficacy Belief, Productivity, Prior Knowledge of Task, Number4, Prior Knowledge of Task
 $R^2 = 0.98$

Table 8: Regression with Modentropy measuring team's conative profile and Length as the DV

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	107214.608	5	21442.922	259.003	.000 ^b
	Residual	1490.226	18	82.790		
	Total	108704.833	23			

a. Dependent Variable: LENGTH

b. Predictors: (Constant), Modentropy, Number4, Teamwork Processes, Collective Efficacy Belief, Prior Knowledge of Task

$R^2 = 0.99$

Table 9: Regression with Productivity measuring team's conative profile and Resources as the DV

ANOVA ^a						
Model	Sum of Squares	df	Mean Square	F	Sig.	
1	Regression	170.932	5	34.186	27.358	.000 ^b
	Residual	22.493	18	1.250		
	Total	193.425	23			

a. Dependent Variable: Resources

b. Predictors: (Constant), Productivity, Teamwork Processes, Collective Efficacy Belief, Prior Knowledge of Task, Number4

$R^2 = 0.88$

Table 10: Regression with Modentropy measuring team's conative profile and Resources as the DV

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	178.271	5	35.654	42.351	.000 ^b
	Residual	15.154	18	.842		
	Total	193.425	23			

a. Dependent Variable: Resources

b. Predictors: (Constant), Modentropy, Number4, Teamwork Processes, Collective Efficacy Belief, Prior Knowledge of Task

$R^2 = 0.92$

Specifically, collective efficacy belief, team familiarity levels with members and the task, and productivity each significantly predicted the length of the bridge when the rest of these variables and teamwork processes were held constant. On the other hand, teamwork processes and team familiarity with other members and with the task each significantly predicted the quantity of resources used when the rest of these variables, collective efficacy belief and Productivity scores were held constant. Furthermore, when the team's conative profile was assessed with the modified entropy score, Modentropy, instead of Warewithal's Productivity scale, only the team's conative profile and prior knowledge of the task and other team members predicted the bridge's length significantly. However, using Modentropy, only collective efficacy belief did not predict Resources when all other variables were held constant. As summarized in Tables 11 and 12, a team's conative profile showed a stronger relationship with the bridge's length when compared with the teams' prior knowledge levels, in fact, conative entropy explained on its own 53% of the variance in length (Table 11). In contrast, the team's prior knowledge of the task had a stronger relationship with the quantity of resources used, explaining

35% or 50% of the variance in resources used depending on the method used to compute team member's prior knowledge of one another (Table 12).

Table 11: Comparison of conative entropy and prior knowledge as predictors of length.

		DV: Length	
		Regression Coefficients	Sr²
Conative entropy represented by :	Predictors:		
Modentropy	Modentropy	-26.61	0.53
	Prior Knowledge of Task	-11.51	0.10
	Number4	-3.73	0.01
Productivity	Productivity	23.35	0.53
	Prior Knowledge of Task	6.55	0.04
	Number4	2.5	0.01

Table 12: Comparison of conative entropy and prior knowledge as predictors of resources used.

		DV: Resources	
		Regression Coefficients	Sr²
Conative entropy represented by :	Predictors:		
Modentropy	Modentropy	-3.52	0.05
	Prior Knowledge of Task	-8.91	0.35
	Number4	3.73	0.06
Productivity	Productivity	1.57	0.02
	Prior Knowledge of Task	-8.8	0.50
	Number4	2.5	0.04

The mixed model analysis indicated that neither prior knowledge of the task and of other team members nor the productivity scores significantly predicted collective efficacy belief when Number4 was used to measure prior knowledge of other team members. However, they all predicted efficacy belief when Teamfamiliarity was used. This indicates the possibility of collinearity in the predictors, perhaps Number4 was highly correlated with other variables such as the productivity score. On the other hand, when Modentropy was used to measure a team's conative profile, none of the previous variables predicted collective efficacy belief regardless of the method used to assess team member knowledge of one another (Tables 13 and 14).

Table 13: Assessment of whether prior knowledge and Modentropy predict collective efficacy belief using Number4

Estimates of Fixed Effects^a							
Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	-380.94	908.19	2.18	-.42	.713	-3991.04	3229.17
Prior Knowledge of Task	-27.41	92.16	2.20	-.3	.792	-390.95	336.12
Number4	7.44	5.58	14.51	1.33	.203	-4.492	19.37
Modentropy	-148.45	314.31	2.15	-.47	.680	-1412.14	1115.24

a. Dependent Variable: CollectiveEB.

Table 14: Assessment of whether prior knowledge and Modentropy predict collective efficacy belief using Teamfamiliarity

Estimates of Fixed Effects^a							
Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	-2377.3	680.47	1.00	-3.49	.177	-11023.52	6268.97
Prior Knowledge of Task	-221.7	67.42	1.00	-3.29	.188	-1078.35	634.95
Modentropy	-804.2	226.67	1.00	-3.55	.175	-3684.26	2075.86
Teamfamiliarity	263.87	67.92	1.00	3.89	.160	-599.11	1126.85

a. Dependent Variable: CollectiveEB.

Similarly, these variables did not significantly predict teamwork processes, except for team familiarity level with one another measured via Number4, when prior knowledge of the task and the teams' conative profiles were held constant.

The results from the Sobel test used to determine whether collective efficacy belief mediated the relationships between objective performance and prior knowledge and productivity indicated that it did to some extent. The mediation effect of collective efficacy was found significant on the relationship between objective performance and team members' prior knowledge of one another when the latter was measured through the overall familiarity within the team (Teamfamiliarity). Similarly, collective efficacy explained part of the relationship between conative entropy and objective performance only when the entropy was measured using Warewithal's Productivity score. On the other hand, teamwork processes did not mediate any of the predicted relationships. These results are summarized in Table 15.

Table 15: Mediation analyses, pilot study

Mediator	Relationship	Mediating effect	Z	P
Collective Efficacy Belief	Productivity→ Length	-696.819	-6.5	0.00
	Productivity→ Resources	-21.219	-6.5	0.00
Collective Efficacy Belief	Modentropy→ Length	17.369	0.45	0.65
	Modentropy→ Resources	0.891	0.47	0.64
Collective Efficacy Belief	Number4→ Length	-0.87	-1.03	0.30
	Number4→ Resources	5.638762	1.26	0.21
Collective Efficacy Belief	Teamfamiliarity→ Length	-226.398	-6.89	0.00
	Teamfamiliarity→ Resources	-6.894	-6.89	0.00
Collective Efficacy Belief	Prior Knowledge of Task → Length	33.288	2.84	0.00
	Prior Knowledge of Task→ Resources	1.014	2.84	0.00
Teamwork processes	Productivity→ Length	2.044	0.06	0.95
	Productivity→ Resources	-2.788	-0.06	0.95
Teamwork processes	Modentropy→ Length	98.649	1.36	0.17
	Modentropy→ Resources	22.272	0.37	0.71
Teamwork processes	Number4→ Length	-6.309	-1.54	0.12
	Number4→ Resources	-3.762	-2.82	0.00
Teamwork processes	Teamfamiliarity→ Length	-0.654	-0.06	0.95
	Teamfamiliarity→ Resources	0.892	0.06	0.95
Teamwork processes	Prior Knowledge of Task → Length	-0.385	-0.1	0.92
	Prior Knowledge of Task → Resources	5.028	1.12	0.26

Conclusion

This pilot study investigated the validity of using the conative profile of multicultural teams as a predictor of team performance. The variables hypothesized to have an impact on this relationship were team conative profile, the members' prior knowledge of the task and of one another, the collective efficacy belief, the teamwork processes and the team's objective performance. Data were collected from 5 teams to assess the research question as well as whether teamwork processes and collective efficacy belief mediated the relationships between conative profile and the two forms of prior knowledge with objective performance. Because of the small sample size of this pilot as well as the fact that it was almost exclusively constituted of engineers, the results cannot be generalized. However, its primary benefits involve the detection of potential issues in data collection and the confirmation of a team's conative profiles as a possible predictor of multicultural team performance.

As illustrated by the analysis, both measures of the conative profile at the team level have some impact on the other variables. If Productivity is part of the package purchased from Kolbe Corp., one could argue the benefit of using it instead of computing Modentropy for each team. With enough data points, a regression model including both measures could be used to determine which showed the greatest impact.

It was also found that, though conative profile can predict objective performance, it was a more valuable predictor of the length achieved than the resources used, questioning the extent to which it can predict efficiency as defined in the industry (the ratio of performance over resources used). In addition, these results suggest that the relationship between a team's conative entropy and its objective performance may only be significantly mediated by collective efficacy belief but not by teamwork processes. Future research could involve reconsidering the items which proved

problematic in assessing the reliability of the teamwork processes subscales. It would also be beneficial to evaluate whether the same variables can predict multicultural team resilience to time constraints. To address this issue, a new mixed-model design was suggested with time as the repeated measure and the only controlled independent variable. The next chapter presents the details of this proposal.

CHAPTER 3: MAIN STUDY

This chapter details the methodology for the main study investigating the relationship between a team's conative profile and its resilience to time constraints; it begins by defining the test participants, the experimental task, and the hypotheses and measures before describing the data collection process and tests used for the data analysis and concluding by interpreting the results from this analysis.

Introduction

Participants

The primary difficulty for this study was recruiting and retaining enough participants to achieve the projected sample size, a challenge also faced during the pilot study which required a semester to recruit 58 participants, 47 of whom took the Kolbe test and of these only 24 were available for a team session. To address this issue, this phase included a motivational compensation of \$20.00 for each session to be paid at the end of the second one and two chances per session to win additional Visa cards. This additional financial reward was also meant to encourage participants to perform well. Furthermore, professors across campus were contacted to disseminate information about the study. Initially, 150 people expressed interest in participating and followed up by providing their demographic information; however, only 119 took the Kolbe test, and because of their results, 10 had to be dropped from the study and one more chose to withdraw when contacted to schedule team meetings. Approaching professors outside of engineering contributed to a sample more representative of diverse educational backgrounds than the pilot study, with only 59% of the sample coming from various engineering fields for the main study as opposed to 96% in the pilot study.

An additional concern resulting from the longitudinal component of the study was scheduling. The requirement to meet twice was emphasized early while presenting the study opportunity to potential participants and reiterated when asking them to submit their availability. This strategy worked fairly well as only one team could not be scheduled for its second session.

In the end, this study involved 108 participants of both genders, primarily students from Clemson University, recruited through word of mouth, flyers posted around campus, emails sent to student organizations and invitations offered in individual classrooms and break rooms. Similar to the pilot study, these participants also represented a diversity of racial origins, ethnicities and educational backgrounds. Demographic information was again provided by email; however, for this study, the participants' availability was collected through a Google form, a sample of which can be found in Appendix H. Based on this information and their Kolbe profiles, participants were grouped into teams of four members. As with the pilot study, the demographic profile was not consistent across teams, but all teams were consistently diverse. Though 27 teams were created and met at least once, complete data are available for only 25 of them.

Task

The bridge-building activity used in the pilot study was again used here to assess the team's analytical and manual aptitudes, as well as its teamwork skills. In this study, the participants met twice and each time were again asked to build a bridge spanning as far as possible, using the least possible amount of resources and able to withstand a pound without collapsing. The time limit for each session was based on the time distribution found through the pilot study (Appendix G), with the average time to completion (25 minutes) selected as the time limit for the low constraint scenario and the tenth percentile of the time distributions (16 minutes)

set as the high constraint limit. A financial reward was awarded to the two teams with the highest objective score, the total of the bridge score and any bonus points, for each condition.

Hypotheses

Though the literature and the pilot study provide some support for using the Kolbe guidelines for team allocation in regards to team performance, there is limited research validating the resilience of such teams. For this purpose, this research proposes the model seen below in Figure 5 which considers the effects of the conative profile, the time constraints, subjective performance, teamwork processes, and prior knowledge of the task and of one another on the objective performance in the context of diverse teams:

Figure 5: Research model for the main study

Based on this model, the following hypotheses were proposed concerning the relationships among the variables:

Hypothesis 1: The interaction between time constraints and the productivity score predicts the objective performance of a multicultural team.

Hypothesis 2: Teamwork processes partially mediate the relationship between the time constraints and the objective performance.

Hypothesis 3: Collective efficacy belief mediates the relationship between a team's conative profile and its objective performance.

Hypothesis 4: Collective efficacy belief mediates the relationship between a team's prior knowledge (both of the task and of individual members) and its objective performance.

Hypothesis 5: The interaction between the time constraints and prior knowledge predicts the objective performance of a multicultural team.

Measures

The same measures as those in the pilot study were used here with the exception that only the entropy score was assessed to determine a team's conative profile. In addition, time, as a fixed predictor, was measured with a timer set to the appropriate limit.

Similarly to the pilot study, team members' prior knowledge of one another was assessed via two measures, Number4 and Teamfamiliarity, the same surveys as the pilot study were used to measure prior knowledge of the task and subjective performance, and again objective performance was evaluated in terms of length and resources (paper, time and tape) used.

Data Collection

Experimental procedure

Prior to the two experimental sessions, the participants provided their demographic profiles, signed the consent form (Appendix I) and took the Kolbe test. Based on their availability and while ensuring that all teams were equally diverse, participants were assigned to teams of four which remained constant throughout the study. The conative profile of each team was assessed with the help of a VBA macro (Appendix J) created to compute entropy as formulated in the pilot study (Eq. 4). The teams then met to perform the experimental task.

The order of the scenarios for each team was randomized based on time constraint. For each of the two sessions, the paper, tape, base boards, one-pound glove and pens needed to complete the task were laid out in advance. At the opening of the first session, participants who had not submitted their consent forms were asked to sign one on site, and five minutes were given to team members to become acquainted. At the beginning of each session, the participants were reminded of their right to quit the study at any time; subsequently, the task was explained to them and participants were reminded of the competitive objective for each session and of the possibility to win prizes: The team with the best efficiency score would win four Visa gift cards, each worth \$35.00, while the second place team would win four Visa gift cards worth \$25.00 each. The method for computing the efficiency score was also explained as being the ratio of the

bridge length and the quantity of resources used with a bonus point for optional planning information submitted by the team. Additionally, all questions related to the study were answered.

Once these explanations were completed and all questions were addressed, the researcher signaled the team to begin and started the timer. Most teams completed their bridges before the awarded time was exhausted, requesting that the timer be stopped; for the remaining teams, members were reminded to stop working on the bridge when the timer rang. All teams then completed the prior knowledge, teamwork processes and the subjective performance surveys. These were collected along with the teams' additional report when those were created, and participants were given permission to leave. However, all preferred to stay to witness the bridge score evaluation, which consisted of measuring the length, assessing whether it supported the pound without collapsing, and counting the resources used for its construction. At the end of the second session, each team member received participation compensation in the form of a \$20.00 Visa gift card, and signed the receipt form. Once all the data were collected, efficiency was compared across teams and the teams with the four best results (2 per sessions) were awarded the Visa gift cards.

Figure 6 summarizes the procedure used in the main study with the participants' actions labeled in orange and the researcher's in black capital letters.

Figure 6: Flow chart of the procedure used for the main study

Experimental design and analysis

Similar to the pilot study, this one was also quasi-experimental; however, it used a mixed design with the entropy score as the nest factor, with all other variables being measured for both sessions. Time constraint scenario was therefore the level1 variable. At the individual level, level 2, data measuring collective efficacy belief, prior knowledge of the task, number of team members' known to some extent in the team (Number4) and teamwork processes was collected. Finally, the data measuring the team's Modentropy, the overall level of familiarity within the team (Teamfamiliarity), the length of the team's bridge and the amount of resources used by the team was computed at the team level, level 3.

The reliability of the subjective measures, except for prior knowledge of the team members and efficacy belief, were assessed using Cronbach's alpha, similar to the pilot study. Aggregation was again justified using Intraclass Correlation Coefficients and index of agreement.

The model suggests the presence of moderated mediation; for example, the mediated relationship between time constraints and objective performance is hypothesized to be moderated by the conative profile and prior knowledge. To assess this hypothesis, a path model with moderation paths is proposed. The analysis of this sub-model primarily consisted of a combination of regressions addressing Hypotheses 1 and 5. The mediation paths of this sub-model, Hypothesis 2, as well as Hypotheses 3 and 4 in the main model were evaluated through simple regressions, multilevel regressions and Sobel testing, similar to the pilot study.

Results

This set of data was screened to ensure the appropriateness of the analysis procedure, again similar to the pilot study. Five outliers were identified with Mahalanobis distances above 70

and clearly segregated from the rest of the data (Figure 7), and eliminated (Fidell & Tabachnick, 2003). Normality was evaluated using skewness and kurtosis (see Appendix K). Both measures of team members' prior knowledge of one another (Number4 and Teamfamiliarity) were highly correlated with a Pearson correlation coefficient of 0.729.

Figure 7: Mahalanobis Distance graph for initial data main study

The Cronbach's Alpha coefficients were computed for the appropriate subjective scales and attested to their reliability (see Table 16). Despite these good coefficients, some items from the teamwork processes survey such as the first item of the Motivating and Confidence Building and of the Affect Management subscales, were eliminated from further analysis because of their

high kurtosis (see Appendix K), without significantly impacting the reliability of the related subscales. For instance, eliminating the first item of the Motivating and Confidence Building subscale only reduced the Cronbach's Alpha from 0.853 to 0.839.

Table 16: Cronbach's Alpha for all teamwork processes subscales and prior knowledge of task, main study

Scale	Initial Cronbach's Alpha
Mission Analysis	0.826
Goal Specification	0.835
Strategy Formulation	0.699
Monitoring	0.818
Resource monitoring	0.854
Team Monitoring	0.718
Coordination	0.902
Conflict Management	0.827
Motivating and Confidence Building	0.853
Affect Management	0.885
Prior Knowledge of Task	0.908

Next, the representative scores of the subscales were computed and tested for normality (see Appendix J), reliability and internal correlations. Their 0.921 Cronbach's Alpha indicated that they, in fact, reliably measured the single concept, teamwork processes. The ICC and reliability scores for the subjective scales reported in Table 17 validated grand mean centering all variables except prior knowledge of the task, for which the data hinted at disagreement within the teams.

Table 17: Intraclass correlations and agreement indices

Variable	ICC1	ICC2	r_{wg}
Collective Efficacy Belief	0.22	0.645	0.586
Number4	0.09	0.46	0.155
Prior Knowledge of Task*	N/A	N/A	N/A
Teamwork Processes	0.28	0.76	0.88

** The data collected for prior knowledge of the task showed actual disagreement within the teams and therefore ICC2 and r_{wg} could not be computed*

Simple regressions were run for each variable measuring team members' prior knowledge of one another to assess the relationship of the variables with objective performance as measured by the length of the bridge or the resources used. In all cases, the model significantly predicted both measures of objective performance.

Tables 18 through 21 detail the individual effects of each variable in the model. Specifically, as seen in tables 18 and 19, using the overall level of familiarity within the team (Teamfamiliarity) to measure team members' prior knowledge of one another, individuals' prior knowledge of task (p=0.05), the team's teamwork processes (p=0.01) and the interaction between individuals' prior knowledge of the task and time constraints (p=0.01) each predicted the resources used by the team when controlling for all other variables. On the other hand, Modentropy (p=0.01), collective efficacy belief (p=0.01), the team members' prior knowledge of one another (p=0.01), and the interaction between individuals' prior knowledge of the task and time constraints (p=0.01) predicted length.

Table 18: Regression coefficients for the model using team familiarity as team members' prior knowledge of one another and resources as the DV

Model	Unstandardized Coefficients		T	Sig.	Unique Effects
	B	Std. Error			Sr ²
(Constant)	1.038	2.972	.349	.727	
Scenario	.097	3.838	.025	.980	0.000
Modentropy	.992	.872	1.138	.257	0.005
Prior Knowledge of Task	.258	.123	2.096	.037	0.016
Teamwork Processes	-1.527	.336	-4.547	.000	0.077
Collective Efficacy Belief	.008	.013	.619	.537	0.001
Prior Knowledge of Task X Scenario	-.713	.173	-4.111	.000	0.063
Modentropy X Scenario	-.660	1.175	-.562	.575	0.001
Teamfamiliarity X Scenario	3.934	2.891	1.361	.175	0.007
Teamfamiliarity	.180	2.046	.088	.930	0.000

a. Dependent Variable: Resources

Table 19: Regression coefficients for the model using team familiarity as team members' prior knowledge of one another and length as the DV

Model	Unstandardized Coefficients		t	Sig.	Unique Effects
	B	Std. Error			Sr ²
(Constant)	-323.373	92.065		.001	
Scenario	-12.757	119.292	0.002	.915	0.000
Modentropy	-96.427	26.995	0.069	.000	0.049
Teamfamiliarity	260.181	63.406	0.127	.000	0.065
Prior Knowledge of Task	2.402	3.807	-.277	.529	0.002
Teamwork Processes	-4.393	10.578	0.038	.678	0.001
Collective Efficacy Belief	-.958	.393	-.250	.016	0.023
Prior Knowledge of Task X Scenario	-15.947	5.377	-.034	.003	0.034
Teamfamiliarity X Scenario	79.054	91.335	.083	.388	0.003
Modentropy X Scenario	-9.293	37.173	.005	.803	0.026

a. Dependent Variable: Length

When the number of people known to some extent (Number4) was used as the measure of team members' prior knowledge of one another, team member's prior knowledge of the task ($p=0.01$) and its interaction with time constraints ($p=0.01$) as well as teamwork processes ($p=0.01$) predicted the resources used when all other variables were held constant (Table 20). On the other hand, individuals' prior knowledge of the task ($p=0.01$), its interaction with time constraints ($p=0.01$), entropy ($p=0.05$) and the interaction of team members' prior knowledge of another with time constraints ($p=0.01$) predicted length when all other variables were held constant (Table 21).

Table 20: Regression coefficients for model using Number4 as team members' prior knowledge of one another and resources as the DV

Model	Unstandardized Coefficients		t	Sig.	Unique Effects
	B	Std. Error			Sr ²
(Constant)	1.598	2.388	.669	.504	
Prior Knowledge of Task	.304	.098	3.105	.002	0.036
Number4	-.125	.145	-.859	.392	0.003
Collective Efficacy Belief	.009	.012	.723	.471	0.002
Modentropy	1.123	.798	1.406	.161	0.007
Scenario	2.439	3.303	.738	.461	0.002
Teamwork Processes	-1.512	.337	-4.488	.000	0.075
Prior Knowledge of Task X Scenario	-.733	.160	-4.570	.000	0.077
Modentropy X Scenario	-.634	1.130	-.561	.575	0.001
Number4 X Scenario	.628	.362	1.732	.085	0.011

a. Dependent Variable: Resources

Table 21: Regression coefficients and unique effects in model using Number4 as team member's prior knowledge of one another and length as the DV

Model	Unstandardized Coefficients		t	Sig.	Unique Effects
	B	Std. Error			Sr ²
(Constant)	-107.918	77.915	-1.385	.168	
Prior Knowledge of Task	11.575	3.206	3.610	.000	0.056
Number4	5.797	4.735	1.224	.222	0.006
Collective Efficacy Belief	-.602	.405	-1.486	.139	0.01
Modentropy	-53.769	26.050	-2.064	.040	0.018
Scenario	-22.567	110.280	-.205	.838	0.000
Teamwork Processes	-5.151	11.202	-.460	.646	0.001
Prior Knowledge of Task X Scenario	-23.178	5.254	-4.412	.000	0.084
Modentropy X Scenario	-38.837	37.814	-1.027	.306	0.004
Number4 X Scenario	35.337	12.300	2.873	.005	0.036

a. Dependent Variable: Length

As these tables show, regardless of the measurement method for the team members' prior knowledge of one another, Modentropy did not predict the resources used but had a significant negative relationship with the length. This negative relationship was also always found between the interaction of time constraints with individuals' prior knowledge of the task and length of the bridge. Time constraints however never presented a significant relationship with either objective performance measure. On the other hand, individuals' prior knowledge of the task, the team's teamwork processes and the interaction between time constraints and individuals' prior knowledge of the task always predicted resources used. The slope of the relationship between individuals' prior knowledge of the task and the team's resources used was always positive, and teamwork processes and the interaction between prior knowledge of the task and time constraints always showed a significant negative relationship with resources used. For instance, when moving from the high time constraint scenario (= 0) to the low time constraint condition (scenario =1), when team members' prior knowledge of one another was measured via the number of people known to some extent in the team (Number4), the

slope between individuals' prior knowledge of the task and length of the team's bridge decreased by 23.18 (Table 21, Figure 8). When team members' prior knowledge of one another was measured through the number of people known to some extent in the team, it was observed that the relationship individuals' between prior knowledge of the task and length of their team's bridge decreased by 23.18 when the teams had more time to complete the task and that, given more time, teams with higher prior knowledge of the task built shorter bridges.

Figure 8: Slopes of the relationship between prior knowledge of the task and length for high and low time constraints

On the other hand, team members' prior knowledge of one another only significantly moderated the effect of time constraints on resources used when measured using the number of people known to some extent in the team (Number4). The overall level of familiarity within a team (Teamfamiliarity) and the collective efficacy belief of a team were also found significantly related to the length of the bridge.

Mixed model analysis with random intercepts and slopes indicated that only team members' prior knowledge of one another predicted collective efficacy belief (see Table 22) and that time constraints were not significantly correlated to teamwork processes. Neither prior knowledge of the task nor the team's entropy predicted its collective efficacy belief; this measure was only predicted by the team members' prior knowledge

of one another. There were also no significant differences in a team's report of teamwork processes regardless of the time given for the task.

Table 22: Summary of the relationships between Modentropy and prior knowledge with collective efficacy belief

Team members' prior knowledge of each other represented by :	Predictors:	Estimate	Sig.
Number4	Modentropy	-10.476	0.439
	Prior Knowledge of Task	0.021	0.892
	Number4	8.76	0.000
Teamfamiliarity	Modentropy	-13.799	0.3
	Prior Knowledge of Task	-1.052	0.082
	Teamfamiliarity	73.178	0.000

The Sobel test analysis used to assess the mediating effects of teamwork processes and collective efficacy belief proposed in the model invalidated almost all of them. Collective efficacy belief partially mediated only the relationship between the overall level of familiarity within the team (Teamfamiliarity) and the length of the bridge; all other mediation effects proposed in the model were found insignificant. The mediation results are reported in Table 23.

Table 23: Sobel test results, main study

Team members' prior knowledge of each other	Mediator	Relationship	Mediating effect (Standard error)	Z	P
Number4	Collective Efficacy Belief	Modentropy → Length	6.306 (9.06)	0.696	0.49
		Modentropy → Resources	-0.094 (0.17)	-0.543	0.59
Teamfamiliarity	Collective Efficacy Belief	Modentropy → Length	13.219 (13.58)	0.973	0.33
		Modentropy → Resources	-0.11 (0.21)	-0.532	0.59
Number4	Collective Efficacy Belief	Number4 → Length	-5.273 (3.61)	-1.461	0.14
		Number4 → Resources	0.079 (0.11)	0.747	0.46
Teamfamiliarity	Collective Efficacy Belief	Teamfamiliarity → Length	-70.104 (29.31)	-2.392	0.02
		Teamfamiliarity → Resources	0.585 (0.95)	0.615	0.54
Number4	Collective Efficacy Belief	Prior Knowledge of Task → Length	-0.013 (0.09)	-0.135	0.89
		Prior Knowledge of Task → Resources	0.0002 (0.001)	0.133	0.89
Teamfamiliarity	Collective Efficacy Belief	Prior Knowledge of Task → Length	1.008 (0.7)	1.444	0.15
		Prior Knowledge of Task → Resources	-0.008 (0.01)	-0.582	0.56
Number4	Teamwork processes	Time constraints → Length	0.268 (0.71)	0.378	0.71
		Time constraints → Resources	0.079 (0.12)	0.659	0.51
Teamfamiliarity	Teamwork processes	Time constraints → Length	0.228 (0.65)	0.352	0.72
		Time constraints → Resources	0.079 (0.12)	0.66	0.51

Conclusion

With more data points than the pilot study, the results from this main study can be used to draw some conclusions regarding the resilience of synergistic multicultural teams. This study supported some of the results from the pilot study, specifically that entropy is a better predictor of length than it is of resources used and, therefore, is not an accurate predictor of efficiency. In addition, collective efficacy belief was found again not to mediate the relationship between Modentropy and objective performance. On the other hand, while in the pilot study, collective efficacy belief was found to partially mediate the relationships between the overall level of familiarity within the team and both measures of objective performance, in the main study collective efficacy belief was found to only explain part of the relationship between the overall level of familiarity within the team and the length of the team's bridge.

Additional questions answered included the first hypothesis, the moderating impact of a team's conative profile on the relationship between the time constraints and its performance, which was not supported by the data. Therefore, this study does not provide a basis to use entropy to build multicultural teams resilient to time constraints. In fact, there did not seem to be a clear relationship between time constraints and objective performance when all other variables were held constant, perhaps because teams most often chose to impose stricter time constraints on themselves, strategically placing their emphasis on resources used to quantify performance. An alternate analysis that might provide some answers would consist in running the model including the other objective performance variable (in this case, resources) to assess the predictors' relationship with one aspect of objective performance (for instance, length) while the other one (resources) is held constant.

Contrary to the expectation expressed through the second hypothesis, there was no indirect effect of time constraints found either on objective performance that would be due to teamwork processes. Similarly, the third hypothesis was not supported by the data as collective efficacy belief was not found to explain the relationships between the team's conative profile and objective performance. Furthermore, the fourth hypothesis was only partly validated; only team member's prior knowledge of one another predicted collective efficacy belief, and the latter only predicted the length of the bridge when the overall level of familiarity within the team (Teamfamiliarity) was used to assess team member's prior knowledge of one another. In other words, the relationship between the overall level of familiarity within a team and the length of its bridge can, in part, be explained by the team's collective efficacy belief. There were both a strong positive direct effect and a negative indirect effect between Teamfamiliarity and length. It seemed that the more familiar team members were with each other, the more confident they were and, while teams with high levels of familiarity also constructed longer bridges, generally, teams with higher efficacy belief tended to build shorter bridges.

Hypothesis 5 was only partly validated with team member's prior knowledge of one another only moderating the relationship between time constraints and length when measured through the number of people known to some extent on the team (Number4). Prior knowledge of the task, however, was consistently found to impact the relationship between time constraints and objective performance. Under less rigid time constraints, higher individuals' prior knowledge of the task led to fewer resources used and shorter bridges. Future research might investigate more thoroughly the particular strategies used by teams, establishing whether these results were intentional; uncovering this information would allow positing on the relationships in the model if the length objective was fixed.

Overall, this research found that a team's conative profile has only limited value in terms of predicting efficiency even though, as in previous studies, it seems to be able to significantly predict performance. There was a strong negative relationship between entropy and the length of the bridge. However, the interaction between entropy and time constraints had no significant impact on objective performance. On the other hand, the interaction between the individuals' prior knowledge of the task and time constraints imposed on the team appears to be a more valuable predictor as it was significantly correlated to both resources used and length.

- Though the overall model yielded a good R^2 , because of the multiple non-significant relationships, there might be some benefit to trimming the model, removing those paths. This should lead to increased effects in the remaining paths.
- Future research could also clarify our results by comparing mono-cultural teams to the diverse teams; this comparison would allow the assessment of whether diversity is inhibiting the guidelines in predicting resilience to time constraints. If so, it would be interesting to look at teams of differing cultural makeups to establish the optimal one.
- Additionally, a different task might appeal to a wider variety of participants, allowing the diversification of the sample and increasing the generalizability of the results. For instance, some purely decision making task could appeal to non-engineers and still lend itself to the observation of resilience within the teams, the researcher would then investigate whether differing time constraints impact the quality of the teams' decisions.

APPENDICES

APPENDIX A: MULTI-PURPOSE EMAIL

Hello,

My name is Melissa Dorlette Paul and I am a graduate student at Clemson University. I am looking for volunteers to participate in a pilot study for my dissertation. I need internationals as well as Americans to participate in this study, the purpose of which is to investigate the efficiency of multicultural teams built using some specific guidelines. The study will require you to meet with your team only once in Freeman Hall, and to take a really interesting and potentially useful test prior to those meetings. The pre-test will be done at your leisure before we meet and will allow the determination of some of your individual strengths and talents. I need to build diverse teams of young adults and really hope you will consider participating.

Your participation in this study is voluntary and confidential. Your identity will be protected. If you are interested in participating, please reply to this email with the following information:

Name:

Race or ethnicity:

Country of origin:

Gender:

Age:

Domain of expertise:

Phone Number:

Email Address:

I am also attaching a consent form that you can sign and either scan and email back to me, or keep until we meet for your team session. Once I have your reply, I will send you an email from the Kolbe system (Kolbe Corp will appear as the sender) with a link to take the pre-test (Kolbe Index A).

APPENDIX B: TEAM CULTURAL COMPOSITION

Team	Team Members' Partial Code	Cultural Profile	Blau's Index
1	LATF-ESES LATM-ESCO ASIF-ESIN CAUF-ESUS	Latino from El Savador, Female, Engineering and Science Latino from Columbia, Male, Engineering and Science Asian from India, Female, Engineering and Science Caucasian from U.S., Female, Engineering and Science	1
2	CAUM-ESUS CAAF-ESUS ASIM-ESIN ASIF-ESTH	Caucasian from U.S., Male, Engineering and Science Black-Caribbean from US, Female, Engineering and Science Asian from India, Male, Engineering and Science Asian from Thailand, Female, Engineering and Science	1
3	ASIM-ESIN ASIM-ESUS ARAM-ESLI ASIF-ESIN	Asian from India, Male, Engineering and Science Asian from U.S., Male, Engineering and Science Arab from Lybia, Male, Engineering and Science Asian from India, Female, Engineering and Science	1
4	CAUF-SEHU ASIM-ESTH CAUM-ESUS CAUF-ESUS	Caucasian from Hungary, Female, Engineering and Science Asian from Thailand, Male, Engineering and Science Caucasian from U.S., Male, Engineering and Science Caucasian from U.S., Female, Engineering and Science	1
5	AFAM-ESUS	African American from U.S., Male, Engineering and	1

Team	Team Members' Partial Code	Cultural Profile	Blau's Index
	CAAF-BBSUS	Science Black-Caribbean from U.S., Female, Business and Behavioral Science	
	AFAF-ESUS	African American from U.S., Female, Engineering and Science	
	ASIF-ESIN	Asian from India, Female, Engineering and Science	
6	ASIF-ESIN ASIM-ESTH ASIM-ESIN CAUF-ESUS	Asian from India, Female, Engineering and Science Asian from Thailand, Male, Engineering and Science Asian from India, Male, Engineering and Science Caucasian from U.S., Female, Engineering and Science	1

APPENDIX C: TEAMWORK PROCESSES SURVEY

INSTRUCTIONS: Below are a number of statements regarding your team. <i>Please indicate to what extent your team worked toward the following statements</i>	
To what extent did your team actively work to:	1 = Not at all to 7 = To a Very Great Extent
Mission analysis	
Identify our main tasks?	(1) (2) (3) (4) (5) (6) (7)
Identify the key challenges that we expect to face?	(1) (2) (3) (4) (5) (6) (7)
Determine the resources that we need to be successful?	(1) (2) (3) (4) (5) (6) (7)
Goal Specifications	
Set goals for the team?	(1) (2) (3) (4) (5) (6) (7)
Ensure that everyone on our team clearly understands our goals?	(1) (2) (3) (4) (5) (6) (7)
Strategy Formulation & Planning	
Develop an overall strategy to guide our team activities?	(1) (2) (3) (4) (5) (6) (7)
Prepare contingency ("if-then") plans to deal with uncertain situations?	(1) (2) (3) (4) (5) (6) (7)
Know when to stick with a given working plan, and when to adopt a different one?	(1) (2) (3) (4) (5) (6) (7)
Monitoring Process Toward Goals	
Regularly monitor how well we are meeting our team goals?	(1) (2) (3) (4) (5) (6) (7)
Use clearly defined metrics to assess our progress?	(1) (2) (3) (4) (5) (6) (7)
Seek timely feedback about how well we are meeting our goals?	(1) (2) (3) (4) (5) (6) (7)
Resource and System Monitoring	
Monitor and manage our resources?	(1) (2) (3) (4) (5) (6) (7)
Monitor important aspects of our work environment (equipment and process operations, information flows)?	(1) (2) (3) (4) (5) (6) (7)
Team Monitoring and Back-up	
Develop standards for acceptable team member performance?	(1) (2) (3) (4) (5) (6) (7)
Balance the workload among our team members?	(1) (2) (3) (4) (5) (6) (7)

INSTRUCTIONS: Below are a number of statements regarding your team. <i>Please indicate to what extent your team worked toward the following statements</i>	
To what extent did your team actively work to:	1 = Not at all to 7 = To a Very Great Extent
Assist each other when help is needed?	① ② ③ ④ ⑤ ⑥ ⑦
Coordination	
Communicate well with each other?	① ② ③ ④ ⑤ ⑥ ⑦
Smoothly integrate our work efforts?	① ② ③ ④ ⑤ ⑥ ⑦
Coordinate our activities with one another?	① ② ③ ④ ⑤ ⑥ ⑦
Conflict Management	
Deal with personal conflicts in fair and equitable ways?	① ② ③ ④ ⑤ ⑥ ⑦
Show respect for one another?	① ② ③ ④ ⑤ ⑥ ⑦
Maintain group harmony?	① ② ③ ④ ⑤ ⑥ ⑦
Motivating and Confidence Building	
Take pride in our accomplishments?	① ② ③ ④ ⑤ ⑥ ⑦
Develop confidence in our team's ability to perform well?	① ② ③ ④ ⑤ ⑥ ⑦
Encourage each other to perform our very best?	① ② ③ ④ ⑤ ⑥ ⑦
Affect Management	
Share a sense of togetherness and cohesion?	① ② ③ ④ ⑤ ⑥ ⑦
Manage stress?	① ② ③ ④ ⑤ ⑥ ⑦
Keep a good emotional balance in the team?	① ② ③ ④ ⑤ ⑥ ⑦

APPENDIX D: COLLECTIVE EFFICACY BELIEF SURVEY

Instruction: Please rate from 0 (definitely none) to 100 (definitely win)

What, do you think, are your team's chances of winning this competition?

APPENDIX E: PRIOR KNOWLEDGE SURVEYS

INSTRUCTIONS: Below are a number of statements regarding your familiarity with your teammates and with the task. <i>Please indicate to what extent you were exposed to these people or had to perform this task prior to this meeting</i>	
To what extent did you know:	1 = Not at all to 7 = To a Very Great Extent with 4 = I have met this person before but we rarely interact
Joe?	(1) (2) (3) (4) (5) (6) (7)
Jane?	(1) (2) (3) (4) (5) (6) (7)
X?	(1) (2) (3) (4) (5) (6) (7)
Y?	(1) (2) (3) (4) (5) (6) (7)
To what extent is it true that:	1 = Not at all to 7 = To a Very Great Extent
You have performed this task before?	(1) (2) (3) (4) (5) (6) (7)
You have performed a similar task before?	(1) (2) (3) (4) (5) (6) (7)

APPENDIX F: CONSENT FORM

Consent Form for Participation in a Research Study Clemson University

Investigating the efficiency of synergistic multicultural teams (pilot study)

Description of the research and your participation

You are invited to participate in a research study conducted by Melissa Dorlette Paul, Stephanie Cantu with Kolbe Corp., and Dr. Anand K Gramopadhye. The purpose of this study is to investigate the efficiency of multicultural teams with different levels of viability (weighted average of synergy and inertia).

Different multicultural teams will be formed with different levels of viability. These teams will compete against each other by trying to perform the experimental task as efficiently as possible. The experimental task consists in building a bridge that spans as far as possible using sheets of paper and scotch tape. The bridge should be able to withstand an applied weight of a pound without collapsing. The team's bridge score will reflect the length achieved while meeting the weight requirement, as well as the amount of resources used including time. Teams who submit a completed design and/or task assignment on paper by the end of the session will be awarded bonus points.

You will first be asked to take an online questionnaire called the Kolbe Index A, in which you will select how you are most and least likely to act in various scenarios. This will allow the determination of some of your strengths and talents, your Kolbe profile. This questionnaire typically takes about 20 minutes but is very insightful and might help you in your decision-making processes in regards to your career. At the session, you will meet your teammates and have a few minutes to break the ice. After which your team will be given the material to complete the task. The researcher will then address your questions, while waiting for you to fill out the prior knowledge surveys. Once those surveys collected, the researcher will signal the team to start working and start the timer. Once the team is done, it will signal the researcher to stop the timer and evaluation will start. All reports, if any, will be collected along with the responses to the collective efficacy and the teamwork processes survey. A session is likely to last anywhere between twenty minutes and one hour, but the team itself will decide its length. Once all the teams have completed their session, objective performance will be compared across teams and members of the team with the best results will be awarded a 25\$ Amazon giftcard.

Please understand that we are not testing your personal capabilities. We are testing the efficiency of teams built using specific guidelines.

Risks and discomforts

There are minimal potential risks associated with participation in this study. Every effort has been made to reduce team conflict while retaining the realistic aspect of this "work" scenario. Please feel free to withdraw participation should you feel this research effort will harm you in any way.

Potential benefits

There are certain benefits to you that would result from your participation in this research. The preliminary survey may help you identify your striving strategies and you might find the experience of working in your assigned team beneficial. However, the extent to which lessons

This form is valid only if the
Clemson University IRB
Stamp of approval is shown here:

CLEMSON UNIVERSITY IRB CONSENT FORM
APPROVED <u>6/3/2014</u>
EXPIRES <u>9/15/2014</u>

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learned through these experiences will help you in the workplace is not guaranteed. This research is a preliminary step in an effort to understand how to develop more resilient teams.

Protection of confidentiality

We will do everything we can do to protect your privacy. The data captured from the preliminary survey will be stored on a secure server at the Kolbe Corp. You are not obligated to give your actual name while taking this survey. An ID number will be provided to you and only the researcher will have access to your personal identifiers that will be stored in a password-protected computer in the Industrial Engineering Department. The survey questionnaires will be kept in a locked cabinet in the researcher's office. The documents will be accessible only to the principal investigator and co-investigators. Your identity will not be revealed in any publication that might result from this study.

In rare cases, a research study will be evaluated by an oversight agency, such as the Clemson University Institutional Review Board or the federal Office for Human Research Protections that would require that we share the information we collect from you. If this happens, the information would only be used to determine if we conducted this study properly and adequately protected your rights as a participant.

Voluntary participation

Your participation in this research study is voluntary. You may choose not to participate and you may withdraw your consent to participate at any time. You will not be penalized in any way should you decide not to participate or to withdraw from this study. If you choose to stop taking part in this study, the information you have already provided will be used in a confidential manner.

Contact information

If you have any questions or concerns about this study or if any problems arise, please contact Dr. Anand Gramopadhye at Clemson University at 864-656-4717.

If you have any questions or concerns about your rights as a research participant, please contact the Clemson University Institutional Review Board at irb@clemson.edu or 864-656-6460.

Consent

I have read this consent form and have been given the opportunity to ask questions. I give my consent to participate in this study.

Participant's signature: _____ Date: _____

A copy of this consent form will be given to you.

This form is valid only if the
Clemson University IRB
Stamp of approval is shown here:

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APPENDIX G: DESCRIPTIVES PILOT DATA

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Stats	Statistic	Statistic	Stats	Statistic	Stats	Std. Error	Stats	Std. Error
LENGTH	24	28.00	195.00	115.4	68.74807	.012	.472	-1.86	.918
Time	24	15.918	40.883	24.62	8.508216	1.06	.472	-.093	.918
Papel	24	3	40	11.83	13.389	1.62	.472	1.09	.918
Tape	24	0	31	6.33	11.339	1.86	.472	1.68	.918
Productivity	24	.20	.38	.2700	.06878	.465	.472	-1.32	.918
Modentropy	24	-3.073	-2.664	-2.85	.140059	-.166	.472	-1.01	.918
Resources	24	-2.09	6.19	.0000	2.89988	1.71	.472	1.36	.918
CollectiveEB	24	.000	100.000	65	36.28084	-.94	.47	-.71	.92
Teamwork Processes									
Mission1	20	5	7	6.2	.834	-.41	.51	-1.4	.99
Mission2	20	4	7	6.1	.945	-.52	.51	-.79	.99
Mission3	20	3	7	5.9	1.210	-.98	.51	.19	.99
Goal1	20	1	7	5.6	1.501	-1.7	.51	3.8	.99
Goal2	20	1	7	5.4	1.667	-1.0	.51	.86	.99
Strategy1	20	1	7	5.3	1.780	-1.0	.51	.44	.99
Strategy2	20	1	7	5.0	1.974	-.73	.51	-.67	.99
Strategy3	20	3	7	5.8	1.251	-.55	.51	-.67	.99
Monitoring1	20	3	7	5.5	1.433	-.42	.51	-1.2	.99
Monitoring2	20	1	7	4.9	1.651	-.76	.51	.21	.99
Monitoring3	20	3	7	5.5	1.318	-.15	.51	-1.3	.99
RaSM1	20	2	7	5.6	1.572	-.87	.51	-.17	.99
RaSM2	20	3	7	5.3	1.302	-.31	.51	-.97	.99
Teamoni1	20	1	7	3.6	1.905	.32	.51	-1.1	.99

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Stats	Statistic	Statistic	Stats	Statistic	Stats	Std. Error	Stats	Std. Error
Teamoni2	20	2	7	5.3	1.593	-.9	.51	-.01	.99
Teamoni3	20	3	7	6.4	1.137	-1.7	.51	2.6	.99
Coordination 1	20	5	7	6.4	.875	-.8	.51	-1.2	.99
Coordination 2	20	4	7	6.0	1.026	-.65	.51	-.67	.99
Coordination 3	20	4	7	6.1	.968	-.60	.51	-.85	.99
Conflict1	20	5	7	6.6	.826	-1.4	.51	.16	.99
Conflict2	20	5	7	6.7	.745	-1.8	.51	1.8	.99
Conflict3	20	5	7	6.7	.657	-2.1	.51	3.2	.99
Motivating1	20	6	7	6.6	.503	-.44	.51	-2.0	.99
Motivating2	20	5	7	6.6	.759	-1.4	.51	.41	.99
Motivating3	20	2	7	5.9	1.348	-1.3	.51	1.9	.99
Affect1	20	4	7	6.4	.883	-1.5	.51	1.5	.99
Affect2	20	5	7	6.5	.759	-1.0	.51	-.37	.99
Affect3	20	5	7	6.6	.598	-1.2	.51	.78	.99
Prior Knowledge of other Team Members									
Member1	20	1	7	4.4	2.644	-.37	.51	-1.8	.99
Member2	20	1	7	4.4	2.540	-.33	.51	-1.6	.99
Member3	20	1	7	4.5	2.645	-.39	.51	-1.7	.99
Member4	20	1	7	3.9	2.681	.14	.51	-1.9	.99
Prior Knowledge of the Task									
Knoweldge1	20	1	7	2.2	2.183	1.6	.51	.97	.99
Knowledge2	20	1	6	2.4	1.759	.86	.51	-.85	.99

APPENDIX H: SAMPLE AVAILABILITY SURVEY

Availability for team meeting

Please only fill this if you know you will be able to come to two team sessions scheduled approximately one week apart. If you wish to withdraw, send me a note (melissp@g.clemson.edu).

Please enter your full name*

General availability*

Please indicate all the times you would typically be available for the team meetings. Note that I will confirm with you specific dates and times for such meetings.

- ☐ Mondays 5-6 PM
- ☐ Tuesdays 1-2 PM
- ☐ Wednesdays 4-5 PM
- ☐ Thursdays 6-7 PM
- ☐ None of these options work for me

Please indicate all the weeks that you can be scheduled in:*

This study will stop running after June. Two team sessions, typically scheduled one week apart, are required to complete the study.

- ☐ Weeks of May 25 - June 6
- ☐ Weeks of June 1- June 13

If email is taking too long to communicate please indicate which additional option you prefer:*

Please note that I only use these when time is running out to confirm your presence at a team meeting or if I believe you may need help finding the meeting location.

- ☐ phone call
- ☐ text message
- ☐ both are fine

APPENDIX I: CONSENT FORM MAIN STUDY

Consent Form for Participation in a Research Study Clemson University

Investigating the efficiency of synergistic multicultural teams

Description of the research and your participation

You are invited to participate in a research study conducted by Melissa Dorlette Paul, Kathy Kolbe with Kolbe Corp., and Dr. Anand K Gramopadhye. The purpose of this study is to investigate the efficiency of multicultural teams with different levels of viability (weighted average of synergy and inertia).

Different multicultural teams will be formed with different levels of viability. These teams will compete against each other in two sessions by trying to perform the experimental task as efficiently as possible. The experimental task consists in building a bridge that spans as far as possible using sheets of paper and scotch tape. The bridge should be able to withstand an applied weight of a pound without collapsing. The team's bridge score will reflect the length achieved while meeting the weight requirement, as well as the amount of resources used including time. In one of the sessions, the teams will be allowed a maximum of 25 minutes to complete the task, and in the other a maximum of 16 minutes. Teams who submit a completed design and/or task assignment on paper by the end of a session will be awarded bonus points.

You will first be asked to take an online questionnaire called the Kolbe Index A, in which you will select how you are most and least likely to act in various scenarios. This will allow the determination of some of your strengths and talents, your Kolbe profile. This questionnaire typically takes about 20 minutes but is very insightful and might help you in your decision-making processes in regards to your career. At the first session, you will meet your teammates and have a few minutes to break the ice. After which, both sessions will follow the same format with your team being given the material to complete the task. The researcher will then address your questions, while waiting for you to fill out the prior knowledge surveys. Once those surveys collected, the researcher will signal the team to start working and start the timer. Once the team is done, it will signal the researcher to stop the timer unless the timer runs out first, in which case the researcher will instruct the team to stop working on the task. All reports, if any, will be collected along with the responses to the collective efficacy and the teamwork processes survey. Depending on the scenario, a session is likely to last between forty-five minutes and one hour, but the team itself will decide its length. Once all the teams have completed a session, objective performance will be compared across teams and members of the team with the best results will be awarded a \$35 Visa gift card; members of the second place team for the session will each be given a \$25 Visa gift card. In addition, at the end of the second team session, all participants will be given a \$20 Visa gift card for participating in the study.

Please understand that we are not testing your personal capabilities. We are testing the efficiency of teams built using specific guidelines.

Risks and discomforts

There are minimal potential risks associated with participation in this study. Every effort has been made to reduce team conflict while retaining the realistic aspect of this "work" scenario. Please feel free to withdraw participation should you feel this research effort will harm you in any way.

This form is valid only if the
Clemson University IRB
Stamp of approval is shown here:

Page 1 of 2

Potential benefits

There are certain benefits to you that would result from your participation in this research. The preliminary survey may help you identify your striving strategies and you might find the experience of working in your assigned team beneficial. However, the extent to which lessons learned through these experiences will help you in the workplace is not guaranteed. This research is an effort to understand how to develop more resilient teams.

Protection of confidentiality

We will do everything we can do to protect your privacy. The data captured from the preliminary survey will be stored on a secure server at the Kolbe Corp. You are not obligated to give your actual name while taking this survey. An ID number will be provided to you and only the researcher will have access to your personal identifiers that will be stored in a password-protected computer in the Industrial Engineering Department. The survey questionnaires will be kept in a locked cabinet in the researcher's office. The documents will be accessible only to the principal investigator and co-investigators. Your identity will not be revealed in any publication that might result from this study.

In rare cases, a research study will be evaluated by an oversight agency, such as the Clemson University Institutional Review Board or the federal Office for Human Research Protections that would require that we share the information we collect from you. If this happens, the information would only be used to determine if we conducted this study properly and adequately protected your rights as a participant.

Voluntary participation

Your participation in this research study is voluntary. You may choose not to participate and you may withdraw your consent to participate at any time. You will not be penalized in any way should you decide not to participate or to withdraw from this study. If you choose to stop taking part in this study, the information you have already provided will be used in a confidential manner.

Contact information

If you have any questions or concerns about this study or if any problems arise, please contact Dr. Anand Gramopadhye at Clemson University at 864-656-3200.

If you have any questions or concerns about your rights as a research participant, please contact the Clemson University Institutional Review Board at irb@clemson.edu or 864-656-6460.

Consent

I have read this consent form and have been given the opportunity to ask questions. I give my consent to participate in this study.

Participant's signature: _____ Date: _____

A copy of this consent form will be given to you.

This form is valid only if the
Clemson University IRB
Stamp of approval is shown here:

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APPENDIX J: VBA MACRO FOR ENTROPY COMPUTATION

```
Sub main()

Dim name, deci As String

Dim i, j, count, avance As Integer

Dim temp, s As Double

Dim cell As Range

name = "team"

count = 1

s = 0

avance = 15

ActiveWorkbook.Worksheets(name).Activate

'ce test est pour une equipe de 4

j = 4

ActiveSheet.Range("b1:b" & j).name = "codes"

'pour tous m

For j = 1 To 4

    'pour tous z
```

```
For i = 1 To 3
```

```
    For Each cell In Range("codes")
```

```
        'choisis le caractere approprie
```

```
        Select Case j
```

```
            Case 1
```

```
                deci = Left(cell.Value, 1)
```

```
            Case 2
```

```
                deci = Mid(cell.Value, 2, 1)
```

```
            Case 3
```

```
                deci = Mid(cell.Value, 3, 1)
```

```
            Case 4
```

```
                deci = Right(cell.Value, 1)
```

```
        End Select
```

```
    If deci = i Then
```

```
        count = count + 1
```

```
    End If
```

Next cell

'ce test est pour une equipe de 4

ActiveSheet.Range("d" & avance) = count / 4

temp = ActiveSheet.Range("d" & avance)

' calcul ln(p)

ActiveSheet.Range("f" & avance).Formula = "=LN(" & temp & ")"

'calcul s

s = s + (temp * ActiveSheet.Range("f" & avance))

count = 1

avance = avance + 1

Next i

Next j

'affiche s

ActiveSheet.Range("h" & 27) = s

End Sub

APPENDIX K: DESCRIPTIVES MAIN DATA

Descriptive Statistics: Main Study

	N	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Modentropy	200	-3.42	-2.494	-2.87569	.254760	.065	-.408	.172	-.810	.342
Tape	196	.0	53.0	9.204	10.8774	118.317	1.994	.174	4.283	.346
Time	196	.13	25.00	15.7396	7.30294	53.333	-.464	.174	-.645	.346
Papel	196	1.0	26.0	8.633	6.0551	36.664	.982	.174	.617	.346
Length	192	28.0	324.0	107.229	71.0245	5044.481	1.023	.175	.603	.349
CollectiveEB	188	.00	100.00	72.2077	25.13951	631.995	-1.039	.177	.499	.353
Teamwork Processes										
MissionA1	191	2.0	7.0	6.000	1.1145	1.242	-1.060	.176	.656	.350
MissionA2	191	1.0	7.0	5.675	1.3056	1.705	-.899	.176	.289	.350
MissionA3	191	2.0	7.0	5.801	1.1618	1.350	-.663	.176	-.259	.350
GoalS1	191	1.0	7.0	5.565	1.3668	1.868	-.776	.176	-.161	.350
Goals2	191	2.0	7.0	5.702	1.3219	1.747	-.900	.176	.012	.350
StrategyFP1	191	1.0	7.0	5.812	1.2123	1.470	-1.352	.176	2.518	.350
StrategyFP2	191	1.0	7.0	4.686	1.6751	2.806	-.430	.176	-.748	.350
StrategyFP3	191	1.0	7.0	5.319	1.4096	1.987	-.754	.176	.137	.350

Descriptive Statistics: Main Study

	N	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
MonitoringPT G1	191	1.0	7.0	5.665	1.3427	1.803	-1.201	.176	1.341	.350
MonitoringPT G2	191	1.0	7.0	5.047	1.6036	2.571	-.790	.176	-.033	.350
MonitoringPT G3	191	1.0	7.0	5.445	1.4531	2.111	-1.018	.176	.627	.350
Resource SM1	191	1.0	7.0	5.594	1.4268	2.036	-1.042	.176	.555	.350
Resource SM2	191	2.0	7.0	5.552	1.1920	1.421	-.684	.176	.269	.350
TeamMB1	191	1.0	7.0	4.555	1.7155	2.943	-.335	.176	-.770	.350
TeamMB2	191	2.0	7.0	5.382	1.3938	1.943	-.756	.176	-.097	.350
TeamMB3	191	2.0	7.0	6.094	1.0165	1.033	-1.133	.176	1.083	.350
Coordination 1	191	2.0	7.0	6.052	1.0026	1.005	-1.194	.176	1.589	.350
Coordination 2	191	2.0	7.0	5.880	1.1338	1.285	-1.009	.176	.767	.350
Coordination 3	191	2.0	7.0	5.898	1.0791	1.165	-1.012	.176	.860	.350
ConflictM1	190	1.0	7.0	5.808	1.2263	1.504	-1.163	.176	1.343	.351
ConflictM2	191	2.0	7.0	6.427	.9416	.887	-2.328	.176	6.488	.350
ConflictM3	191	3.0	7.0	6.408	.8588	.738	-1.853	.176	4.050	.350
MotivatingCB 1	191	1.0	7.0	6.026	1.1807	1.394	-1.641	.176	3.406	.350

Descriptive Statistics: Main Study

	N	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
MotivatingCB2	191	2.0	7.0	5.927	1.1584	1.342	-1.129	.176	.882	.350
MotivatingCB3	191	1.0	7.0	5.615	1.4067	1.979	-1.186	.176	1.300	.350
AffectM1	191	1.0	7.0	5.953	1.0577	1.119	-1.469	.176	3.429	.35
AffectM2	191	1.0	7.0	5.623	1.2873	1.657	-1.226	.176	1.819	.35
AffectM3	191	2.0	7.0	6.042	1.1042	1.219	-1.387	.176	2.083	.35
Prior Knowledge Team Members										
PriorKM1	196	1.0	7.0	3.796	2.4092	5.804	.136	.174	-1.550	.346
PriorKM2	196	1.0	7.0	3.980	2.4723	6.112	-.026	.174	-1.639	.346
PriorKM3	196	1.0	7.0	4.005	2.4484	5.995	-.025	.174	-1.591	.346
PriorKM4	196	1.0	7.0	3.832	2.4739	6.120	.086	.174	-1.616	.346
Number4	200	.0	4.0	2.220	1.3641	1.861	.231	.172	-1.517	.342
Teamfamiliarity	196	.30357 143	.80357 14286	.5575801 7492711	.1509829 6911012	.023	-.046	.174	-1.385	.346
Prior Knowledge of Task										
Prior Knowledge of Task1	196	1.0	7.0	3.923	2.6793	7.179	-.003	.174	-1.819	.346
Prior Knowledge of Task2	196	1.0	7.0	4.260	2.4006	5.763	-.178	.174	-1.570	.346

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