NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

TEAMHARMONY: EMPLOYING MATCHMAKING ALGORITHMS TO TEAM-BUILDING

by

Ian B. MacGregor
Jared D. Tomberlin

December 2017

Thesis Advisor: Anna Simons
Second Reader: Robert Burks

Approved for public release. Distribution is unlimited.

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE		*Form Approved OMB No. 0704–0188*

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.

1. AGENCY USE ONLY (*Leave blank*)	2. REPORT DATE December 2017	3. REPORT TYPE AND DATES COVERED Master's thesis
4. TITLE AND SUBTITLE TEAMHARMONY: EMPLOYING MATCHMAKING ALGORITHMS TO TEAM-BUILDING		**5. FUNDING NUMBERS**
6. AUTHOR(S) Ian B. MacGregor and Jared D. Tomberlin		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000		**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A		**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB number _____NPS.2017.0037-IR-EM2-A_____.

12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release. Distribution is unlimited.	12b. DISTRIBUTION CODE

13. ABSTRACT (maximum 200 words)

The Army is concerned with ways in which it can improve talent management. It focuses almost exclusively upon individuals and their unique qualifications and experiences. However, the Army is not a collection of individuals, rather, it is a collection of teams. Our research examines the applicability of using matchmaking algorithms to model team chemistry to optimize job placement. We adopted a practical, qualitative approach, using data from discussions with subject matter experts, as well as a review of the relevant literature. We found that although the social science community has not reached a consensus concerning human chemistry, the tech community has found ways to predict a measure of human chemistry, and Army Special Operations Forces leaders should consider pilot efforts to improve talent management using these algorithms to augment current methods. For instance, the Robin Sage exercise during the Special Forces Qualification Course would provide an ideal venue.

14. SUBJECT TERMS matchmaking, algorithm, team-building, talent management, TM, IBM, Saberr, NASA, bots, online dating, Robin Sage, human resources, HR, S1, personnel, personality, psychology, values, psychometrics, human chemistry, cohesion, group, team, staff, staffing, social, eHarmony, toxic, toxicity, groupthink, SFAB	15. NUMBER OF PAGES 85
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UU

i

THIS PAGE INTENTIONALLY LEFT BLANK

TEAMHARMONY: EMPLOYING MATCHMAKING ALGORITHMS TO TEAM-BUILDING

Ian B. MacGregor
Major, United States Army
B.A., Campbell University, 2006

Jared D. Tomberlin
Major, United States Army
B.S., University of Colorado at Colorado Springs, 2006

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN DEFENSE ANALYSIS

from the

**NAVAL POSTGRADUATE SCHOOL
December 2017**

Approved by: Dr. Anna Simons
Thesis Advisor

Dr. Robert Burks
Second Reader

Dr. John Arquilla
Chair, Department of Defense Analysis

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

The Army is concerned with ways in which it can improve talent management. It focuses almost exclusively upon individuals and their unique qualifications and experiences. However, the Army is not a collection of individuals, rather, it is a collection of teams. Our research examines the applicability of using matchmaking algorithms to model team chemistry to optimize job placement. We adopted a practical, qualitative approach, using data from discussions with subject matter experts, as well as a review of the relevant literature. We found that although the social science community has not reached a consensus concerning human chemistry, the tech community has found ways to predict a measure of human chemistry, and Army Special Operations Forces leaders should consider pilot efforts to improve talent management using these algorithms to augment current methods. For instance, the Robin Sage exercise during the Special Forces Qualification Course would provide an ideal venue.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS AND ABBREVIATIONS

ARI	Army Research Institute
ARSOF	Army Special Operations Forces
CA	Civil Affairs
CIG	Commander's Initiatives Group (CIG)
CPP	Consulting Psychologists Press
DARPA	Defense Advanced Research Projects Agency
DIUx	Defense Innovation Unit Experimental
EO	Equal Opportunity
FFM	Five Factor Model
IO	Industrial-Organizational
IT	Information Technology
MBTI	Myers-Briggs Type Indicator
MiTT	Military Transition Team
NCOER	Noncommissioned Officer Evaluation Report
OER	Officer Evaluation Report
OIF	Operation Iraqi Freedom
OND	Operation New Dawn
PMAD	Personnel Management Authorization Document
PO	Psychological Operations
PII	Personally Identifiable Information
SF	Special Forces
SFAB	Security Force Assistance Brigades
SHARP	Sexual Harassment/Assault Response and Prevention
SME	Subject Matter Expert
TCS	Team Composition System
TMTF	Talent Management Task Force
TOPS	team optimal profile system

THIS PAGE INTENTIONALLY LEFT BLANK

ACKNOWLEDGMENTS

THIS PAGE INTENTIONALLY LEFT BLANK

I. THE ARMY'S TALENT MANAGEMENT GAP

> We will do what it takes to build an agile, adaptive Army of the future. We need to listen and learn—first from the Army itself, from other services, from our interagency partners, but also from the private sector, and even from our critics. Developing a lethal, professional and technically competent force requires an openness to new ideas and new ways of doing things in an increasingly complex world. We will change and adapt.
>
> — General Mark A. Milley,
> 39th Chief of Staff of the Army[1]

A. HUMAN CHEMISTRY

Within groups of people, there exists the powerful social phenomenon known as *human chemistry*. Although many definitions of human chemistry exist, within this paper, we define human chemistry as *the reactions based upon abstract elements of personality and experience which occur when two or more people interact, and cause the resulting relationship to be positively cohesive or toxic*. Much like the weather, human chemistry is hard to predict, and its manifestation changes as individuals enter or depart the group, or as they experience personal changes.

Human chemistry may result in a group having high levels of cohesion, or result in a group becoming fragmented and toxic. Because of human chemistry's overwhelming potency in determining the efficacy of any group, Army leaders have sought to manufacture positive chemistry through cohesion-building events. However, unless these leaders have spent many years working closely with particular individuals, they do not have many mechanisms to predict whether people within a group will naturally *click* as a team, let alone will seek to work well together in the absence of an external, unifying event.

---

[1] Mark A. Milley, "39th Chief of Staff of the Army Initial Message to the Army," accessed April 26, 2017, https://www.army.mil/e2/rv5_downloads/leaders/csa/Initial_Message_39th_CSA.pdf.

Looking beyond the military, to science and to cutting-edge businesses, we have found that it is possible to predict human chemistry, to an extent, using matchmaking algorithms.

B.   ARMY TALENT MANAGEMENT'S MISSING PART

Many current and former Army leaders and thinkers recognize the need to groom, mentor, and retain their talented soldiers, and most believe the systems in place are insufficient. Some argue that the Army structure is not conducive to inspiring people to remain in the Army, leading to a loss in talent and readiness.[2] Focusing on the Army's promotion and retention structures, retired Lieutenant General David Barno and Dr. Nora Bensahel both agree that the Army's talent management systems are archaic and in need of redesign to meet the needs of *millennial* generation soldiers who face an ever less certain world.[3] Most importantly, they both recognize that there seems to be no universal agreement about what the core talent management problems are, much less how to solve them.[4]

Common to most of the talent management discussion is the hallowed American concept of the individual as the unit of account—and for good reason, as this is a foundational concept that members of the Army are sworn to defend. Given such an orientation, the themes of personal experience and performance, competition, mentorship, and leadership development remain dominant. However, while certainly worthy of attention, these unique, individual-focused aspects represent only part of the equation for what goes into making a formidable Army.

According to retired General Raymond T. Odierno in TP 525-3-7, "the squad will remain the foundation and cornerstone of the Army."[5] Similarly, the smallest elements

---

[2] Tim Kane, *Bleeding Talent: How the U.S. Military Mismanages Great Leaders and Why It's Time for a Revolution* (New York: Palgrave Macmillan, 2012), 5–8.

[3] David Barno and Nora Bensahel, "Can the U.S. Army Halt Its Brain Drain?" *The Atlantic*, November 5, 2015, https://www.theatlantic.com/politics/archive/2015/11/us-Army-tries-halt-brain-drain/413965/.

[4] Ibid.

[5] Department of the Army, *The U.S. Army Human Dimension Concept*, TRADOC Pam 525-3-7, (U.S. Army Training and Doctrine Command, 2014), 8, http://www.tradoc.army.mil/tpubs/pams/TP525-3-7.pdf.

within any unit are the buddy teams—this is true from basic training through Ranger school, and is evident within highly specialized sniper and dive teams. Regardless of duty position and level of command, the buddy team is a constant: commanders have their senior noncommissioned officers (NCOs); staff officers have their NCO counterparts. Because the Army is built upon relationships and not lone individuals at every level, it is surprising that a comprehensive study of the quality of relationships among soldiers, and whether or not there is a way to predict and model team chemistry to improve team effectiveness, has not been undertaken (Figure 1).
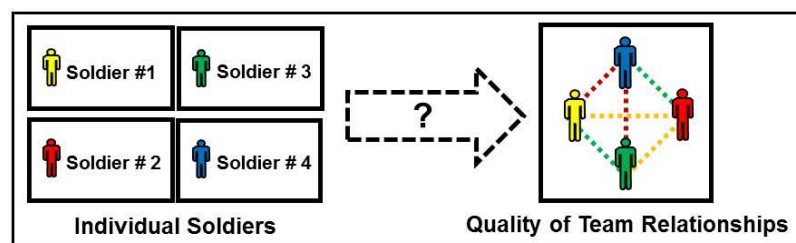
Army personnel management systems are geared toward highlighting the quality of individuals. Few, if any, systems exist to illuminate the quality of team relationships.

Figure 1.   The gap between managing individuals and managing relationships

It is our contention that, by addressing the relational aspects of Talent Management, the Army should be able to gain insight into, and maybe even correct, many of the issues plaguing the force, from suicide and work-related stress, to inappropriate sexual behavior. Sociologist Dr. John Bruhn highlights that in Emile Durkheim's classic studies on suicide, Durkheim observed correlations between suicide and the health of social connections.[6] Given the likelihood that some suicides are tied to dysfunctional relationships, it makes sense to try to diagnose unhealthy relationships along with unhealthy minds when seeking to prevent suicide. An article in *Military Review* highlighted that "Psychiatric casualties have been highest among men who did

---

[6] John G. Bruhn, "The Concept of Social Cohesion," in *The Group Effect: Social Cohesion and Health Outcomes* (Dordrecht: Springer, 2009), 32, 35, DOI 10.1007/978-1-4419-0364-8_2.

not form close relationships with other members of their small unit."[7] Obviously, if there were a way to predict and better ensure positive interpersonal relationships, instances and costs of behavioral health issues would diminish. The Army currently spends an unprecedented number of hours on training designed to counter destructive behaviors, such as suicide prevention and Sexual Harassment/Assault Response and Prevention (SHARP) training among others.[8] Left unaddressed is how many of these behaviors are truly root problems in and of themselves, and how many are merely symptoms of broken relationships and poor interpersonal connections. While the safe academic answer would be "both," it should ultimately save time, resources, and—most importantly—lives if it were possible to better predict likely conflicts between personality types, particularly when different personality types are known to exhibit different behaviors.

To complicate the situation further, the Army increasingly finds itself in a bind: it is confronted by an increasingly volatile and complex world, yet its force size will at best remain constant, and at worst will decrease.[9] This is also the situation facing Army Special Operations Forces (ARSOF). Being the first choice for many *Gray Zone* operations, ARSOF is already stretched thin. The development of the Security Force Assistance Brigades (SFAB) is an example of both the Army's changing mission set and ARSOF's being too overextended to fill all its traditional advisory roles.[10] Moreover, the timeline between a new team's inception and the execution of its mission is incredibly short (some new units are deploying less than a year after their formation), increasing the necessity that leaders be able to assemble cohesive teams as early as possible to mitigate

---

[7] Robert J. Rielly, "Confronting the Tiger: Small Unit Cohesion in Battle," *Military Review* (November/December 2000): 62, http://usacac.army.mil/sites/default/files/documents/cace/DCL/DCL_SmallUnitCohesion.pdf.

[8] Leonard Wong and Stephen J. Gerras, *Lying to Ourselves: Dishonesty in the Army Profession*, (Carlisle Barracks, Pennsylvania: United States Army War College Press, 2015), https://ssi.armywarcollege.edu/pdffiles/pub1250.pdf.

[9] Conrad Crane, "The Future Soldier: Alone in a Crowd," *War on the Rocks*, January 19, 2017, https://warontherocks.com/2017/01/the-future-soldier-alone-in-a-crowd/; and Leon Panetta et al., *Building a F.A.S.T. Force: A Flexible Personnel System for a Modern Military*, (Washington, DC: Bipartisan Policy Center, 2017), https://cdn.bipartisanpolicy.org/wp-content/uploads/2017/03/BPC-Defense-Building-A-FAST-Force.pdf.

[10] Tim Ball, "Replaced? Security Force Assistance Brigades Vs. Special Forces," *War on the Rocks*, February 23, 2017, https://warontherocks.com/2017/02/replaced-security-force-assistance-brigades-vs-special-forces/.

conflict during training. To rapidly build and field cohesive—often *ad hoc*—teams to assess, understand, and defeat a full array of possible threats requires that Army and ARSOF leaders must seek new and different talent management solutions.

Interestingly, the Army is not necessarily opposed to conducting psychological predictive research. In 2015, the Army allowed scientists from Harvard to access troves of personnel data in order to construct a tool to predict which service members are most likely to commit violent crimes in the future.[11] In thinking about how this tool might be applied, we cannot help but foresee more harm than good. The researchers claim their methodology will help medical providers pinpoint where they need to focus "interventions."[12] However, won't focused interventions also stigmatize and isolate the currently innocent? Wouldn't a better use of Army data and research be to ensure that teams are composed of individuals who will complement each other by reinforcing each other's strengths and curbing each other's negative proclivities?

C.   CURRENT TALENT MANAGEMENT TOOLS ARE LACKING, BUT ALGORITHMS MAY BE THE ANSWER

Tools to assist leaders manage talent exist, but they are insufficient. Depending upon their sizes, capabilities, and budgets, Army units currently have an array of available talent management tools to help leaders optimize whom they hire and where they put these people. However, unless the leaders are at the regiment level or higher, many of these tools are limited to highly generalized and often embellished performance reports and experience résumés.

The talent management of individuals in the Army today is predicated on two components: professional performance records and command teams' intuition. While necessary, these two components are insufficient for assessing the quality of an individual's relationship to (and effect on) his team. Professional performance records (Commissioned and Noncommissioned Officer Evaluation Reports [OERs and NCOERs]) are extremely subjective because they capture only a relative qualitative

---

[11] Department of Health Care Policy, "Predicting Violent Crime," Harvard Medical School, October 6, 2015, https://hms.harvard.edu/news/predicting-violent-crime.

[12] Ibid.

assessment that is based on the average performances of all others within a rating pool. Command team intuition is even more subjective and relative, since it is only as effective and comprehensive as the wisdom and experiences of those in command.

At the moment, too little use is made of a third available component, psychological and personality profiling. Without this, there is a gap in the holistic assessment of a potential team member (Figure 2). Analyzing an individual's psychology and personality is an objective process since it is grounded on and draws from several hundred years of scientific behavioral research. That makes it a useful adjunct to professional performance records and command teams' intuition, especially since an individual's psychological makeup is comprised, in part, of the attributes and quirks that help determine how his presence will affect his team (Figure 3).

Army personnel management systems track professional performance. Unit command teams use experiential intuition when staffing teams. Apart from SOF units, there are no systems in place to gauge psychological makeup.

Figure 2.   Components of holistic team member assessment
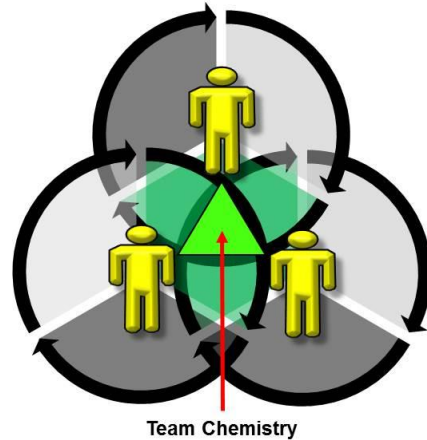
Team Chemistry

Psychological assessment is critical for predicting the quality of team chemistry.

Figure 3.   Team chemistry model

Despite offering a somewhat negative assessment of the Army's current talent management tools, we do not advocate that performance reports or command intuition be significantly revamped or eschewed. Despite being imperfect, those systems—when used correctly—effectively capture a soldier's valued role within the force and his potential for greater responsibility. However, we suggest the implementation of an additional tool to aid decision makers in effectively placing their valued soldiers onto teams.

Many ARSOF commands recognize the value of psychological profiling. As a result, they employ Army and civilian psychologists to assist with assessment and selection processes to determine whether candidates are a good fit for their particular ARSOF units.[13] However, the SOF community is still relatively large, and minimal resources are available for assessing whether a *particular* individual is a good fit for a specific staff, company level team, or smaller element. Given sufficient resources, SOF units could potentially assess all individuals for fitness prior to and as they integrate onto teams. However, because it is unlikely ARSOF units will receive additional funding or have enough psychologists available to perform these assessments, it seems worthwhile to try other approaches to solve this problem. Big data analytics and matchmaking algorithms—like those that power online matchmaking, or dating, websites—offer one

---

13 U.S. Army, "RASP 1 & 2," Goarmy, Last modified July 23, 2015, http://www.goarmy.com/ranger/training/rasp.html.

potential tool for psychological profiling that could assist with forming teams with high levels of positive human chemistry.

The development of an algorithmic decision aid offers the potential to complement existing talent management tools by allowing leaders at all levels to use existing psychological science to predict and prevent, or pinpoint and alleviate, human chemistry friction. Since the actual development of such a decision aid would go far beyond the scope of this thesis, we will limit our research to exploring three underlying questions:

1) Might matchmaking algorithms accurately predict human chemistry?

2) Can algorithms be converted into a user-friendly, Army-specific application? and

3) Would ARSOF leaders be willing to employ an algorithmic aid?

After presenting our research findings, we assess the practicality of using matchmaking algorithms for talent management, and recommend steps the Army should take in order to develop a scalable decision aid for the force (see Figure 4).

We acknowledge that the tool we describe, like any system, contains within it the potential for abuse or exploitation. Yet, we also believe the tool has the potential to make some processes more efficient, and so we propose that it be tested through pilot efforts.
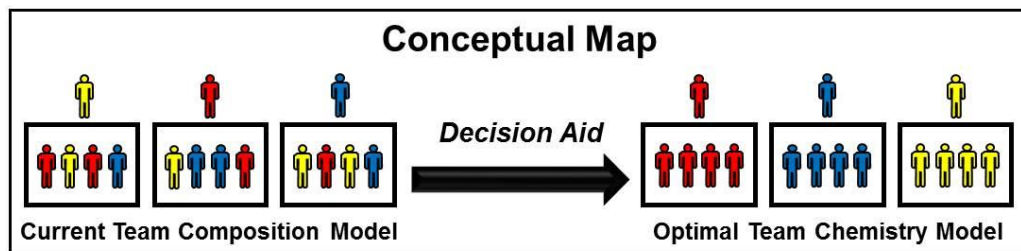
Our research explores a method of bridging the gap between current personnel management systems and team management systems. Uniform colors do not represent uniform personalities, rather the uniform colors represent teams with optimal positive chemistry.

Figure 4.   Conceptual map

8

D.   METHODOLOGY

We adopted a practical, qualitative approach. To conduct our research, we collected data from discussions with subject matter experts (SME) and personal experiences, as well as a review of the literature that were particularly interested in best practices. Additionally, we spoke with Army SMEs to ascertain current talent management initiatives and goals. Lastly, we built several models—which are present throughout this thesis—to assist in explaining the Army's need for and possible application of matchmaking algorithms.

1.   Industrial-Organizational and Social Psychology

Because there is no definitive consensus about human chemistry or why one group might have better chemistry than another, we intentionally reached out to a broad range of experts who are working on the topic of human chemistry. Psychologists we spoke with were either university professors or Army psychologists doing research in the realm of human chemistry. After canvassing a broad range of research approaches, we distilled these to those we regarded as most apt for consideration by the Army, in general, and by ARSOF in particular.

2.   Information Technology

We contacted various information technology (IT) entities that are currently designing and implementing algorithmic decision aids to optimize human chemistry outcomes, to include NASA, IBM, and Saberr. Examining IT industry best practices enabled us to better assess the potential application of similar technology to meet the unique needs of the Army.

3.   Army Talent Management

We reached out to a broad range of Army talent management SMEs, such as those in the Talent Management Task Force (TMTF) at Fort Leavenworth and the Special Operations Community. From the Army TMTF we gained an understanding of initiatives currently underway as well as the TF's view about how the Army needs to refine its talent management capabilities. We gained experiential insights from the Special

Operations community by speaking with mid- to senior-level leaders who have commanded and managed organizations from the platoon to the O-6 level. These discussions helped us gauge their perceptions about current talent management, as well as their receptiveness to the development and implementation of an algorithmic decision aid for team building within the ARSOF community.

II.   THE STATE OF THE SCIENCE

A.   HUMAN CHEMISTRY RESEARCH

In order to appreciate the challenges that inhere in predicting human chemistry, we first turned to the field of psychology. Within psychology, we looked specifically at sports psychology and industrial-organizational psychology to see how they address similar team-associated challenges.

We began at the individual level of analysis, and moved to the group level, deliberately choosing not to explore the organizational level.[14] The individual level of analysis is critical for establishing the foundation upon which human relationships are built, but it is insufficient for a full discussion of human chemistry within small military units. The organizational level is too broad. Plus, our own personal experiences suggest that it is at the group level—in a squad, on a battalion staff, or as members of a company command team—that soldiers derive the most strength to overcome peril and adversity, as well as solve most of the Army's problems.[15]

B.   ELEMENTS OF HUMAN CHEMISTRY ASSESSMENT

1.   KSAOs

When discussing optimal placement of an individual into a job, industrial-organizational psychologists will often refer to a grouping of qualities dubbed "knowledge, skill, ability, and other personal characteristics" (KSAO) (Figure 5).[16] Knowledge describes a person's education. Skill concerns what someone can presently do. Ability refers to what someone has the potential to learn or do. Other personal characteristics is somewhat of a catch-all category that describes a person's attitude

---

[14] For the purposes of this paper, we define a group, or team, as being comprised of between two to ten people.

[15] Rielly, "Confronting the Tiger," 62-63.

[16] Paul E. Spector, s.v. "KSAOs," in *The Blackwell Encyclopedia of Management*, ed. Cary L. Cooper (Blackwell Reference Online), accessed September 27, 2017, http://www.blackwellreference.com/public/tocnode?id=g9780631233176_chunk_g978140511697814_ss1-4.

personality characteristics. Having an understanding of KSAOs is important when discussing talent management, especially when trying to design comprehensive solutions. However, because our research deals primarily with interpersonal interactions at the group level, we especially focus on those items found within the other personal characteristics category. These are essential to a fit among individuals.
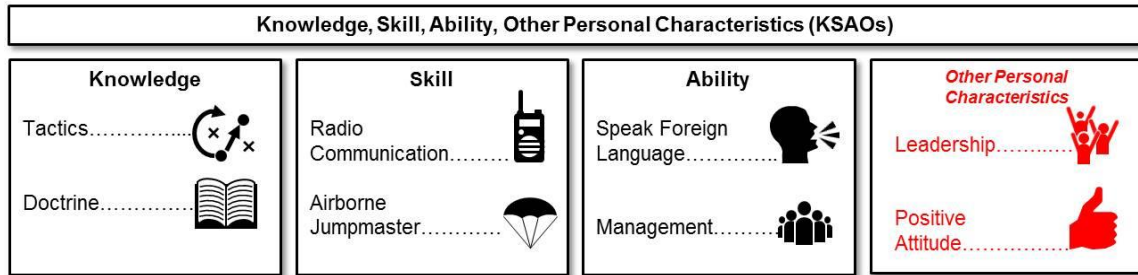
KSAOs form the core of many systems designed to optimize the pairing of a person to a work position.

Figure 5.   KSAOs

2.   The Big 5

A common starting point for assessing human chemistry according to the psychology literature is individual human personality traits. To map and assess these traits, many psychologists rely upon a framework known as the Five Factor Model (FFM) or *Big 5* personality traits assessment. The Big 5 is the latest manifestation of psychometrics dating back to Freud and Jung, and distills research done by generations of scientists. The five factors are *Openness to experience*, *Conscientiousness*, *Extroversion*, *Agreeableness*, and *Neuroticism*.[17] Many questionnaires have been devised that incorporate the Big 5 to glean broad, yet relatively accurate, personality assessments of individuals. These questionnaires require test-takers to respond to simple statements, such as "I often feel blue." Respondents are asked to choose among at least five options along

---

[17] Courtney Ackerman, "The Big Five Personality Theory: The 5 Factor Model Explained (+PDF)," Positive Psychology Program, June 23, 2017, https://positivepsychologyprogram.com/big-five-personality-theory/.

an agreement spectrum.[18] Once all answers are tallied, the questionnaire measures where someone falls along the spectrum of each of the five personality trait categories.

Big 5 assessment tools work best among Western, educated, predominantly English-speaking people. Ongoing research focuses on whether social personalities universally fit neatly into the five categories. One of the obstacles to perfect validation of the Big 5 stems from language and translation issues on the questionnaires themselves.[19] For example, to translate a concept like *feeling blue* requires special effort since it is a colloquial English term. Another area where the Big 5 has not yet been completely validated is among non-Western, less settled peoples.[20]

The Big 5 should not be mistaken for another version of the popular Myers–Briggs Type Indicator (MBTI) assessment. Although both tools share some similar characteristics—they are questionnaire-based and use terminology stemming from Carl Jung's theories—they are viewed very differently by psychologists. Psychologists are continually refining but still using the Big 5 model, while MBTI critics contend the MBTI is little more than pseudo-science.[21] In fact, the president of Consulting Psychologists Press (CPP)—the company that owns the MBTI test—conceded to the BBC that the MBTI "was never intended to be predictive, and should never be used for hiring, screening or to dictate life decisions."[22]

---

[18] "The Big Five Personality Test," Truity, accessed 2017, https://www.truity.com/test/big-five-personality-test.

[19] Willem K. B. Hofstee et al., "A Comparison of Big-Five Structures of Personality Traits in Dutch, English, and German," *European Journal of Personality* 11, no. 1 (1997): http://s3.amazonaws.com/academia.edu.documents/46752417/A_Comparison_of_Big-Five_structures_of_p20160624-28204-1eeoc7p.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1501098613&Signature=15G NUNMzVER7NW67%2F4cxxCOc8MY%3D&response-content-disposition=inline%3B%20filename%3DA_Comparison_of_Big-Five_structures_of_p.pdf.

[20] Gurven et al.'s research of the applicability of the FFM among Bolivian Amazon tribes suggests that there may be different categories of personality types among nomadic people; and Michael Gurven et al., "How Universal Is the Big Five? Testing the Five-Factor Model of Personality Variation among Forager–Farmers in the Bolivian Amazon," J*ournal of Personality and Social Psychology* 104, no. 2 (2013): doi:10.1037/a0030841.

[21] Adam Grant, "Goodbye to MBTI, the Fad that Won't Die," Psychology Today, September 18, 2013, https://www.psychologytoday.com/blog/give-and-take/201309/goodbye-mbti-the-fad-won-t-die.

[22] Anthony Zurcher, "Debunking the Myers-Briggs Personality Test," BBC News (blog), July 15, 2014, http://www.bbc.com/news/blogs-echochambers-28315137.

C.   COHESION AND ITS RELATIONSHIP TO PERFORMANCE

1.   Social and Task Cohesion

Prevalent throughout the sports psychology literature are the concepts of *social* and *task* cohesion. Each describes unique ways in which team-members bind themselves together. It is important to understand the differences between these two categories because they are among the most common terms used to describe cohesion at a team level.

> ***Social cohesion*** refers to the nature and quality of the emotional bonds of friendship, liking, caring, and closeness among group members. A group displays high social cohesion to the extent that its members like each other, prefer to spend their social time together, enjoy each other's company, and feel emotionally close to one another.[23]

> ***Task cohesion*** refers to the shared commitment among members to achieving a goal that requires the collective efforts of the group. A group with high task cohesion is composed of members who share a common goal and who are motivated to coordinate their efforts as a team to achieve that goal.[24]

Albert Carron, an international leader in sports group dynamics, has conducted considerable research on various sports teams. He and his colleagues have also designed and tested questionnaire tools to allow players and coaches to diagnose areas of task and social cohesion, and to identify conflict among members of different sports teams.[25] His research offers clear evidence that teams that have higher levels of task cohesion, despite whatever positive or negative levels of social cohesion they might exhibit, are more successful than are their competitors.[26] Therefore, at first glance, it would make sense to assume that the Army ought to likewise focus on task cohesion in order to optimize

---

[23] Gregory M. Herek, "Unit Cohesion and the Army Mission," Discover Psychology — Psychology (blog), 2012, http://psychology.ucdavis.edu/rainbow/html/Army_cohesion.html.

[24] Ibid.

[25] Kyle F. Paradis, Albert Carron, and Luc J. Martin, "Development and Validation of an Inventory to Assess Conflict in Sports Teams: The Group Conflict Questionnaire," *Journal of Sports Sciences* 32, no. 20 (October 2014): doi:10.1080/02640414.2014.970220.

[26] Raphael Brandon, "Team Sports: Team Cohesion and Success: What Is the Link?" Peak Performance Lite, last modified 2016, http://www.pponline.co.uk/encyc/team-sports-team-cohesion-and-success-what-is-the-link-78#/.

overall effectiveness, particularly given the fact that Army teams in a specific configuration generally retain the same personnel for no longer than eighteen to twenty-four months.

2. Group Cohesion

Despite the prevalence of this social versus task cohesion distinction, we found that the concept of cohesion described in meta-research done by Daniel Beal and his colleagues, for which they drew on 64 different studies, offers a concept that better fits our professional, all-volunteer Army.[27] For clarity, we refer to this cohesion as *group* cohesion to distinguish it from task and social cohesion.[28]

According to Beal et al, group cohesion is composed of three inseparable parts, all of which are related to team performance in some way: "interpersonal attraction, group pride, and task commitment."[29] Like social cohesion, interpersonal attraction refers to how well the individuals within a team get along with each other and the level of ease with which they communicate and collaborate to problem solve. Task commitment finds its parallel in task cohesion. Group pride is the component of group cohesion that renders this concept especially fitting for the Army, since it speaks to an individual's attraction to the group's identity itself, and not merely to a job or to other group members. In fact, many special operators initially volunteered for their respective units largely because of their desire to identify with those units.

3. Performance

Along with providing a helpful definition of cohesion, Beal et al. outline a concept of performance measurement and utility that is especially relevant for Army culture. They demonstrate that gauging performance using the criteria of behavior and measures of efficiency is better than gauging performance using criteria based upon

---

[27] Daniel J. Beal et al., "Cohesion and Performance in Groups: A Meta-Analytic Clarification of Construct Relations," *Journal of Applied Psychology* 88, no. 6 (2003): doi:10.1037/0021-9010.88.6.989.

[28] There exists much debate over cohesion types, particularly task and social. We chose Beal et al.'s work because it nicely bridges the science gap between current matchmaking algorithms and Army culture.

[29] Beal et al., "Cohesion and Performance in Groups," 990.

outcomes and measures of effectiveness. Their work also reveals that the type of group task flow—or the amount and sequencing of necessary collaboration—helps determine whether or not high group cohesion is even a requirement for success.[30]

Oftentimes, particularly in sports, it makes sense to think of performance in terms of outcome and effectiveness. Sports teams derive their greatest value from viewership and from wins and losses. Without these metrics, a sports team cannot generate the resources it needs to continue to exist. However, a factor which might play an outsized role in outcome and effectiveness is luck. Maybe the opposing team's star player becomes ill before a game, leading to an outcome which would either otherwise not occur or would not have been as easy to achieve. A winning outcome achieved in part by luck looks little different from an outcome won through hard work or unusual talent—the result is the same.

Behavior and efficiency, on the other hand, minimize the role luck plays in a situation because both are comprised of the deliberate, conscious, and trained choices of the team members themselves, as well as their established practices. This seems to closely match the way in which the Army ought to view the performance of its teams. The Army cannot control luck, but it can shape the ways in which people behave, along with the systems they use to maximize efficiency. Behavior and efficiency encompass both short- and long-term mission effects. Not only must a team successfully accomplish its immediate mission, but it must also do so in such a way as to mitigate the creation of second and third order problems in the process, such as socially or emotionally burning out its team members. Tellingly, the Army's leadership implicitly acknowledges that the need for good behavior trumps merely good outcomes. We see this in the heightened concerns about toxic leadership recently. The good news is that because good behaviors and efficiency build consistency and a culture of trust, they inherently lead to good outcomes and effectiveness.[31]

---

30 Ibid., 998.

31 Ibid.

Despite the positive effects of cohesion on performance, the amount of attention required to achieve or acquire cohesion can vary. For instance, the group's task flow and level of required collaboration will likely determine whether cohesion should be a team builder's top concern. Also, as the nature of a group's work becomes less collaborative, the requirement for group cohesion invariably decreases.

Building upon the work of organizational design sociologist James D. Thompson, Tesluk et al. categorize group task flows into "four patterns of teamwork:" *pooled* or *additive*, *sequential*, *reciprocal*, and *intensive*."[32]

Pooled describes group work which requires the least amount of collaboration. Each team member is responsible for his or her own portion of the task.[33] As long as all team members contribute sufficient effort to their portions, the work output is successful. Oftentimes, each team member's assigned tasks require extensive specialized education and training. A surgical team, for example, has a pooled task flow. The team's success depends on each member's ability to perform his or her own specific tasks, such as administering anesthesia, doing the surgery, monitoring the patient's vital signs, etc.

Sequential task flow is much as it sounds. Tasks flow from one member of the team to the next, as on an assembly line, and only one member can do what is required at any one point in time.[34] An American football team displays sequential task flow in the sense that each player performs his task in sequence according to a planned pattern.[35]

Reciprocal task flow is similar to sequential task flow in that only one member of a team does the work at any given point in time. However, with a reciprocal flow, the direction is dynamic and can shift between any of the team members.[36] Soccer players

---

[32] P. E. Tesluk et al., "Task and Aggregation Issues in the Analysis and Assessment of Team Performance," in *Team Performance and Measurement: Theory, Methods, and Applications*, ed. M. T. Brannick, E. Salas, and C. Prince (Mahwah, NJ: Erlbaum, 1997), 199.

[33] Ibid., 201.

[34] Ibid.

[35] Erik Jansen, "Division of Labor, Information Processing, and Workflow Interdependence" (lecture, Naval Postgraduate School, Monterey, CA, January 31, 2017).

[36] Tesluk, "Task and Aggregation Issues," 201.

exhibit reciprocal task flow. Although each player has a role on the field, the action is fluid, allowing the players to shift their formations through time and space.

Finally, there is intensive task flow, which is the most collaborative: all team members collaborate simultaneously to define and solve their given problem.[37] *Ad hoc* task forces, designed to address a specific problem, exhibit intensive task flow. Team members' roles are not fully defined, and their communication systems are flattened, allowing the team to rapidly adapt and adjust to an uncertain environment or problem set. Although the team members may be responsible for some highly specialized tasks, often they are generalists who have had many diverse, previous roles and responsibilities (Figure 6).
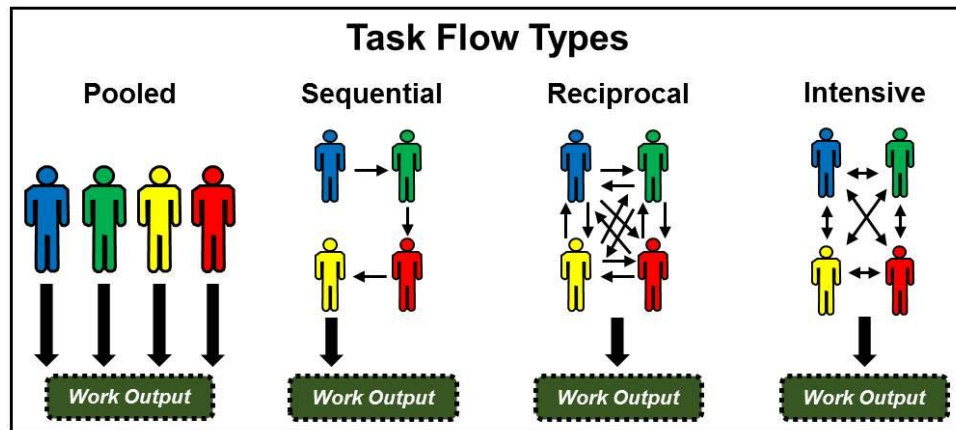
Four task flow types exist at the group level: pooled, sequential, reciprocal, intensive

Figure 6.   Group task flow types

Cohesion is important in pooled and sequential task flow groups in order to prevent major personality clashes and dysfunction. However, because group members' individual roles and tasks are differentiated, it is more important that team members be highly skilled than cohesive.[38]

---

[37] Ibid., 201.

[38] Differentiated roles, or tasks, means each is essential and not interchangeable. A surgical team has highly differentiated roles. The surgeon and the anesthetist are both necessary for success, but since neither can learn the other's job in a quick and efficient manner, they must both be present for the procedure despite their level of cohesion.

In contrast, most tactical and operational missions in the Army require task flow groups that are reciprocal or intensive in nature; flexibility is key among team members who need to collaborate and adjust to one another in a dynamic environment. Despite having defined roles, Soldiers regularly cross train in individual tasks, such as the orders process, marksmanship, and trauma care, enabling them to transition into different roles when executing a mission. Since collaboration is more important than the performance of differentiated tasks, these teams require the highest levels of group cohesion in order to maximize performance.

D. PROBLEMATIC CHEMISTRY

Chemistry, as we describe it in this thesis, can take positive and negative forms. Moreover, chemistry does not always come from an equal distribution of individual inputs—some individuals' personality traits have the ability to overpower or dilute the combined traits of other team members, resulting in varying effects on group cohesion and productivity.

1. Toxicity

Human *toxicity*, specifically as it relates to toxic leaders or co-workers, is a talent management topic of extreme interest at the moment in the Army.[39] Former U.S. Army War College professor, Dr. George Reed defines toxic leaders and team members as those exhibiting "demotivational behavior that negatively impacts unit morale and climate."[40] Although an argument can be made that a toxic individual will be toxic anywhere—since his behaviors are by definition immoral or amoral—toxicity affects team members in different ways depending upon their personalities and their group chemistry.[41] Whenever group cohesion persists, or even increases among the non-toxic team members, this likely results from team members banding together due to a shared aversion to the toxic personality, or the hostile work conditions he or she creates.

---

[39] Daniel Zwerdling, "Army Takes on Its Own Toxic Leaders," NPR, January 6, 2014, http://www.npr.org/2014/01/06/259422776/army-takes-on-its-own-toxic-leaders.

[40] George E Reed, *Tarnished: Toxic Leadership in the U.S. Military* (Lincoln: Potomac Books, 2015), 15, https://muse.jhu.edu/book/41613.

[41] Ibid., 10–15.

Unfortunately, the long-term net effect of toxicity is generally negative. This is because toxic individuals increase the stress levels of their teams and organizations. Their toxicity is often invisible to their superiors because toxic individuals often lead their teams to produce substantive short-term mission successes. In some instances, short-term successes may in fact trump the negative effect of toxic personalities. However, "prolonged use of negative leadership to influence followers undermines the followers' will, initiative, and potential and destroys unit morale."[42] In order to minimize this and decrease the chances that individual Soldiers will become emotionally spent and thus be of less value to Army teams, developing the ability to assess and even mitigate toxic chemistry should be considered critical.

2. Groupthink

A commonly voiced concern is that positive human chemistry will lead to the performance trap of *groupthink*. By groupthink we are referring to Dr. Irving Janis's theory that describes what occurs when a group of people allows its members' individual desires for group harmony to supersede their responsibility to provide their leader with effective counsel and to critically problem solve.[43] However, while groupthink may be a particular danger for groups with high group cohesion, we agree with Janis that high group cohesion does not guarantee groupthink.[44] Moreover, while the danger of groupthink always exists, we have seen no instance or case study that suggests that matchmaking algorithms directly lead to a crippling groupthink situation. In fact, the evidence suggests otherwise: groupthink is not a major issue for when there is group cohesion.

---

[42] Department of the Army, *Army Leadership*, ADP 6-22, (Washington, DC: Headquarters, Department of the Army, 2012), http://cape.army.mil/repository/doctrine/adp6-22.pdf.

[43] "Groupthink," *Psychology Today*, last modified 2017, https://www.psychologytoday.com/basics/groupthink; and Irving L. Janis, *Victims of Groupthink: A Psychological Study of Foreign-Policy Decisions and Fiascoes* (Boston: Houghton Mifflin Company, 1972), 9.

[44] Janis, *Victims of Groupthink*, 198-202.

3. Lookism

Personality quirks which fit into the category known as *lookism* consist of an individual's psychological reactions toward another person's physiognomy, not personality.[45] Although lookism as a form of social prejudice has a negative, even immoral, connotation in formal business settings, there seems to be a tacit acknowledgement that it is an acceptable societal sin. The popularity of physical attraction-based dating apps like *Tinder*, and the employment of physically attractive anchors on major news networks illustrate that society is comfortable with some measure of lookism, especially when it comes to private personal relationships and entertainment.[46]

Lookism seems to have its largest impact upon human chemistry during initial interactions or first impressions, and can enhance or degrade human chemistry. For example, someone might initially pursue a relationship based largely upon physical attraction, but will then have to take into account aspects of the other person's personality if the relationship is to endure. For relationships to thrive, the overall chemistry has to be good. However, if personalities clash, initial physical attraction will be insufficient to maintain positive chemistry over time.

Lookism can also negatively impact human chemistry prior to a meaningful interpersonal connection. In the original *Star Wars* film, a grotesque cantina patron greets the protagonist, Luke Skywalker, by saying that neither he nor his friend "like" Luke—even though they have never met Luke previously. This exchange proves fatal to both antagonists.[47] Although this is an example drawn from a movie, most people can relate to

---

[45] Chris Warhurst et al., "Lookism: The New Frontier of Employment Discrimination?" *Journal of Industrial Relations* 51, no. 1 (2009): 132, doi:10.1177/0022185608096808.

[46] Fitz Tepper, "Here's Who Fared Best on Dating Apps in 2016," TechCrunch, January 3, 2017, https://techcrunch.com/2017/01/03/heres-who-fared-best-on-dating-apps-in-2016/; and Meghan Casserly, "Sexy News Anchors' Surprising Effect on Women," Forbes, January 11, 2011, https://www.forbes.com/sites/meghancasserly/2011/01/27/study-sexy-news-anchors-fox-news-megyn-kelly-laura-berman/#58b9e67c3f9a.

[47] Luke Skywalker's two antagonists are Dr. Cornelius Evazan and Ponda Baba from *Episode IV—A New Hope*, directed by George Lucas (1977; Twentieth Century Fox Film Corporation), Film.

the antagonists' mutual *disgust*.[48] Director George Lucas ensures viewers will feel disgust by making Luke's antagonists physically revolting. Fortunately, positive interpersonal connections can usually overcome negative forms of lookism, and although lookism adds a certain flavor to human chemistry, its impact seems to dissipate over time.

E.   POSITIVE CHEMISTRY

Although it seems that problematic chemistry can yield toxicity, groupthink, and lookism, positive chemistry is a bit more difficult to categorize. We have found no prominent classes of positive chemistry. In fact, research into optimal team composition reveals no single superior form.[49] Thus, rather than try to develop a typology of our own here, in the next chapter we describe several different types that IT matchmakers have found to be effective.

---

[48] Erik D'Amato, "Mystery of Disgust," *Psychology Today*, January 1, 1998, https://www.psychologytoday.com/articles/199801/mystery-disgust.

[49] Laurie B. Buchanan, "The Impact of Big Five Personality Characteristics on Group Cohesion and Creative Task Performance," (PhD diss., Virginia Polytechnic Institute and State University, 1998), https://vtechworks.lib.vt.edu/bitstream/handle/10919/30415/etd.pdf?sequence=1.

III.   THE STATE OF THE TECHNOLOGY

A.   HISTORY OF MATCHMAKING

As early as 1965, tech savvy entrepreneurs were exploring various ways to match-make couples using algorithms. Calculating individuals' personal preferences and personality characteristics enabled online matchmaking companies to align profiles in search of a compatibility match.[50] Jeff Tarr was one such matchmaking pioneer who leveraged burgeoning computer technology to help him and his classmates meet compatible dating partners. While a Harvard undergraduate, he developed and sold for three dollars apiece a personality survey to his fellow students, and then used a rented five-ton IBM 1401 computer to process the answers.[51] In so doing, he began *Operation Match*, an algorithmic-based dating service that provided its customers with lists of their top six potential matches.[52] By the end of 1966, Operation Match had received roughly "90,000 applications and taken $270,000 in revenue," and had unexpectedly inaugurated the birth and rise of computer assisted dating.[53]

Since its beginning as an extracurricular college project, computer assisted dating has continued to keep pace with technological advancements, and "through the internet, home computing, broadband, smartphones, and locations," its potential and capabilities have grown in popularity and effectiveness.[54] According to the American National Academy of Sciences, "more than a third of people who married in the US between 2005 and 2012 met their partner online."[55] As matchmaking sites gather more data, it is likely the algorithms will continue to self-refine and improve.

---

50 James Bridle, "The Algorithm Method: How Internet Dating Became Everyone's Route to a Perfect Love Match," *The Guardian*, February 9, 2014, https://www.theguardian.com/lifeandstyle/2014/feb/09/match-eharmony-algorithm-Internet-dating.

51 Adam Zewe, "Alumni Profile: Jeff Tarr, A.B. '66," Harvard John A. Paulson School of Engineering and Applied Sciences, February 8, 2016, https://www.seas.harvard.edu/blog/2016/02/alumni-profile-jeff-tarr-ab-66.

52 Ibid.

53 Bridle, "The Algorithm Method."

54 Ibid.

55 Ibid.

Although all online dating websites incorporate algorithms to facilitate some form of matchmaking, not all of those algorithms are geared toward making matches based on compatibility or predictions about good chemistry. Websites and smartphone applications, such as *AdultFriendFinder*, Tinder, and *Grindr*, offer a menu of potential partner options that are based mostly upon superficial physical qualities and proximity.[56] A small, but growing selection of sites, such as *eHarmony* and *PerfectMatch*, do employ algorithms designed to match people who are likely to have a long-term interpersonal chemistry.[57] The matchmaking algorithms associated with these dating sites are the focus of our thesis.

Some skeptics question whether compatibility algorithms truly provide better matches than do more traditional dating methods. In 2012, a group of psychologists looked at the full range of internet matching sites and concluded that sites offering to make compatibility matches are in fact over-advertising.[58] At best, these sites provide a means to screen out likely incompatible partners, but are unable to make high validity match claims. Despite their findings, however, the authors did indicate that should dating sites incorporate more "rigorous psychological science," their predictive capabilities will improve.[59]

B. EXPANDING USE OF ALGORITHMIC TECHNOLOGY

Since the arrival of the Information Age, humans have been able to use computers to store, manage, and process a remarkable and unprecedented amount of information. In 2007, the scientists at IBM began developing a question-answering computer system named *Watson*. Designed primarily to assist medical professionals diagnose and treat illnesses, Watson had the capacity to store information, access data, and respond to verbal

---

[56] Eli J. Finkel et al., "Online Dating: A Critical Analysis from the Perspective of Psychological Science," *Psychological Science in the Public Interest* 13, no. 1 (March 2012): 8, http://journals.sagepub.com/stoken/rbtfl/cK9EB6/4zQ0AM/full.

[57] Ibid.

[58] Ibid., 48.

[59] Ibid., 53.

human questions without human assistance.[60] Watson's powerful proof of concept came in 2011 when it competed on the trivia gameshow *Jeopardy!* against the show's highest earning contestant and the contestant who held the show's longest winning streak, and Watson defeated both human players.[61]

It did not take long for people outside of the dating world to realize the tremendous potential of being able to link people—for business purposes—by combining the analytic power of Watson-like computing with matchmaking algorithmic technology.

IBM has developed a platform called *Personality Insights* that uses "linguistic analytics to infer individuals' personality characteristics, including Big Five, Needs, and Values, from digital communications such as email, blogs, tweets, and forum posts."[62] Basically, Personality Insights takes an individual's written material or correspondence, analyzes the content for word usage, tone, register, and sentence construction, and then maps aspects of the individual's psychology and personality. One application of this technology is *Investment Advisor*, an IBM service that connects investors with financial advisors who will be most likely to meet their unique investment preferences.[63] Investment Advisor streamlines the investor-advisor matchmaking process, saving time and money by recommending matches that are more likely to foster better working relationships, communication, and shared understanding of goals.

Non-romantic matchmaking algorithms like these have still broader applications as well. For instance, NASA developed personality-profiling technology that is currently used by companies that employ telephonic customer service representatives. During a customer's initial phone call, thousands of algorithmic bots create a psychological map of the customer using speech-based analytics (which are similar in concept to IBM's text-

---

[60] Frank Stein, "*Jeopardy!*, the 2nd Machine Age, and the 3rd Offset" (lecture, Naval Postgraduate School, Monterey, CA, April 27, 2017).

[61] D. A. Ferrucci, "Introduction to 'This is Watson.'" *IBM Research and Development* 56, no. 3/4 (2012), doi:10.1147/JRD.2012.2184356.

[62] IBM, "Watson Personality Insights," IBM - United States, accessed July 31, 2017, https://www.ibm.com/watson/services/personality-insights/.

[63] Brian Walter, "Investment Advisor," IBM, accessed July 31, 2017, http://investment-advisor.mybluemix.net/.

based analytics). When the same customer calls the company again in the future, the bots pair him or her with a service representative with whom he or she should have positive interpersonal chemistry, resulting in a higher likelihood of problem resolution and customer satisfaction.[64]

IBM's and NASA's efforts represent instances in which algorithmic technology is being used to connect pairs of people. There are also companies trying to achieve broader matches among multiple people, in teams, and across entire organizations.

C.   TEAM FORMERS

Over the last few years, civilian consulting firms have begun exploring the use of matchmaking algorithms in the workplace for multi-person team building. The frontrunner in this effort is a London-based company, founded by Dr. Alistair Shepherd in 2013.

Shepherd's company, Saberr, has developed algorithm-based customizable software that allows project leaders to model the chemistry of their current teams and predict the chemistry of the teams they seek to build. Although Saberr's products do not make fail-proof predictions, they do increase the likelihood of predicting team cohesiveness and success.[65]

Shepherd, an aerospace engineer who studied entrepreneurship at Harvard and MIT, founded the company out of a desire to understand the reasoning behind the alarming failure rates of startup companies.[66] According to Harvard Business School Professor Noam Wasserman, "More than 80% of startups fail to deliver a return to their investors, and two thirds of that is down to team dynamics."[67] Saberr originally set out to predict team chemistry in the startup environment, and quickly discovered that by

---

64 "Algorithms Are Taking Over the World: Christopher Steiner at TEDxOrangeCoast," TEDx Talks, Video, 11:15. October 31, 2012, https://m.youtube.com/watch?v=H_aLU-NOdHM.

65 Sue Tabbitt, "Forget Myers-Briggs, Algorithms Can Better Predict Team Chemistry," *The Guardian*, May 27, 2016, https://www.theguardian.com/small-business-network/2016/may/27/forget-myers-briggs-algorithms-predict-team-chemistry.

66 Ibid.

67 Tabbitt, "Forget Myers-Briggs."

analyzing personalities and values (or what Shepherd calls "deep motivators") of individuals in a group, it is possible to discover "the relationship dynamics of pairs and groups" in the workplace.[68] According to Shepherd, personality, particularly as expressed through the Big 5, helps determine a person's "role fit."[69] Values, separated into sub-categories *similarities* and *tolerance*, indicate the quality of a person's interpersonal fit.[70] For instance, if two people have very similar values, they are likely to have a positive chemistry; however, if they have dissimilar values, they can still have positive chemistry as long as they both have a high values tolerance level.

Using over three and a half million online dating profiles as a data source, Saberr began running analytics on successful matches.[71] Saberr defined a successful match as two individuals who met each other, and then simultaneously closed their accounts. The programmers chose this definition because of its implication that the individuals who matched were satisfied with their interpersonal chemistry and did not see a need to pursue anyone else. Most companies essentially do the same thing: after they find the right person for a job, they cease searching for people to fill that job.

Analysis of the successful matches revealed patterns and trends that correlated in the personality type and results from the values questionnaire associated with each profile. Although the dating questionnaires had been developed based on romantic interests, Saberr "hypothesized that compatible interpersonal values were at the core of successful relationships," and thus designed a non-romantic questionnaire based on personality and values.[72]

---

[68] Alistair Shepherd, phone correspondence, Monterey, CA, May 26, 2017.

[69] Ibid.

[70] Values as Shepherd described are based upon the recent values theory of Shalom Schwartz. Schwartz has been developing his theory of human values since the early 1990s. He defines values as the motivations, or preferences, that work alongside someone's personality to drive his or her behavior. Originally, the theory listed ten human values: benevolence, universalism, self-direction, stimulation, hedonism, achievement, power, security, conformity, and tradition. Recent research into Schwartz's theory has examined the potential existence of fifteen total values.; and Willem E. Saris, Desiree Knoppen, and Shalom H. Schwartz, "Operationalizing the Theory of Human Values: Balancing Homogeneity of Reflective Items and Theoretical Coverage," *Survey Research Methods* 7, no. 1 (2013): https://ojs.ub.uni-konstanz.de/srm/article/view/5040/4992.

[71] Shepherd, phone correspondence.

[72] Ibid.

Saberr designed its own questionnaire and built an algorithmic tool for team leaders and individuals called "Base."[73] Base is "based on Schwar[t]z Values Framework and The Big Five personality traits," and allows a user to assess his own personality and values tolerances, or to model the chemistry of his team or group.[74] The assessment process begins when the primary user e-mails a survey link to members of his team. Each survey takes roughly fifteen minutes to complete and consists of questions asking the respondent how they would feel about working with a particular type of individual they know (Figure 7). Other than an individual's work or personal e-mail address, no demographic or personally identifiable information (PII) is required for the survey. After all questionnaires are complete, the primary user receives a zero to one hundred score (with one hundred being the best) rating the team's chemistry and an assessment of where the team's strengths and weaknesses reside in terms of chemistry (Figure 8).[75] However, if it is only the primary user who completes the questionnaire, the primary user can glean useful information by receiving an assessment of his own personality and values, which will help illumine his preferred style for executing tasks.[76] A team leader can use Base to assess a team currently in existence, or to predict how the addition or loss of a team member will affect its overall chemistry. The concept behind Base differs from most of the IO psychology in that it adds a focus on interpersonal fit, thereby going beyond the standard approach of only taking into account roles and organizational fit.[77]

---

[73] "Base," Saberr, last modified 2017, https://www.saberr.com/base.

[74] Ibid.

[75] Ibid.

[76] Ibid.

[77] Shepherd, phone correspondence.

It's important to him to form his own opinions and have original ideas.

How similar to you is he?

| Totally like me |
| A lot like me |
| A bit like me |
| A bit different from me |
| Not like me |
| Not like me at all |

Saberr's questionnaire is similar in form and substance to those in Big 5 and Schwartz Values assessments.

Figure 7.   Sample question from Saberr's Base[78]

---

[78] The image is used with Saberr's permission; and Source is "Base," Saberr, last modified 2017, http://www.saberr.com/product/base.
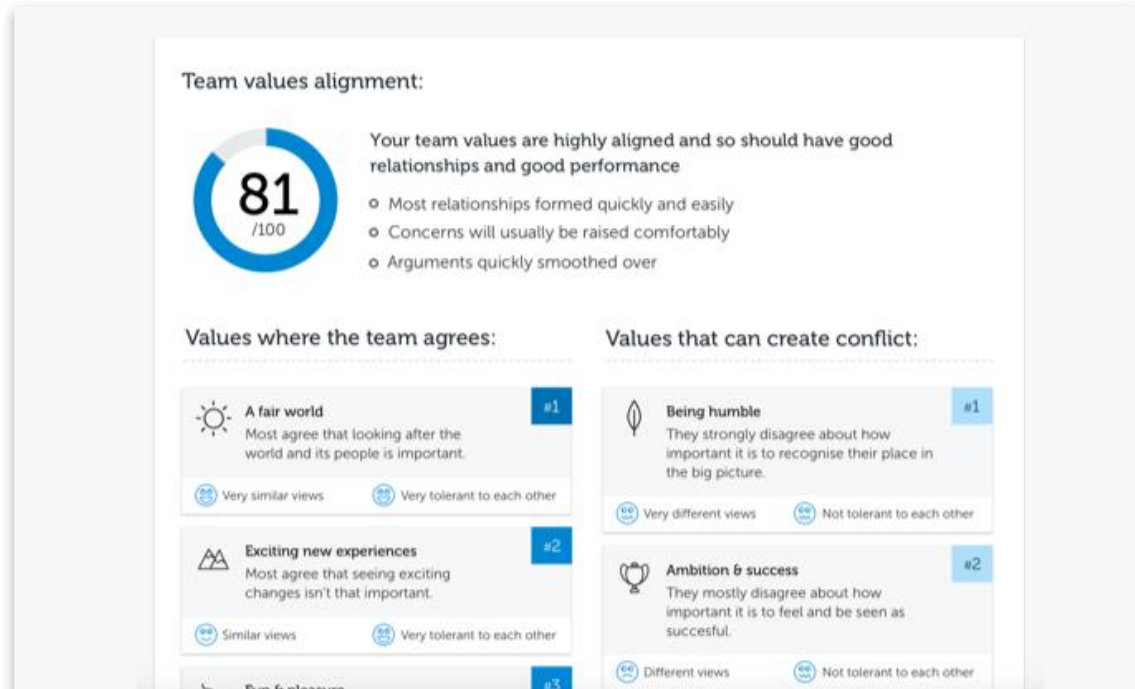
After receiving all questionnaire data, Saberr's Base produces a predictive assessment of the team chemistry.

Figure 8. Example of Base's assessment output[79]

According to Shepherd, Saberr's program has on several occasions proven itself to be highly effective in predicting team chemistry leading to successful outcomes. During the first test of the software, the University of Bristol sought to conduct a "business plan competition" among eight newly formed teams. Having no background demographic, "skill level, qualification, or experience" data on the people comprising the teams—other than the psychological data gleaned from the Saberr questionnaires—Saberr's algorithm assessed the positive chemistry levels of each team and predictively rank ordered the teams in terms of which would be the most successful. It did so with one hundred percent accuracy.[80]

[79] The image is used with Saberr's permission; and Source is "Base," Saberr, last modified 2017, http://www.saberr.com/product/base.

[80] Shepherd, phone correspondence; and Scott Carey, "London-based Startup Saberr can Predict if Someone is the Right Fit for Your Company with Its Predictive Recruitment Algorithm," Techworld, December 18, 2015, https://www.techworld.com/startups/london-based-startup-saberr-can-predict-if-someone-is-right-fit-for-your-company-3632290/.

Saberr uses a cloud-based system to store its clients' data. Once created, the data becomes the sole property of the Saberr client. According to Shepherd, the United Kingdom has far stricter privacy and ethics codes than does the U.S. Saberr's software has complied with both countries' regulations with no major concerns.[81]

We asked Shepherd if he had encountered any instances of the Saberr algorithm being ineffective or inaccurate. He said that the algorithm is not effective or beneficial to groups whose members do not collaborate regularly, such as teams with pooled or sequential task flows. He also said that there are about three to four percent of questionnaire respondents who dislike the results.[82] However, their displeasure is typically predicted during the assessment process. For example, a person who measures high in the Big 5 neuroticism category will predictably be upset in learning that he is neurotic. Thus, in an indirect way, the algorithm has served as its own proof of concept, even though some people do not like it.

Over time, Saberr has been able to refine its algorithm and has developed additional coaching tools designed to address and improve a group's specific chemistry.[83] Although the algorithm does not "have a perfect track record of predicting team performance… due to the complexity of different team environments," it is shown itself to be highly worthwhile and beneficial to teams.[84]

D.   END USERS

Saberr's products are used by a number of fortune 500 companies, for instance the Bank of Ireland, Deloitte, and Virgin Hotels.[85]

Virgin Hotels has been a Saberr client for several years. Clio Knowles, the *Vice President of People* for Virgin Hotels, speaks highly of Saberr's technology, and says it

---

[81] Shepherd, phone correspondence.

[82] Ibid.

[83] "CoachBot," Saberr, last modified 2017, https://www.saberr.com/coachbot/.

[84] Shepherd, phone correspondence.

[85] "Working Well Together," Saberr, last modified 2017, https://www.saberr.com.

has been a great tool for matching teams within her department.[86] Knowles uses Saberr's system as an aid in the management of her 21-person team, and to assist in the interviewing process when bringing new teammates on board.[87] Knowles's department at Virgin does not use Saberr's system as a stand-alone replacement for determining who to hire, or how to align teams, but rather as another lens through which to look at how people might interact, and the effects their chemistry might have on daily business.[88]

Over the past few years, Saberr's software has identified individuals at Virgin whom it assessed to be *personality outliers*, meaning there was a higher that usual likelihood that they would not mesh well with their teammates. Due to various factors, the individuals were brought onto the team anyway. However, not long after being hired, each of the individuals ended up moving on.[89] Saberr's assessment was the not the reason for their removal from the team, but the software did accurately predict that their personalities would not fit.[90] Obviously, given the accuracy of these predictions, leaders at Virgin have more reason to take Saberr predictions seriously in future hiring decisions.

E.   PREVIOUS ARMY RESEARCH

We found no previous or current U.S. Army research devoted to exploring the use of matchmaking algorithms to predict chemistry. Yet, we did find that the concept of using psychology-based algorithms to improve team composition and personnel management is not entirely foreign. In fact, the Army briefly pursued the production of such an algorithmic decision aid a little over a decade ago.

Over the course of OPERATION IRAQI FREEDOM/NEW DAWN (OIF/OND), which lasted from 2003-2011, the U.S. Army deployed military advisors to Iraq in an effort to build and train Iraqi security forces. Officially labeled *Military Transition Teams*

---

[86] Clio Knowles, phone correspondence, Monterey, CA, June 2, 2017.

[87] Ibid.

[88] Ibid.

[89] Ibid.

[90] Ibid.

(MiTT) in 2005, these small teams consisted of roughly fifteen soldiers each.[91] As the US government focused its efforts to transitioning control of stability operations to the Iraqi government, the importance of MiTTs gradually increased.[92] As these small teams became more important, so did the related suggestion that they be composed of individuals who were not only skilled at their individual jobs, but also had a high degree of team cohesion. Army decision makers then turned to psychologists working with the Army Research Institute (ARI) to develop a decision aid that would help leaders build optimally composed teams.[93]

1. TOPS

Between 2006 and 2007, an ARI-led team developed an algorithmic decision aid called the "Team Optimal Profile System (TOPS)."[94] ARI's intent in developing TOPS was to enhance the Army's ability to rapidly form effective teams through maximizing the use of available personnel and information about them. Interviewing "21 team staffing subject matter experts (SMEs) from 17 well-respected [military and civilian] organizations," the ARI team was able to list the needs that Army leaders had when staffing teams.[95] Among these, the researchers found that an individual's *fitness* for a team was the quality which leaders most often tried to assess and weigh against the individual's knowledge, skills, and abilities. In other words, the ability to be an effective team member was often as important as the ability to be an effective and competent individual.

---

[91] Kimberly Metcalf, phone correspondence, Naval Postgraduate School, Monterey, CA, March 8, 2017; and Timothy Deady, "A Year with the Best Division in the Iraqi Army," *Military Review* (November/December 2009): 44, http://usacac.army.mil/CAC2/MilitaryReview/Archives/English/MilitaryReview_20091231_art008.pdf.

[92] Deady, "A Year with the Best Division," 43.

[93] The Army Research Institute for the Behavioral and Social Sciences is an organization of psychologists charged with studying individual and team performance and developing relevant tools and methods to enhance U.S. Army readiness. It has several offices located throughout the continental United States, each office having its own focus areas.; and Metcalf, phone correspondence.

[94] Jamie S. Donsbach et al., *Team Composition Optimization: The Team Optimal Profile System (TOPS)*, v, (Fort Leavenworth, Kansas: U.S. Army Research Institute for the Behavioral and Social Sciences, 2009).

[95] Ibid., 5.

The ARI team combined the data it gleaned from the SME interviews with extant IO psychology research, and built into TOPS an Army-focused taxonomy for building teams.[96] The TOPS product worked in the following way. For example, say Captain Green wants to build a complete Special Forces (SF) A-Team from scratch. He opens the TOPS program and begins in-putting all of the team-specific qualities that he needs on his ideal A-Team, such as language skills, rank requirements, team size, freefall parachute qualification, etc. Having built the requirements for his ideal team, Green then in-puts the professional records of all available personnel for the ranks or positions he seeks to fill. TOPS matches records to Captain Green's needs, and recommends a configuration, as well as a list of personnel for him to assemble into a team. Not only can TOPS assist Captain Green in forming a team, but it can also help him—or anyone— reconfigure a team in transition.

2.   TCS

In 2010, the ARI team continued to build upon its efforts to improve TOPS's information processing and predictive capabilities. This resulted in the development of "an automated team composition decision aid" called the Team Composition System (TCS) (Figure 10).[97]

a.   *TCS Algorithm*

The first TCS component produced during this development phase was the TCS algorithm. Three approaches to team staffing informed this algorithm: "individual position-fit," "weighting," and "team profile" (Figure 9).[98]

Individual position-fit measures an individual's KSAOs against the KSAOs required for a specific position.[99] Individual position-fit is similar to the Army's concept of *strength management*. When filling a Personnel Management Authorization Document

---

[96] Ibid., vi.

[97] Scott I. Tannenbaum et al., *Forming Effective Teams: Testing the Team Composition System (TCS) Algorithms and Decision Aid*, 1, 2010.

[98] Ibid., 3.

[99] Ibid., 3.

(PMAD) vacancy within an Army unit, the strength manager tries to identify individuals in the available pool of personnel who meet the vacant billet's requirements. The soldier who most closely matches the requirements is placed in the billet. Because the individual position-fit approach is individually focused, it does not take into account existing unit members when making a position recommendation.

The Weighting approach views all individuals on a team as being unequal, and treats them as though they are on a spectrum. Some team members have the ability to "carry or undermine" the team, while others may be *weak links*.[100] For example, fictitious Team X is composed of four people. Two of the team members, Sergeant Blue and Specialist Red, have equal leadership ability. However, because Blue is filling the team's *leader* role his leadership ability deserves a greater weight than does Red's. Considering a team's unique structure and operating environment, the weighting approach suggests all team members' abilities be weighted uniquely.

The team profile approach treats all individuals' skills equally by averaging abilities across the team as whole. Additionally, it takes into consideration special required skills, such as language abilities or jump master qualification, and whether or not the team has those abilities represented on it.[101] Structurally, this approach is akin to the individual position-fit approach; however, it looks at the team instead of the individual as the unit of measurement.
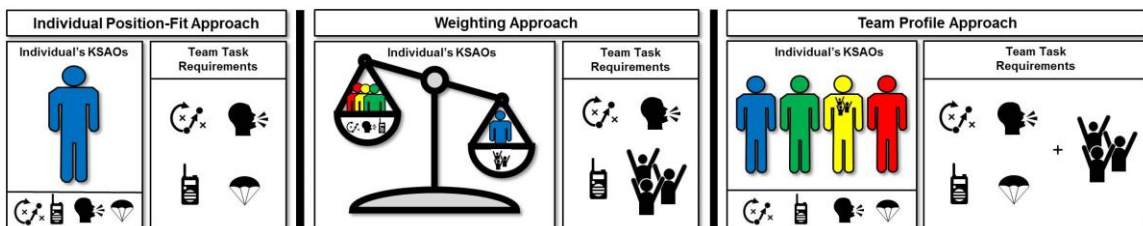
The TCS algorithm is composed of three approaches.

Figure 9.   Team staffing approaches

---

100 Ibid., 2.

101 Ibid., 3.

Combining these three team staffing approaches, the TCS algorithm enabled the TCS itself to incorporate more diverse factors and concepts than could the TOPS, leading to the generation of more robust team composition recommendations for end users.

b. TREO

The other TCS item ARI produced was the "Team, Role Experiences and Orientation (TREO) survey" tool. The TREO was a 48-item questionnaire that had the purpose of predicting an individual's "teamwork style."[102] After an individual took the survey, he would find himself categorized into one of six team roles: *organizer*, *innovator*, *doer*, *challenger*, *team builder*, or *connector*.[103] A team leader who was given a compilation of the assessed roles of his current or future team could then develop a predictive model to determine how well, or poorly, his team members would work with each other given their particular mission set. For instance, a team composed mostly of innovators would probably not make for the best Ranger fire team, but might instead excel as a Commander's Initiatives Group (CIG). While the TREO did not address interpersonal chemistry as we have defined it, it sought to optimize team performance by balancing roles and matching roles to mission sets.

Through a series of three unique tests using the TCS algorithm and TREO tool in collaborative team settings, the ARI team found the TCS decision aid to be a better predictor of teamwork potential than traditional talent management mechanisms or systems. ARI's success led it to develop a TCS prototype, ready to employ at the user level. Deliberately designed to be basic in form and capability, this prototype showed promising results, which the ARI team hoped it could further refine into a more powerful, scalable tool for government and civilian team builders.

---

[102] Ibid., 3.

[103] Ibid., 4.
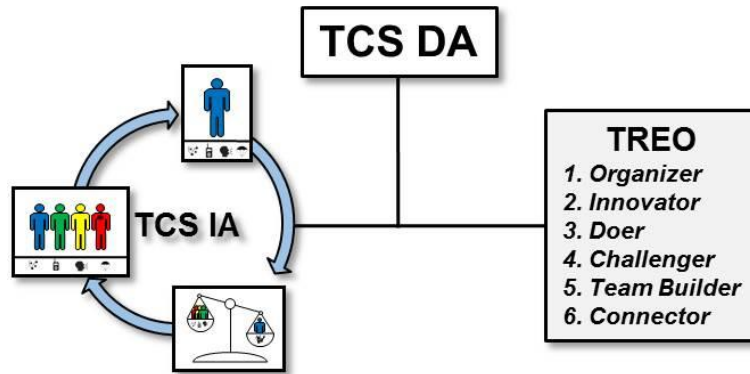
The TCS Decision Aid incorporates a team composition algorithm and a survey tool.

Figure 10.   Composition of the TCS decision aid

Unfortunately, the TCS project did not receive much support or use by the U.S. Army.[104] We can only speculate as to why. Perhaps potential end-users balked at having to pre-configure their ideal team characteristics at the beginning of a staffing process, since it would have taken time to learn and use a new system. Also, there may have been a natural reticence to using a math-based system to manage humans. Alternatively, the timing might have been problematic; with 2010 being close to the end of OPERATION IRAQI FREEDOM/NEW DAWN (OIF/OND), decision makers may have not seen the need to invest in software for MiTTs which they optimistically might have thought would soon be dissolved. Whatever the reason for its disappearance, ARI's research went largely unnoticed and forgotten.

F.   THE TECHNOLOGY EXISTS

Although ARI's research never gained a foothold, the technology for predicting human chemistry exists and is continuing to improve with promising results. ARI's attempt reveals that the Army has recognized the need to optimize team composition in the team building phase in the past, and has been willing to invest resources to address the problem. If ARI's work was combined with today's computing power, it should be possible to develop a tool that will be both effective and well received. Of course,

---

104 Metcalf, phone correspondence.

successful implementation requires an appetite among leaders in the force for such a tool, which is what we address in the next chapter.

IV. ASSESSING THE ARMY AND ITS APPETITE FOR ALGORITHMS

A. APPLICABILITY TO THE ARMY

To determine the applicability of implementing a team-building decision aid, in the Army, we spoke with thirty-two Commissioned, Warrant, and Non-Commissioned Officers, and Civilians throughout ARSOF, to include individuals from Special Forces (SF), Civil Affairs (CA), Psychological Operations (PO), Engineer (EN), Adjutant General (AG), and Infantry (IN) branches. All respondents were SMEs, having experience building, managing, and leading organizations ranging in size from a CA Detachment to a Special Forces Group.

We structured our discussions around a series of five questions (Table 1), after showing respondents a brief video we produced. The video was two minutes, fifty seconds long, and explained some of the predictive analytic capabilities of existing matchmaking systems that assist in pairing two- or multi-individual teams based upon compatibility measures. It served as an *elevator speech* that clarified what we were asking respondents to consider. The questions we then posed concerned not just the applicability of using a matchmaking decision aid within ARSOF, but also the appetite among current service members for learning and implementing such a system. We asked the SMEs to respond to our questions either verbally or in written form.[105]

---

[105] The discussions we had were organic in nature, meaning that although we presented a video and questions, we allowed everyone to respond as they saw fit. Some respondents answered all questions; some did not. Some provided new insights which we had not anticipated. Although we provide numbers on the following pages, these numbers should be understood as only our rough assessments of how respondents viewed certain questions and topics.

Table 1.   Discussion questions

	Discussion Questions
1.	Would algorithms be a valid/valuable resource to assist leaders with strengthening team chemistry/cohesion?
2.	If an efficient, user-friendly algorithmic decision aid existed, would you use it? If not, why? What would convince you to use it?
3.	What are the drawbacks to building a decision aid like this?
4.	How much time would you be willing to invest in using this?
5.	What steps should be taken to build a decision aid for modifying team chemistry?

After consolidating all responses, we could identify several trends. It is important to highlight that we could identify no rank-, culture-, or experience-specific responses. Also, we did not find that millennial or mid-level officers were any more or less receptive to new technological systems than ARSOF senior leaders. Rank, branch, or experience did not seem to color individual respondents' sentiments. In the sections below, we consider the responses to each of our questions.

1.   Would algorithms be a valid/valuable resource to assist leaders with strengthening team chemistry/cohesion?

We phrased this question in a deliberately vague and open-ended way, realizing that every respondent would answer it differently, given his or her background in terms of education and experience. Responses to this question were mostly binary. Respondents answered either *yes* or *no*, with few caveats: twenty believed such a tool would be both valid and valuable in assisting to strengthen team chemistry/cohesion.[106] Those within the yes group indicated that a decision aid could be beneficial in assisting junior leaders' judgment and confirming senior leaders' intuition when placing new personnel onto teams, and in the creation of *ad hoc* or new organizations, such as those within the SF Groups' 4th Battalions. For instance:

> Yes. I definitely think it would be a great resource to assist leaders with strengthening cohesion. I look [at] it as a consulting tool that a trained SME/"consultant" could guide a team through taking the test. The team could sit with the "consultant" and analyze the team dynamics.[107]

---

[106] 15% did not answer this question.

[107] MAJ, SF, email correspondence, Monterey, CA, June 16, 2017

Four respondents said they believe that such a system would only work well at certain levels within a military organization.

Three people answered *no*, and provided several reasons for their response. One objection was that the military has tried—and failed—with similar systems in the past. Another said that he did not believe it is possible to design cohesion before forming the team:

> No - my read is that strengthening chemistry and cohesion happens after the team has already been formed. Rather algorithms could help in culling the herd, prior to assignment, and identifying from a field of many (support soldiers and officers) candidates more like[ly] to fit in and perform.[108]

2. If an efficient, user-friendly algorithmic decision aid existed, would you use it?

In the Army, the term *Good Idea Fairy* is commonly used to describe an idea that would improve operations, but for reasons having to do with time or resources, its implementation would ultimately be wasteful. We used this question to probe whether current decision makers see both a theoretical and practical value in developing a new decision aid.

Similar to the responses to the first question, most of the respondents (18 people) said they would use such a decision aid, especially when it came to placing incoming service members:

> Yes, I would absolutely use an algorithmic decision aid to assist with pinpoint[ing] assignment of officers and senior NCOs. A tool like this would help CDRs make decisions about the best place to pin point incoming SMs [Service Members].[109]

Sixteen of the eighteen individuals who said they would use an algorithmic decision aid clarified that, while they would use the system, they would not allow it to replace any personal or gut instinct or advice from officer or NCO counterparts. For

---

[108] LTC, SF, email correspondence, Monterey, CA, June 19, 2017.

[109] LTC, LG, email correspondence, Monterey, CA, July 18, 2017.

them, the tool would serve to primarily provide insight or an additional viewpoint when considering a new soldier.

Two people stated that they were undecided about using such a decision aid. They expressed skepticism that a chemistry decision aid would be able to transcend different environments and organization dynamics.

> Probably not—there's more to a team's efficacy than personalities. I would likely question the data that drove the assessment and prefer to make my own assessment of the individual and their ability to form a cohesive team based on a number of other factors.[110]

> I would be concerned that the personality assessment and team cohesion in a training environment would not necessarily apply in other environments. A cohesive team in a high stress combat environment, may not necessarily operate the same way in an embassy or interagency environment.[111]

3.   What are the drawbacks to building a decision aid like this?

We regarded this and the next question as the most important in our discussions since further reflection about decision aids could potentially lead to not wanting to pursue an algorithmic aid. We received the widest range of responses to this question since there are numerous issues that could arise with the development and implementation of a new talent management system. Regardless of a respondent's position on using algorithms, he or she identified meaningful setbacks worthy of a developer's consideration. The main themes that emerged were the difficulty of getting end user buy-in, the potential of respondents to game the system, the potential of leaders to misuse the system, and the potential for stunted leader development.

Also, there was a strong sentiment conveyed in many of the discussions that though imperfect, the current system has worked. Trying to implement something new (and potentially complicated) will require too much effort and will not make enough of a difference to matter in a timely manner. It would be easier to *just stick with what we've got*.

---

[110] LTC, SF, email correspondence, Monterey, CA, July 19, 2017.

[111] MAJ, PO, email correspondence, Monterey, CA, July 7, 2017.

a. End User Buy In

Getting buy-in will always be a challenge with any new system. At face value, a system that works like eHarmony or Match.com might come across as being out of place in a military setting, and the benefits of using such a program might not be immediately visible. There seem to be several philosophies for getting buy-in. The first is top-down, command-mandated buy-in. Essentially, if the leaders make a talent management tool a priority, their subordinates will follow.

> Place Command emphasis on it. If it's easy to use and the Commanders tell you to use it, then it could theoretically take hold…. This raises the question: how do you motivate Commanders and Senior NCOs to focus on this processes [sic] in order to improve the force? What's their buy-in and benefit (short-term & long-term) for them?[112]

Two respondents were not convinced a top-down approach would work and recommended that buy-in start at a grassroots level, and spread via word of mouth.

> With the explosion of machine learning and a younger generation who is willing to test out these predictive models, the time is right to test and apply this technology to improve unit cohesion at the smaller unit levels. I would recommend that you sell the concept to the smaller unit levels first. What I have seen is a natural resistance to change amongst some of the more senior members of the ARSOF enterprise and perhaps they wouldn't be as comfortable with this approach.[113]

Regardless of the initial source of support (top-down or bottom-up), the system itself must include built-in incentives in order to encourage usage. The Army already has mandatory personnel-related, periodic requirements, such as the Multi-Source Assessment and Feedback (MSAF) 360 Program, that many people feel free to ignore because the requirements: 1) are not a priority; 2) have no real consequence for delinquency; and/or 3) compete for time with arguably more important items on the training calendar.[114]

---

[112] MAJ, SF, email correspondence, Monterey, CA, June 14, 2017.

[113] ARSOF HR Civilian, phone correspondence, Naval Postgraduate School, Monterey, CA, August 14, 2017.

[114] Secretary of the Army, *Changes to the Army Evaluation Reporting System*, Army Directive 2011-16, (Washington, DC, 2011), https://msaf.army.mil/ReferenceDocuments/Army%20Directive%202011-16.pdf.

b.   Gaming the System

The most common theme that emerged regarding the potential drawbacks of a decision aid revolved around the accuracy of the data received and the propensity for people to try and game the system—or answer a questionnaire untruthfully in an attempt to receive a desirable outcome or assessment. A personality evaluation system is only as effective as respondents' desire and ability to self-reflect and self-assess. A person might even skew an assessment simply through misunderstanding a question.

> At some point (and usually pretty early on), people will want to game the system and provide answers that they perceive the system wants vice being honest and that will obviously skew the data. Lastly, I believe that there exists an inherent distrust in providing accurate data about oneself over concerns of what else this could be used for. Again, contributing to skewed data.[115]

> When you took the tests in the Q-Course or any other military setting, were you more concerned about the accuracy of the results, or the consequences answering as expected had on your future success in the program? It may be fairly easy for Soldiers to learn how to game the system, if the right answer leads to career opportunities.[116]

> Most in the military are almost pre-conditioned to answer questions about ourselves to what we think the answer should be.[117]

c.   Unhealthy Temptation

Another concern respondents mentioned was that commanders and command teams would manipulate the system to create an organization that might not be healthy, but would serve senior leaders' purposes. A commander might be tempted to seek and thus assess for highly agreeable personalities in order to build an organization full of compliant individuals, increasing the propensity for groupthink.

> Commanders may abuse the system to shape teams that they prefer. A highly aggressive commander may prefer that all of his teams mirror his personality or preference, thereby depriving the unit of dissenting views or subordinates that approach complex problems with more thought and

---

[115] COL, SF, email correspondence, Monterey, CA, July 11, 2017.

[116] MAJ, SF, email correspondence, Monterey, CA, July 11, 2017.

[117] MAJ, SF, email correspondence, Monterey, CA, June 29, 2017.

rigor. I can easily see this being used to generate teams of "yes men" if not effectively supervised.[118]

More concerning than the likely temptation to deliberately select people according to particular traits was the fear that leaders would do the opposite and deliberately discriminate against people because of personal qualities the leaders do not like.

> The EO and EEO aspects of such a decision aid would be of concern to me if made into a formal assessment and decision-making aid.[119]

> I like the idea, as long as it's used as an additive tool not a discriminatory tool.[120]

Any tool that takes into account an individual's personality traits inherently highlights what makes one person different from another. There could be significant issues should a highly-qualified candidate perceive (correctly or incorrectly) that he was not accepted for a position because of an algorithmic decision aid. Because personality traits are specific to a person, and are products of an individual's background, upbringing, education, and life experience, determining that a person might not be the best fit for an organization because of his personality could prove to be problematic for decision makers.

d.   *Minimize Leader Development*

Furthermore, many of our SMEs expressed the view that allowing leaders to build teams from algorithms would deprive them of the valuable opportunity to personally learn how to manage dynamic organizations and gain experiential wisdom through having to deal with interpersonal conflict. They might over-rely on the tool itself, using it as a substitute for human intuition. Also, there is a common, strongly held belief that regardless of how well personalities initially fit together, shared struggle and hardship will overcome personality conflict and forge cohesive teams.

> [Using decision aids] Could be bad for leadership development—if leaders have teams that are easiest for them to lead, then they might not be able to

---

[118] MAJ, PO, email correspondence, Monterey, CA, July 7, 2017.

[119] LTC, SF, email correspondence, Monterey, CA, July 19, 2017.

[120] CSM, SF, email correspondence, Monterey, CA, July 19, 2017.

gain leadership experience because there are no (or less) leadership challenges.[121]

I imagine the other sticking point is going to be trying to prove (to the Army/SOCOM, not for the thesis) that these new modeled teams are more effective than the teams assembled the old fashioned way. Arguing against simplicity and the sacred commander's intuition will be the biggest hurdles I think.[122]

4. How much time would you be willing to invest in using this?

As with the previous question, question four probes the appetite a decision maker might have for implementing a new system given his or her already busy duty schedule. After all, it would take time to learn a new system, as well as to fully implement it throughout a formation. Then, there is how frequently the system would be used. We intentionally left the wording of this question vague and open-ended in order to allow the SMEs, particularly those with more hands-off styles, to answer as they felt comfortable.

Of the nineteen who responded to this question, twelve said that they would be willing to invest an initial period of time to learn the system (a few hours), and then use the system afterwards for continued team building and talent management if it were simple, streamlined, and easy to use. Drawing from the responses, it appears that a one hour-long block of instruction explaining what the system does and how it works, followed by an annual requirement to take the 15 minute-long questionnaire, would be preferable.

Up front time, if it takes more than an hour, then you start to lose attention.[123]

Since we get so many online surveys, I would say 30–45 minutes to learn or use the system. Anything longer and you will start to have people not answering the questions truthfully. They will just want to get done with it.[124]

---

[121] MAJ, CA, personal correspondence, Naval Postgraduate School, Monterey, CA, June 14, 2017.

[122] MAJ, SF, email correspondence, Monterey, CA, July 10, 2017.

[123] MAJ, SF, personal correspondence, Naval Postgraduate School, Monterey, CA, June 14, 2017.

[124] MSG, CA, email correspondence, Monterey, CA, June 22, 2017.

One concern that was consistently raised was adding yet another requirement to an already task-saturated schedule full of competing requirements. Systems like the MSAF 360, which is an online profiling and assessment system already available, are often regarded as burdensome requirements, especially when they do not add value, or produce any tangible worthwhile results. The fear is that adding another online assessment will take time away from training or other requirements; there are already plenty of other things soldiers can do with their time. Having to learn and use this system could potentially be just another distraction that does not yield a good pay off.

> Tough call. At the SF Company Command level, I imagine most Commanders would invest moderate amounts of time into this system. However, my guess is that this would compete with other personnel management requirements (e.g., awards, evaluations, recommendations, counseling, etc.) which already do NOT receive the amount of attention or detail that they deserve.[125]

> In an over-surveyed military, would this just be another test/survey/annual requirement that becomes more of a chore than a product that an individual soldier puts into it.[126]

5. What steps should be taken to build a decision aid for modifying team chemistry?

Three trends consistently surfaced in the answers to the fifth question. According to respondents, for an algorithmic decision aid to be successful, there needs to be: a clear—possibly team- or unit-specific—definition of what a good/bad team looks like; a practical, quantifiable set of chemistry screening criteria; and a user-friendly, military-focused, standardized program interface which can facilitate periodic assessment.

a. *Define Good and Bad*

Defining what factors make a good/bad team seems to be the most complicated aspect of developing a decision aid. *Tribalism* and other forms of either positive or negative bias would likely contaminate the process, making consensus nearly impossible. One SF LTC summed up the major issues when responding:

---

[125] MAJ, SF, email correspondence, Monterey, CA, June 14, 2017.

[126] LTC, SF, email correspondence, Monterey, CA, July 10, 2017.

First, we would need to have the identified personality test that will be applied across the regiment (and "matching" doesn't just mean personality type, it can also be based on level of experience, age, etc.). Then, we would need to test both superior and inferior ODAs to identify if there are any identifiable links between performance and personality. This would have to be done across the regiment to avoid certain "tribal" traits found in particular groups from skewing your findings.[127]

This concern echoes the fact that throughout various industries, organizations, and environments, there are different variables that contribute to cohesion and success. The personality traits and team chemistry required for a cohesive and successful basketball or sales team can differ greatly from those required for a cohesive military formation. The biggest challenge would be identifying which specific attributes or characteristics should be combined and deciding how those attributes would be weighted for a military formation.

b.   *Build the Set of Metrics*

While baseline work has been done to study individual personalities and how the combination of certain personality traits among a group of individuals contributes to team chemistry and cohesion, our discussions identified that it is important to distinguish how this might prove different in the military.

> Start with industry and see what they're doing. Gather feedback from officers and NCOs on what screening criteria/distribution of attributes we should have in our units. Begin testing... At some point we'd need to identify some quantifiables to compare standard assignment units against personality driven ones.[128]

> There should be some deliberate effort to codify "team chemistry/cohesion." It has been used in the civilian world for some time now, and could provide insight into an approach for the military.[129]

---

[127] LTC, SF, email correspondence, Monterey, CA, July 17, 2017.

[128] MAJ, SF, email correspondence, Monterey, CA, July 5, 2017.

[129] MAJ, PO, email correspondence, Monterey, CA, July 2, 2017.

c.   *Keep a Military Focus*

Five respondents emphasized that any systems or algorithms designed must be military-specific based on military-specific research. Additionally, a system must ensure that teams and organizations are designed to encompass a broad range of personalities.

> In my opinion, the most effect[ive] teams blend introvert to extrovert personalities across the spectrum of personality traits. Aptitude algorithms typically set a base line standard that a SM must meet to be considered for an organization. Personality algorithms are more effective for designing strong teams. The exact algorithm that blends personalities would need further analysis. To begin, it is safe to say that a blended approach (either very strong at each end of the spectrum or team members that are individually blended) is the best place to start.[130]

B.   RESPONSES TO SEVERAL CONCERNS

While we are unable to fully address all of the concerns our respondents raised given the military's lack of experience with matchmaking algorithms in a team setting, we feel our research does provide insights into pressing issues, such as gaming the system, over reliance, and unhealthy manipulation.

1.   Gaming the System

Two aspects of the matchmaking work against being able to "game" the system: the questionnaire format, and relative team composition. Questions do not permit binary, yes or no answers. Instead, each question generates five or six possible answers along a spectrum. Moreover, because the output of the team survey includes every individual on the potential team, it is in everyone's best interest to answer each question as truthfully as possible in order to avoid becoming *the* source of friction. Answering in too exaggerated a fashion, or in deliberately untruthful ways, will likely lead to faulty insights that can do more harm than good to team cohesion.

2.   A Crutch

Given the potential to gain powerful insights about one's team, the temptation to use matchmaking tools in lieu of making interpersonal connections will be strong,

---

[130] LTC, LG, email correspondence, Monterey, CA, July 18, 2017.

especially if the predictions the tools make are sound. However, each leader will need to find his own style and develop self-discipline to balance the benefits of using this tool with refining his own judgment. Perhaps in some cases, for leaders with low emotional intelligence, relying on a matchmaking tool might benefit the team overall and even educate the leader about interpersonal relationship dynamics. Some leaders might be particularly intuitive when it comes to managing people, and may not feel the need to use such a tool. In this case, the tool may not be used to predict, so much as confirm that the leader is making sound choices.

3. Unhealthy Manipulation

As with any tool that promises to make certain systems more efficient, some individuals will seek to exploit it for inappropriate reasons. In the case of a talent management tool, these reasons would likely be discriminatory in nature. In order to get ahead of, and mitigate, this risk, any unit attempting to develop such a tool for the Army ought to work closely with the Army's Equal Opportunity (EO) entities to ensure appropriate checks and balances are built into the system. Moreover, much as now, leaders will need to continue to police their own peers, as well as subordinate leaders, to strengthen the integrity of the force.

C. THE CONDITIONS ARE SET

As we have seen thus far, the science, technology, and military appetite exist for pursuing a matchmaking tool for the Army, and for ARSOF in particular. In the next chapter, we lay out an argument for the way ahead.

V.   DISCUSSION, RECOMMENDATIONS, AND CONCLUSION

A.   ANSWERS TO THE INITIAL QUESTIONS

In order to open our discussion, we return to the questions we asked at the beginning of our thesis.

1.   Might matchmaking algorithms accurately predict human chemistry?

Regarding the predictive accuracy of matchmaking algorithms, we are unable to reach a conclusive yes. The lack of consensus among psychologists with regard to human chemistry is the biggest obstacle to being fully confident that matchmaking algorithms work. Nevertheless, the psychologists' theories and models have provided solid foundations upon which technologists have built their matchmaking algorithms. The technologists have made, and continue to make, significant headway in using their algorithms to create beneficial, chemistry-related aids, as attested to by the algorithms' users. However, while promising, these testimonials are experiential only, and the scientific research into human chemistry remains contradictory and inconclusive.

For instance, previously mentioned 2012 research by Finkel et al. concluded that matchmaking algorithms cannot yet accurately predict chemistry.[131] Despite the fact that the study is five years old (as of this writing) and significant technological advances have occurred since then, we think there would be no huge risk in agreeing with the study's findings were we merely discussing long-term romantic relationships. However, for Army purposes, cohesive relationships need only last for eighteen to twenty-four months, not a lifetime, and require no degree of romance (let alone sexual attraction).

Because of the seemingly successful uses to which matchmaking algorithms have been put in business settings, we see this as a realm in which matchmaking algorithms display their greatest utility. Testimonials to the algorithms' efficacy suggest that not only do algorithms screen out incompatible people, but they also provide fairly accurate

---

[131] Finkel et al., "Online Dating," 59.

insights as to which teams will be cohesive and compatible. The true extent of their accuracy remains to be seen.

2. Can algorithms be converted into a user-friendly, Army-specific application?

It remains to be seen whether matchmaking algorithms are suitable for an Army setting, particularly given the Army's unique nature and team members' job of often working with each other in austere, isolated conditions for extended periods of time. There may be some stressors involved with combat situations which affect personalities, and thus interpersonal relationships, in such a way as to negatively impact the predictive power of algorithms. However, most Army proofs of concept follow a well-established path: they must first be developed and tested in a simulated training environment with the tacit understanding that combat factors are never fully replicable. In our recommendation section, we make several recommendations as to where ARSOF can begin testing this concept.

Our discussions with the Talent Management Task Force, Defense Advanced Research Projects Agency (DARPA) and Defense Innovation Unit Experimental (DIUx) indicate that there are no efforts underway at this time to explore the use of matchmaking algorithms for team building. However, were ARSOF to serve as the test bed and produce good results, we believe an Army-specific application would follow in relatively short order.

3. Would ARSOF leaders be willing to employ an algorithmic aid?

In a perfect world—i.e. a world with no competing requirements— we believe most ARSOF leaders would answer yes, given the responses we received in our discussions. A tool which promises to simultaneously provide new insights and free up a decision maker's time would be incredibly attractive. However, based upon our discussions with SMEs and psychologists, we notice that SMEs (and even we ourselves) find it difficult to truly conceptualize how such an aid would work. As with many other new programs, most people would probably need to see the algorithms applied to fully appreciate how they operate.

Based upon what we have seen of Saberr's (and others') products, we believe matchmaking algorithms are inherently incentivizing which should impel Army leaders to want to try them. Team members, too, will want to use the software if they feel it will offer them insights into ways they can assess and strengthen their own teams. Most soldiers have felt the emotional drain of dysfunctional working relationships to some degree, so they will most likely welcome a tool which mitigates this form of personal and professional frustration.

B.   MATCHMAKING ALGORITHMS COMPLEMENT THE ARMY'S CONCEPT OF LEADERSHIP

The concepts and theories underlying matchmaking algorithm technology complement Army doctrine regarding leadership and the professional ethic. According to ADP 6-22, military leaders are obligated to develop their subordinate personnel and build cohesive teams. The insights provided by matchmaking programs can reveal nuances about personalities and provide additional material for robust counseling sessions. These insights would help with building a team, reorganizing a team, and receiving a new team member, in addition to individual counseling.

The ability to understand one's subordinates is critical, particularly when it comes to developing empathy for what drives individuals' opinions, actions, and reactions.[132] Matchmaking technology can assist leaders at all levels with honing their understanding. For example, when a new platoon leader joins a seasoned platoon, he will be able to access and review the team chemistry information about his subordinate squads, as well as gauge the likely chemistry he can expect to share with his platoon sergeant. Armed with these assessments, as well as with insights generated from his personal interactions, he will be better postured to "work to build or restore relationships, determine shared goals, remove perceived threats or other actions, and clarify how the influence action relates to their personal values."[133]

---

[132] Department of the Army, *Army Leadership*, 2–3.

[133] Ibid., 2.

Another area where matchmaking technologies would benefit leaders is in receiving new personnel or reorganizing personnel already on-hand. Given a commander's responsibility to cultivate his soldiers' "health, welfare, morale, and discipline," along with his "freedom to place people in the best situation to maximize their talent," matchmaking technology can provide recommendations for optimal team placement.[134] Given his unique mission priorities, a leader might choose to organize teams of equal chemistry, or if he needs to create a cohesive detachment which will operate outside his direct purview, he can stack it with personnel who will have the strongest likelihood of being cohesive.

Lastly, but not least importantly, Army leaders must "act to promote long-term stewardship of the Army."[135] By using a matchmaking tool to assess and potentially strengthen the chemistry of his teams, a leader would reduce the likelihood that his soldiers will feel isolated from their comrades and spiral into destructive, disruptive behaviors.

C. RECOMMENDATION 1: CONDUCT AN ASSESSMENT AT ROBIN SAGE / SLUSS-TILLER EVENT

Because the affirmative data thus far has been experiential, and has come solely from civilian sources, we recommend that USASOC conduct an assessment of a human chemistry decision aid at one of its qualification course culminating events, such as Robin Sage or Sluss-Tiller. Wherever the test is applied, the conditions must replicate a team-forming, combat situation that includes creative problem-solving scenarios. We propose executing the test at Robin Sage and recommend the following outline for a pilot.

First, the research team should gather historic data (to include about class sizes, pass/graduation rates statistics, team performance, and peer evaluations from previous Robin Sage classes). This data would be used to develop a baseline against which to measure the algorithm.

---

[134] Ibid., 4, 8.

[135] Ibid., 8.

Researchers would then conduct two iterations of assessments at Robin Sage using algorithmic predictive software similar to or actually developed by Saberr that would provide team profiling and coaching services for team and talent management. The purpose of testing would be to validate the capability of using the predictive analysis of matchmaking algorithmic technology to assist in the development of teams and talent management.

For testing, a class size of at least 100 students should be processed through the Saberr system (consisting of a 15 minute-long online questionnaire), and researchers would interpret the feedback, make predictions on team and individual performance, and compare the findings with the outcomes of the exercise.

The first iteration of testing would be used to gather data, without adjusting the teams it would also serve to validate the predictive analysis of the tool in relation to the performance and cooperativeness of the teams in Robin Sage.

During the second iteration of testing, teams would be reorganized after taking the questionnaire, based on software recommendations and coaching to optimize team cohesion and maximize successful outcomes across all teams. Peer evaluations, cadre observations, and completion rates would be taken into account to see how well the predictive analysis did.

After these two iterations of testing are complete, all new and historic data would be analyzed, and captured in a paper detailing the findings of the research. A preliminary determination would be made as to whether available predictive analytics would benefit ARSOF units when they build teams for combat missions. Testing would demonstrate the extent to which a Saberr-like software can recommend solutions to team cohesion challenges, prevent conflict, and optimize team performance. It could be too, that test results suggest further refinements or more tailored adjustment of the software are needed before a second pilot effort is tried.

D. RECOMMENDATION 2 (CONDITIONAL): ADD MATCHMAKING TOOL TO EXISTING PLATFORMS

The Army currently has several web-based architectures which could support the implementation of an Army-wide matchmaking tool. We offer these as in-place solutions in order to mitigate the development of a completely new system. The two platforms which could easily incorporate such a tool are the MSAF 360 and the Assignment Interactive Module (AIM) 2.0.

Matchmaking tools which rely on questionnaires for input work nearly identically to the way in which the MSAF 360 receives data: one person initiates a survey by emailing links to a specific population (Figure 11). Neither MSAF 360 nor AIM 2.0 requires demographic or personally identifiable information outside of an e-mail address. However, unlike with MSAF, which recipients have very little incentive to complete, recipients of the team-building tool could either be compelled by order (last resort) or impelled by the promise of reduced personality clashes (preferred). Currently, soldiers are required to initiate a 360 assessment every thirty-six months. Because personality and values remain relatively constant from a person's mid-twenties till they are in their forties, we recommend soldiers execute a questionnaire as part of the PCS or redeployment process in order to capture any changes which may have occurred.[136]

---

[136] Shepherd, phone correspondence.

The core aspect of the MSAF 360 is a multi-page questionnaire, which could be transformed into a chemistry questionnaire with minimal aesthetic or formatting differences.

Figure 11.   MSAF 360 questionnaire page[137]

Regarding a location for information storage and computation, the Army's new AIM 2.0 program would be ideal given its intended purpose of being a collaborative tool for soldiers and talent managers. Within the AIM 2.0 is a page called "My Resume" that is specifically intended to contain all of a soldier's non-professional data which might be of interest to the unit (Figure 12). A soldier's inputs from a team-building questionnaire could be housed on this page. As needed, a talent manager would be able to access the data and build it into a team chemistry model composed of all other current or tentative team members. Having a model to predict chemistry would enable a talent manager to make stronger recommendations for personnel movements or reorganization.

137 Adapted from "Multi-Source Assessment and Feedback," Combined Arms Center – Center for Army Leadership, accessed October 31, 2017, https://msaf.army.mil/Home/LeadOn.aspx.
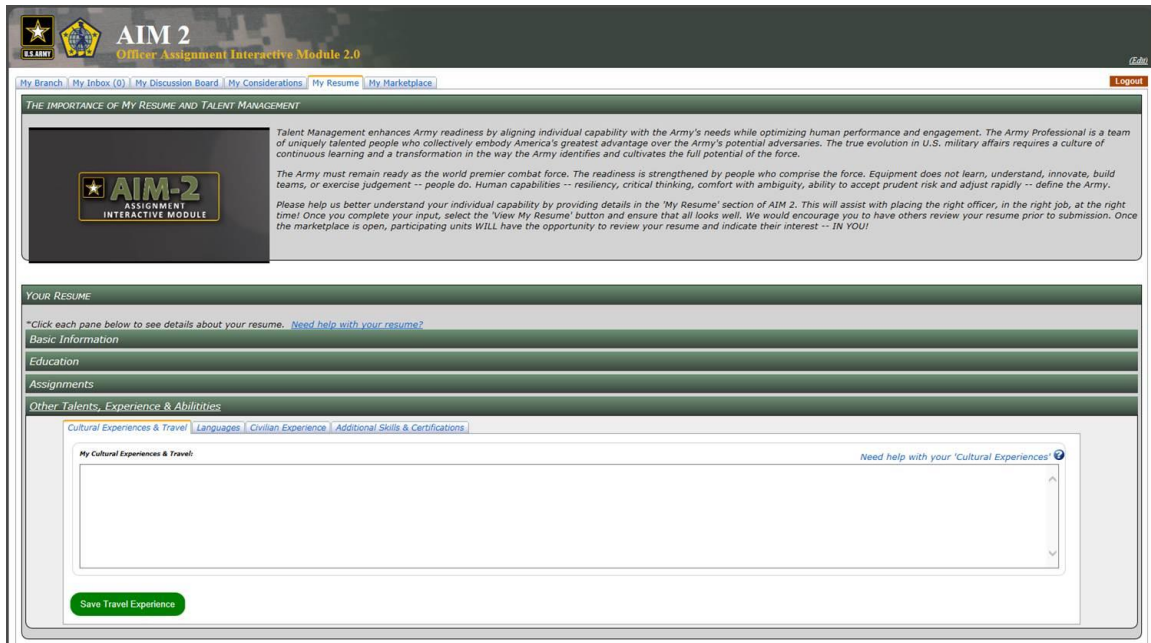
The "My Resume" screen has a section for inputting a service member's unique qualities. This page could house the soldier's personality assessment data for use by personnel managers.

Figure 12.   AIM 2's "My Resume" page[138]

E.   RECOMMENDATION 3: TOPICS FOR FUTURE RESEARCH

Topics that stand out as worthy of future research are: a reengagement with the Army Research Institute to build on its past work and pursue more refined efforts, as well as finalized products; applications and usage of text-based analytics versus using self-reporting questionnaires for evaluating individuals; and exploration of ways to gauge how chemistry works among America's adversaries for the purpose of exploitation.

1.   Text-Based Analytics versus Questionnaire Self-Reporting

Many of the ARSOF SMEs with whom we spoke brought up the potential for people to game any type of system based upon self-assessment questionnaires, and the fallibility that is inherent in any type of personality testing. These two subjects will likely continue to be an issue, and can be exacerbated by the fact that most personality tests or

---

[138] Adapted from "AIM 2 Officer Assignment Interactive Module 2.0," U.S. Army Human Resources Command, accessed October 12, 2017, https://aim.hrc.army.mil/officer.aspx.

evaluations are done in situations when an individual knows he is being evaluated, and is eager to succeed.

As mentioned earlier in this thesis, the work that IBM is doing with Watson Personality Insights is an example of a pioneering effort to map someone's personality and values through text-based analytics. If the Army were to pursue any predictive analytic system that sought to use matchmaking algorithms to build teams or organizations based on personality profiles and value systems, collecting the most accurate information about an individual's personality traits, characteristics, and values would be of the upmost importance. The use of text-based analytics might assist in developing a more well-rounded assessment of a person. Evaluations could combine the current approach of personal interviews and self-reporting questionnaires, with text-based analysis.

Research into the current state of text-based analytics should focus on how and where organizations are using it, its capabilities, and its accuracy. If text-based analysis proves promising, further research could be conducted to determine what challenges there are or how difficult it would be to introduce a text analyzing application or platform into the current military evaluation process (i.e. MSAF 360, AIM 2.0, the psychological assessment process, etc.). Lastly, pilot efforts could be used to determine how text-based analytics could be applied to understanding an individual, to assist in job placement and talent management.

2.   Assess Adversaries' Chemistry

Along with benefitting talent managers, matchmaking algorithms might help intelligence analysts with their assessments of neutral and adversarial personalities and networks. Social Network Analysis (SNA) is a burgeoning field of study which examines the connections between people, places, and/or things in order to illuminate relationships. As matchmaking algorithms and computing power continue to advance, they could be incorporated into SNA, or similar efforts designed, to assess the quality and robustness of connections between people for the purposes of exploitation.

F. CONCLUSION

As it tries to address challenges associated with talent management and retention, the Army is highly focused on the "right person with the right talents in the right job."[139] While this is certainly an important concept, we advocate a stronger focus on *right team* since this, ultimately, is what the Army also requires. There are many ways in which the Army can accomplish this. Our recommendation of using matchmaking algorithms is but one approach that is grounded in both science and powerful technology. Ideally, by leveraging such an approach, as well as other technologies, the Army will continue to make progress as it strives to adapt in order to overcome the challenges posed by an "increasingly complex world."[140]

---

[139] Kent M. MacGregor and Charles L. Montgomery, "Talent Management: Right Officer, Right Place, Right Time," U.S. Army, January 9, 2017, https://www.army.mil/article/179947/talent_management_right_officer_right_place_right_time.

[140] Milley, "Initial Message to the Army."

LIST OF REFERENCES

Ackerman, Courtney. "The Big Five Personality Theory: The 5 Factor Model Explained (+PDF)." Positive Psychology Program. June 23, 2017. https://positivepsychologyprogram.com/big-five-personality-theory/.

Ball, Tim. "Replaced? Security Force Assistance Brigades Vs. Special Forces." *War on the Rocks*. February 23, 2017. https://warontherocks.com/2017/02/replaced-security-force-assistance-brigades-vs-special-forces/.

Barno, David, and Nora Bensahel. "Can the U.S. Military Halt Its Brain Drain?" *The Atlantic*, November 5, 2015. https://www.theatlantic.com/politics/archive/2015/11/us-military-tries-halt-brain-drain/413965/.

Beal, Daniel J., Robin R. Cohen, Michael J. Burke, and Christy L. McLendon. "Cohesion and Performance in Groups: A Meta-Analytic Clarification of Construct Relations." *Journal of Applied Psychology* 88, no. 6 (2003): 989–1004. doi:10.1037/0021-9010.88.6.989.

Brandon, Raphael. "Team Sports: Team Cohesion and Success: What is the Link?" Peak Performance Lite. Last modified 2016. http://www.pponline.co.uk/encyc/team-sports-team-cohesion-and-success-what-is-the-link-78#/.

Bridle, James. "The Algorithm Method: How Internet Dating Became Everyone's Route to a Perfect Love Match." *The Guardian*, February 9, 2014. https://www.theguardian.com/lifeandstyle/2014/feb/09/match-eharmony-algorithm-Internet-dating.

Bruhn, John G. "The Concept of Social Cohesion." in *The Group Effect: Social Cohesion and Health Outcomes*, 31–48. Dordrecht: Springer, 2009. DOI 10.1007/978-1-4419-0364-8_2.

Buchanan, Laurie B. "The Impact of Big Five Personality Characteristics on Group Cohesion and Creative Task Performance." PhD diss., Virginia Polytechnic Institute and State University, 1998. https://vtechworks.lib.vt.edu/bitstream/handle/10919/30415/etd.pdf?sequence=1.

Casserly, Meghan. "Sexy News Anchors' Surprising Effect on Women." Forbes. January 11, 2011. https://www.forbes.com/sites/meghancasserly/2011/01/27/study-sexy-news-anchors-fox-news-megyn-kelly-laura-berman/#58b9e67c3f9a.

Carey, Scott. "London-based Startup Saberr can Predict if Someone is the Right Fit for Your Company with its Predictive Recruitment Algorithm." Techworld. December 18, 2015. https://www.techworld.com/startups/london-based-startup-saberr-can-predict-if-someone-is-right-fit-for-your-company-3632290/.

Combined Arms Center – Center for Army Leadership. "Multi-Source Assessment and Feedback." Accessed October 31, 2017. https://msaf.army.mil/Home/LeadOn.aspx.

Crane, Conrad. "The Future Soldier: Alone in a Crowd." *War on the Rocks*. January 19, 2017. https://warontherocks.com/2017/01/the-future-soldier-alone-in-a-crowd/.

D'Amato, Erik. "Mystery of Disgust." *Psychology Today*. January 1, 1998. https://www.psychologytoday.com/articles/199801/mystery-disgust.

Deady, Timothy. "A Year with the Best Division in the Iraqi Army." *Military Review* (November/December 2009): 43–56. http://usacac.army.mil/CAC2/MilitaryReview/Archives/English/MilitaryReview_20091231_art008.pdf.

Department of Health Care Policy. "Predicting Violent Crime." Harvard Medical School. October 6, 2015. https://hms.harvard.edu/news/predicting-violent-crime.

Department of the Army. *Army Leadership*. ADP 6–22. Washington, DC: Headquarters, Department of the Army, 2012. http://cape.army.mil/repository/doctrine/adp6-22.pdf.

———. *The U.S. Army Human Dimension Concept*. TRADOC Pam 525-3-7. U.S. Army Training and Doctrine Command, 2014. http://www.tradoc.army.mil/tpubs/pams/TP525-3-7.pdf.

Donsbach, Jamie S., Scott I. Tannenbaum, George M. Alliger, John E. Mathieu, Eduardo Salas, Gerald F. Goodwin, and Kimberly A. Metcalf. *Team Composition Optimization: The Team Optimal Profile System (TOPS)*. Fort Leavenworth, Kansas: U.S. Army Research Institute for the Behavioral and Social Sciences, 2009.

Ferrucci, D. A. "Introduction to 'This is Watson.'" *IBM Research and Development* 56, no. 3/4 (2012): 1:1-1:15. doi:10.1147/JRD.2012.2184356.

Finkel, Eli J., Paul W. Eastwick, Benjamin R. Karney, Harry T. Reis, and Susan Sprecher. "Online Dating: A Critical Analysis from the Perspective of Psychological Science." *Psychological Science in the Public Interest* 13, no. 1 (March 2012): 3–66. http://journals.sagepub.com/stoken/rbtfl/cK9EB6/4zQ0AM/full.

Grant, Adam. "Goodbye to MBTI, the Fad That Won't Die." *Psychology Today*. September 18, 2013. https://www.psychologytoday.com/blog/give-and-take/201309/goodbye-mbti-the-fad-won-t-die.

Gurven, Michael, Christopher Von Rueden, Maxim Massenkoff, Hillard Kaplan, and Marino Lero Vie. "How Universal Is the Big Five? Testing the Five-Factor Model of Personality Variation among Forager–Farmers in the Bolivian Amazon." *Journal of Personality and Social Psychology* 104, no. 2 (2013), 354–370. doi:10.1037/a0030841.

Herek, Gregory M. "Unit Cohesion and the Military Mission." *Discover Psychology — Psychology* (blog). 2012. http://psychology.ucdavis.edu/rainbow/html/military_cohesion.html.

Hofstee, Willem K. B., Henk A. L. Kiers, Boele De Raad, Lewis R. Goldberg, and Fritz Ostendorf. "A Comparison of Big-Five Structures of Personality Traits in Dutch, English, and German." *European Journal of Personality* 11, no. 1 (1997): 15–31. http://s3.amazonaws.com/academia.edu.documents/46752417/A_Comparison_of_Big-Five_structures_of_p20160624-28204-1eeoc7p.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1501098613&Signature=15GNUNMzVER7NW67%2F4cxxCOc8MY%3D&response-content-disposition=inline%3B%20filename%3DA_Comparison_of_Big-Five_structures_of_p.pdf.

IBM. "Watson Personality Insights." IBM - United States. Accessed July 31, 2017. https://www.ibm.com/watson/services/personality-insights/.

Janis, Irving L. *Victims of Groupthink: A Psychological Study of Foreign-Policy Decisions and Fiascoes*. Boston: Houghton Mifflin Company, 1972.

Kane, Tim. *Bleeding Talent: How the U.S. Military Mismanages Great Leaders and Why It's Time for a Revolution*, 2013 ed. New York: Palgrave Macmillan, 2012.

Lucas, George, dir. *Episode IV—A New Hope*. 1977; Beverly Hills, CA: Twentieth Century Fox Film Corporation, 1977. Motion Picture.

MacGregor, Kent M., and Charles L. Montgomery. "Talent Management: Right Officer, Right Place, Right Time." U.S. Army. January 9, 2017. https://www.army.mil/article/179947/talent_management_right_officer_right_place_right_time.

Milley, Mark A. "39th Chief of Staff of the Army Initial Message to the Army. " Accessed April 26, 2017. https://www.army.mil/e2/rv5_downloads/leaders/csa/Initial_Message_39th_CSA.pdf.

Panetta, Leon, Jim Talent, Jim Jones, and Kathy Roth-Douquet. Building a F.A.S.T. Force: A Flexible Personnel System for a Modern Military. Washington, DC: Bipartisan Policy Center, 2017. https://cdn.bipartisanpolicy.org/wp-content/uploads/2017/03/BPC-Defense-Building-A-FAST-Force.pdf.

Paradis, Kyle F., Albert Carron, and Luc J. Martin. "Development and Validation of an Inventory to Assess Conflict in Sports Teams: The Group Conflict Questionnaire." *Journal of Sports Sciences* 32, no. 20 (October 2014): 1966–1978. doi:10.1080/02640414.2014.970220.

Psychology Today. "Groupthink." Last modified 2017. https://www.psychologytoday.com/basics/groupthink.

Reed, George E. *Tarnished: Toxic Leadership in the U.S. Military*. Lincoln: Potomac Books, 2015. https://muse.jhu.edu/book/41613.

Rielly, Robert J. "Confronting the Tiger: Small Unit Cohesion in Battle." *Military Review* (November/December 2000): 61–65. http://usacac.army.mil/sites/default/files/documents/cace/DCL/DCL_SmallUnitCohesion.pdf.

Saberr. "Working Well Together" Accessed June 2017. https://www.saberr.com.

———. "Base." Last modified 2017. http://www.saberr.com/product/base.

———. "Base." Last modified 2017. https://www.saberr.com/base.

———. "CoachBot." Last modified 2017. https://www.saberr.com/coachbot/.

Saris, Willem E., Desiree Knoppen, and Shalom H. Schwartz. "Operationalizing the Theory of Human Values: Balancing Homogeneity of Reflective Items and Theoretical Coverage." *Survey Research Methods* 7, no. 1 (2013): 29–44. https://ojs.ub.uni-konstanz.de/srm/article/view/5040/4992.

Secretary of the Army. *Changes to the Army Evaluation Reporting System*. Army Directive 2011–16. Washington, DC, 2011. https://msaf.army.mil/ReferenceDocuments/Army%20Directive%202011-16.pdf.

Spector, Paul E. "KSAOs." in *The Blackwell Encyclopedia of Management*, edited by Cary L. Cooper. Vol. 5. Blackwell Reference Online, Accessed September 27, 2017. http://www.blackwellreference.com/public/tocnode?id=g9780631233176_chunk_g978140511697814_ss1-4.

Tabbitt, Sue. "Forget Myers-Briggs, Algorithms Can Better Predict Team Chemistry." *The Guardian*, May 27, 2016. https://www.theguardian.com/small-business-network/2016/may/27/forget-myers-briggs-algorithms-predict-team-chemistry.

Tannenbaum, Scott I., Jamie S. Donsbach, George M. Alliger, John E. Mathieu, Kimberly A. Metcalf, and Gerald F. Goodwin. *Forming Effective Teams: Testing the Team Composition System (TCS) Algorithms and Decision Aid*. 2010.

TEDx Talks. "Algorithms Are Taking Over the World: Christopher Steiner at TEDxOrangeCoast." Video, 11:15. October 31, 2012 https://m.youtube.com/watch?v=H_aLU-NOdHM.

Tepper, Fitz. "Here's Who Fared Best on Dating Apps in 2016." TechCrunch. January 3, 2017. https://techcrunch.com/2017/01/03/heres-who-fared-best-on-dating-apps-in-2016/.

Tesluk, P. E., J. E. Mathieu, S. J. Zaccaro, and M. A. Marks. "Task and aggregation issues in the analysis and assessment of team performance." in *Team Performance and Measurement: Theory, Methods, and Applications*, edited by M. T. Brannick, E. Salas, and C. Prince, 197–224. Mahwah, NJ: Erlbaum, 1997.

Truity. "The Big Five Personality Test." Accessed 2017. https://www.truity.com/test/big-five-personality-test.

U.S. Army Human Resources Command. "AIM 2 Officer Assignment Interactive Module 2.0." Accessed October 12, 2017. https://aim.hrc.army.mil/officer.aspx.

U.S. Army. "RASP 1 & 2." Goarmy. Last modified July 23, 2015. http://www.goarmy.com/ranger/training/rasp.html.

Walter, Brian. "Investment Advisor." IBM. Accessed July 31, 2017. http://investment-advisor.mybluemix.net/.

Warhurst, Chris, Diane Van den Broek, Richard Hall, and Dennis Nickson. "Lookism: The New Frontier of Employment Discrimination?" *Journal of Industrial Relations* 51, no. 1 (2009): 131–136. doi:10.1177/0022185608096808.

Wong, Leonard, and Stephen J. Gerras. *Lying to Ourselves: Dishonesty in the Army Profession*. Carlisle Barracks, Pennsylvania: United States Army War College Press, 2015. https://ssi.armywarcollege.edu/pdffiles/pub1250.pdf.

Zewe, Adam. "Alumni Profile: Jeff Tarr, A.B. '66." Harvard John A. Paulson School of Engineering and Applied Sciences (blog). February 8, 2016. https://www.seas.harvard.edu/blog/2016/02/alumni-profile-jeff-tarr-ab-66.

Zurcher, Anthony. "Debunking the Myers-Briggs Personality Test." BBC News (blog). July 15, 2014. http://www.bbc.com/news/blogs-echochambers-28315137.

Zwerdling, Daniel. "Army Takes on Its Own Toxic Leaders." NPR. January 6, 2014. http://www.npr.org/2014/01/06/259422776/army-takes-on-its-own-toxic-leaders.

INITIAL DISTRIBUTION LIST

1.   Defense Technical Information Center
      Ft. Belvoir, Virginia

2.   Dudley Knox Library
      Naval Postgraduate School
      Monterey, California