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**NAVAL
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MONTEREY, CALIFORNIA

**HUMAN SYSTEMS INTEGRATION
CAPSTONE**

HSI FRAMEWORK FOR ORGANIZATIONS

by

Jessica L. Shihady

September 2014

Project Supervisor: Kip Smith, Ph.D.

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This capstone project took an inside look into the organizational structure of the Keesler Air Force Base’s Base Operational Medicine Cell (BOMC). By conducting a macroergonomic analysis, I was able to make recommendations for an effective and fully harmonized organizational design. Human systems integration (HSI) played a pivotal role in the evaluation of the Keesler BOMC, as Manpower, Personnel, and Training (MPT) are key drivers in the development of organizations. The results of this analysis lead to the development of BOMC requirements and subsequently HSI requirements for organizations, or an HSI Framework for Organizations.

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I. INTRODUCTION

In the United States Air Force (USAF), a system is generally thought of in terms of technology. The USAF follows the Department of Defense (DoD) Acquisition Framework for developing their technology systems. This framework is built around a series of recurring, structured systems engineering (SE) processes with embedded human systems integration (HSI) activities. While these technology systems comprise a large part of the Line of the Air Force (LAF), there are other types of systems that support our warfighters. A system is defined as “a group of related parts that move or work together;” suggesting that systems can also be a compilation of human activities and interactions (Merriam-Webster, 2014). The Air Force Medical Service (AFMS) has been charged with the delivery of health care for the USAF and is an example of a human activity system. It is an organization, within which there are many workplaces, and these are prototypical of workplaces in the USAF. The LAF and AFMS currently have no framework for developing workplaces and organizations like those found within the AFMS system.

A. BACKGROUND

The AFMS has identified its strategic objectives as shown in Table 1.

Table 1. AFMS Strategic Objectives (U.S. Air Force Medical Service, 2014c)

MISSION	“Ensure medically fit forces, provide expeditionary medics, and improve the health of all we serve to meet our Nation’s needs”
VISION	“Our supported population is the healthiest and highest performing segment of the U.S. by 2025”
READINESS	Enhance Full Spectrum of Military Medical Operations Consolidation to a single, Joint capability solution establishes the technical foundation for Joint workflows and training, thereby allowing Health Services Interoperability (i.e., the ability for a healthcare team to efficiently and effectively accomplish exams and waivers on service members from sister Services).

<p>BETTER CARE</p>	<p>Apply HSI to AFMS and Line Air Force Capabilities and Systems</p> <ul style="list-style-type: none"> • Improved human-system interfaces to accommodate the target audience of medical personnel, decrease physical and cognitive workload, and decrease likelihood for errors. • Potential to develop alternative data entry interfaces (e.g., tablets with exam specific apps) that decrease duplicative documentation, time to complete exams, and likelihood for transcriptional errors. <p>Reduce Variability</p> <p>Improved human-system interfaces will increase likelihood that exams are conducted in a consistent format and essential elements of information are obtained, thereby reducing waste and rework.</p> <p>Drive Innovation</p> <p>Consolidation to a single, Joint materiel solution is a prerequisite for approval of health information technology enhancements needed to innovate on exam and waiver workflows.</p>
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In support of the AFMS mission, most bases have a Flight Medicine Clinic which provides total routine care for aircrew members and their dependents as well as for those in special operations duties. Currently, the USAF is in the process of dividing the Flight Medicine Clinic services into two separate functions, primary care for all member beneficiaries (active duty, their dependents and retirees) and occupational medicine services (active duty only). In addition to providing care for occupational illness and injury, occupational medicine services include managing member profiles for physical training (PT) tests and medical boards ensuring that airmen adhere to USAF performance standards. A profile is used as a communication tool, from medical providers to the commander, identifying the PT status of an airman and whether or not an airman is fit for duty or deployment.

B. PROBLEM STATEMENT

Currently the AFMS operates ad-hoc, rather than as an integrated system. “The lack of an integrated system results in diagnostic errors, failures to identify deteriorating patients, communication errors, and inefficient work” (Booz Allen Hamilton, 2014). In order to achieve the Air Force Surgeon General (SG)’s vision

for the AFMS that "...our supported population is the healthiest and highest performing segment of the U.S. by 2025," the current system will have to change (U.S. Air Force Medical Service, 2014a).

The AFMS has accomplished initial conceptual design activities for a new family of systems (FoS) to achieve the capability of managing the health and performance of "populations." A population is "comprised of heterogeneous subpopulations living in 'neighborhoods' that are physically identifiable as organizations with varying demographics, cultures, and health and human performance needs" (U.S. Air Force Medical Service, 2014a). What makes this FoS novel is the shift of medical care from individual-based and reactive to population-based and proactive (i.e., preventative medicine); and from providing healthcare services to providing health and performance outcomes. Performance outcomes include the percentage rate of airman availability and personalized patient outcome measures and value (i.e., outcome divided by cost).

To keep the task manageable, this project will look at the Keesler Air Force Base's Base Operational Medicine Cell (BOMC) rather than focusing on the entire AFMS. The BOMC is the installation specialty clinic designed as a dedicated system to deliver high value occupational and operational medicine clinical capabilities. BOMC providers possess knowledge of local and workplace hazards and risks (Tvaryanas, 2013). The Keesler BOMC performs tasks with evident outcomes and interacts in minimal and clear ways with the rest of the AFMS, which is part of the external environment in which the Keesler BOMC operates. In early 2014, a *Flight and Operational Medicine Clinic Workflow Analysis* study was completed. Several observations and assessments were made during the course of the study, and as a result, several improvement measures have been identified and implemented. The 711 HPW/HPAM decided to use Keesler 81st Medical Group (MDG) BOMC as their initial test site because of its unique population of students as compared to other bases. After a final assessment on 1 October 2014, 711 HPW/HPAM will initiate similar processes at other test sites. While each base has its own unique identity, the basic BOMC

process is (or at least should be) the same. In fact, the first thing the 711 HPW/HPAM implemented was a standard set of workflows so that every BOMC location uses the same process. These have been very well received and account for a majority of the improvements observed at Keesler. While this is a great start, more must be achieved in order to reach the SG's mission. The parallel development of a framework for planning and addressing HSI activities will support the AFMS as it proceeds through the design and deployment of their new FoS.

I propose to conduct a macroergonomic analysis of the Keesler BOMC organization and provide an HSI-focused framework for establishing organizational harmony. This document will serve as a blueprint for an integrated set of similar macroergonomic interventions within the AFMS that has the ultimate goal of aligning the entire AFMS with the SG's strategic goal.

C. ASSUMPTIONS

Systems are not just technological systems. For this project, organizations and workplaces are referred to as systems. The same systems' thinking applies to these organizational systems as it does for purely technical systems. While the process for developing organizations is assumed to be different than that of developing technical systems, readers of this paper are expected to have a basic understanding of the DoD acquisition and Joint Capabilities and Integration Development System processes.

Since human interactions within an organization occur mostly in a team context, it is assumed that workplaces are intended to function as teams. For this project, I emphasize the importance of teamwork, team performance, and team effectiveness. I also developed teamwork requirements and teamwork knowledge, skills, and abilities (KSA).

The AFMS has spent several months documenting why the AFMS exists, the current organizations and workplaces, and their current, baseline processes. I assume the accuracy of these data and use them as a basis for this project. I

also assume that the Keesler BOMC is representative of all BOMCs in the USAF and expect my analysis and recommendations to generalize to BOMC locations across the globe. Additionally, I assume that BOMCs are representative of other organizations in the AFMS and expect my analysis and recommendations to generalize to other organizations across the AFMS.

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II. AFMS STRUCTURE AND PRIOR WORK

To advance my knowledge and understanding of the AFMS and its strategy for improving health, I conducted a literature review of the Human Performance Concept of Operations (CONOPS), Air Force Medical Home CONOPS, BOMC, and AFMS HSI Guidebook. Details from the literature review provided a good basis for conducting a macroergonomic analysis of the Keesler BOMC and identifying the requirements for an organizational framework. In the subsequent paragraphs, I identified the current AFMS structure and prior work that has been accomplished to date. This was really the first step and part 1 of the methodology; subsequent parts are discussed in section III Methodology.

A. HUMAN PERFORMANCE CONCEPT OF OPERATIONS

The USAF Office of the Surgeon General (SG) has prepared the *Human Performance Concept of Operations (HP CONOPS)* (2014) detailing why the AFMS exists and outlines the steps necessary for achieving the SG's goal that "...our supported population is the healthiest and highest performing segment of the U.S. by 2025." There are three basic concepts of the HP CONOPS: the Human Performance Operations Center (HPOC), Air Force Medical Home (AFMH), and Clinic Innovation, Test and Evaluation System (CITES). HPOC performs analysis and evaluation activities to acquire knowledge and insight into specific populations and "neighborhoods" (i.e., organizations). Further, HPOC provides strategic guidance to the AFMH, who uses this data to provide patient-centered and performance-focused outcomes to its beneficiaries. CITES identifies, tests and evaluates process improvements and practice innovations as a result of the capability gaps identified by the HPOC.

The HP CONOPS emphasizes human performance as an important variable in population health. Human performance is defined in terms of sustainment, optimization and enhancement. Medical care provided to all member beneficiaries, with a focus on populations and preventative medicine, is

the concept of human performance sustainment. The HP CONOPS not only supports the health and well-being of its current Airmen, but also their families and retirees. Airmen's children are the Airmen of tomorrow, and today's Airmen are the retirees of tomorrow. Human performance optimization most closely aligns with human systems integration (HSI) ensuring that Airmen have the necessary resources, medical or otherwise, in order to perform at their best. Going beyond this level of optimal performance, through science and technology initiatives to include both medical and technological, is the focus of human performance enhancement (U.S. Air Force Medical Service, 2014b).

The HP CONOPS identifies the following capabilities required to sustain, optimize, and enhance the human performance of populations:

- *Define measurable health and human performance sustainment thresholds for all beneficiaries based on operational, occupational and/or personal, patient-oriented goals.*
- *Centrally accumulate and analyze population data, determine effective evidence-based practices, and disseminate the knowledge to the healthcare teams caring for the representative populations.*
- *Dedicate a doctrinal team to write and publish health and human performance sustainment doctrine based on best historical practices and evidence accrued from tests of new concepts.*
- *Capture the hard requirements necessary to realize the 10-year health and human performance sustainment goals and ensure they are met by whatever Health Information Technology (HIT) or Electronic Health Record (EHR) system the Department of Defense chooses to implement.*
- *Define the requisite team compositions to serve the resident populations at each facility across the USAF and roll those requirements up into an overall manpower and personnel requirement for the AFMS.*
- *Define desirable outcomes for specific populations, determine how much they cost, and publish the associated values.*
- *Foster and institutionalize innovation and the dissemination of health and human performance sustainment knowledge throughout the enterprise.*

B. AIR FORCE MEDICAL HOME

The AFMH CONOPS identifies what functions are necessary for supporting the HP CONOPS. This CONOPS highlights four characteristics of high value healthcare organizations that will support the SG’s goal of being the “healthiest and highest performing segment” of the population. These values as identified in Table 2 “need to be ingrained within the organizational culture of the AFMH” (U.S. Air Force Medical Service, 2014a).

Table 2. Characteristics of High Value Organizations (U.S. Air Force Medical Service, 2014a)

Characteristic	Description
Specification and planning	Operational and clinical decisions are predefined to include such processes as workflow, the use of clinical algorithms and decision aids, and establishing homogeneous subpopulations of patients. Subpopulations served by an AFMH could be defined by groups of like Air Force Specialty Codes (AFSCs), organizations, or other fitting paradigm. As much as possible, workflows for requirements such as occupational exams, profiles, and waivers, as well as for the most common acute care encounters, are created to streamline effort, standardize processes, and emphasize outcomes. Clinical decision aids and algorithms are built into the supporting HIT and EHR. Such planning will demand LAF and medical leadership oversight and substantive input from the healthcare team to ensure success.
Infrastructure design	The subpopulations and pathways defined by specification and planning are supported by intentionally designed microsystems incorporating facilities, staff, HIT, and policies that combine to deliver health and human performance. Each subpopulation may dictate different manning models for the healthcare teams. For example, the team responsible for Battlefield Airmen might incorporate sports physiologists and therapists along with a flight surgeon and independent duty medical technicians. Likewise, the physical infrastructure may be reconfigured to accommodate patient flow, minimize chokepoints, and facilitate integration and communication between teams, ancillary services, and the patients themselves. Of course, HIT and the EHR should be seamlessly woven into the infrastructure design to facilitate the delivery of healthcare and monitor human performance indicators.

Measurement and oversight	Internally derived metrics are used to assess processes and performance and measure outcomes and cost. HIT captures epidemiological data and the associated costs, enabling the teams to analyze the care provided to their populations. For instance, using the Battlefield Airman example, metrics might include operational availability rate, injury rates during training, preventive and performance enhancement services delivered, return to duty time, and patient and line commander satisfaction. Whatever the metrics, the results should contribute to continued improvement and job satisfaction, for the populations served as well as those providing those services.
Knowledge and innovation	Collected organizational knowledge is disseminated to achieve selfless improvement and innovation for both the healthcare team and the patient. The essence is for the healthcare teams to accumulate and share knowledge and insight, to practice root cause analysis, and to innovate new solutions aimed at improving the performance of their specific subpopulations. Knowledge and innovation should be publicized to the larger healthcare system as well as to the patient population. In fact, patients should be valued members of the teams in seeking continuous improvement and innovation.

Based on these characteristics of high value health organizations, the AFMH has identified five value-generating functions that it must perform as illustrated in Table 3.

Table 3. AFMH Value-Generating Functions (U.S. Air Force Medical Service, 2014a)

Function	Description
Direct Patient Care	Direct patient care is patient centered, physician-led, and care team executed. Patient care services are focused on optimizing the health and function (i.e., performance) of individuals and the overall empanelled population. In the case of Airmen, patient care teams assess and provide indicated health and performance interventions on the basis of the clinical and occupational presentation of the Airman. The human performance requirements to perform the mission are holistically woven into the clinical setting to arrive at an optimized care plan. It should be noted that the provision of medical care to special duty personnel (i.e., operators) and other Airmen (non-operators) are unified within a single direct patient care system.
Mission Support	Ultimately, mission support is defined and judged a success by the supported commanders. It is population centered, human performance integrator facilitated, patient care team provider led, and extended team executed.

Occupational Exams and Standard	Administrative and clinical operational and occupational assessments are a set of proscribed workflows that arise because an individual is an Airman (i.e., required by policy) and/or has an occupational exposure. These workflows are largely scripted and standardized; they are patient centered and technician led and executed with the support of credentialed providers with specialty training in occupational medicine.
Airman Availability Management	This function accomplishes operational and occupational dispositions on Airmen following healthcare transactions and performs case management of those requiring occupational rehabilitation until return to duty or transition into the Integrated Disability Evaluation System (IDES). It requires specialty training in occupational medicine; it is patient-centered, occupational health nurse led, and team executed. Operational and occupational dispositions are accomplished using a “shared responsibility” model that involves collaborative decision making between the Airman, the Airman’s commander, and AFMH personnel.
Governance	Governance is AFMH commander led and executed. Each of the aforementioned value-generating functions requires measurement and oversight to enable data driven decision making and system management. The AFMH should develop, collect and publish performance data that demonstrates how the organization as a whole, each function, and each care team has performed on a number of metrics that are primarily used for internal process control and performance management. The AFMH should also integrate these measurement activities with other organizational priorities such as awards, annual target setting, and improvement activities, making measurement an integral part of accountability and performance management. Lastly, the AFMH must continue to innovate with workflows by creating, testing, improving, and implementing workflow redesigns to achieve high levels of efficiency and quality.

A process for how to achieve the functions of the AFMH is being modeled after the Patient-Centered Medical Home (PCMH) developed by the Agency for Healthcare Research and Quality (AHRQ). The PCMH is transforming traditional healthcare services to preventive medical care provided to subpopulations. Features include comprehensive care provided by a provider team, patient-centered care, coordinated care across all elements of the health care system, accessible services, and quality and safety. Within the AFMH, medical care is patient-centered and performance-focused. Medical care is personalized and customized according to the particular needs of a specific “neighborhood,” which is shaped by the respective organizations’ missions. The AFMH provides team-based care to these “neighborhoods” which have unique characteristics and

health concerns, thus providing specialized care and sustaining the health and performance of a specific population. For example, Provider A (or Team A) provides health and performance sustainment to Squadron A, Maintenance Squadron, and Provider B (or Team B) provides support to Squadron B, Flying Squadron. Providers/teams focus on the needs and health concerns of their particular squadron (the needs and health concerns of maintainers differ from those of aviators). This approach thus optimizes and enhances the health and performance of that specific subpopulation rather than just the individual. This reflects the proactive approach to population health initiated by the PCMH.

Health is viewed as more than just “the absence of disease.” It is the active management of not only the physical, but also the mental and social aspects of our health (U.S. Air Force Medical Service, 2014b). Health and performance sustainment requires more than just an annual visit to the doctor – it is a continual process of examining lifestyle, the environment in which we live and work, the people in which we socialize, and the policies and regulations dictated to us.

A holistic approach to health and performance requires an understanding of the individual pieces of health as well as the whole picture. The AFMH CONOPS follows the 7-tier health impact pyramid for ensuring the sustainment of health and performance as illustrated in Figure 1. This includes the integration of 7 different elements that must be understood for population health. In order to optimize and enhance health and performance, all of the elements of the health impact pyramid must be utilized. The top of the pyramid focuses on individual care, followed by subsequently larger views to include not only the individual, but the entire population. Through the integration of patient care, the health system, various education and training opportunities to target and communicate risks with the population, as well as environmental and policy directives, the AFMS is better able to care for and ensure the health and performance of Airmen, their families, and retirees.

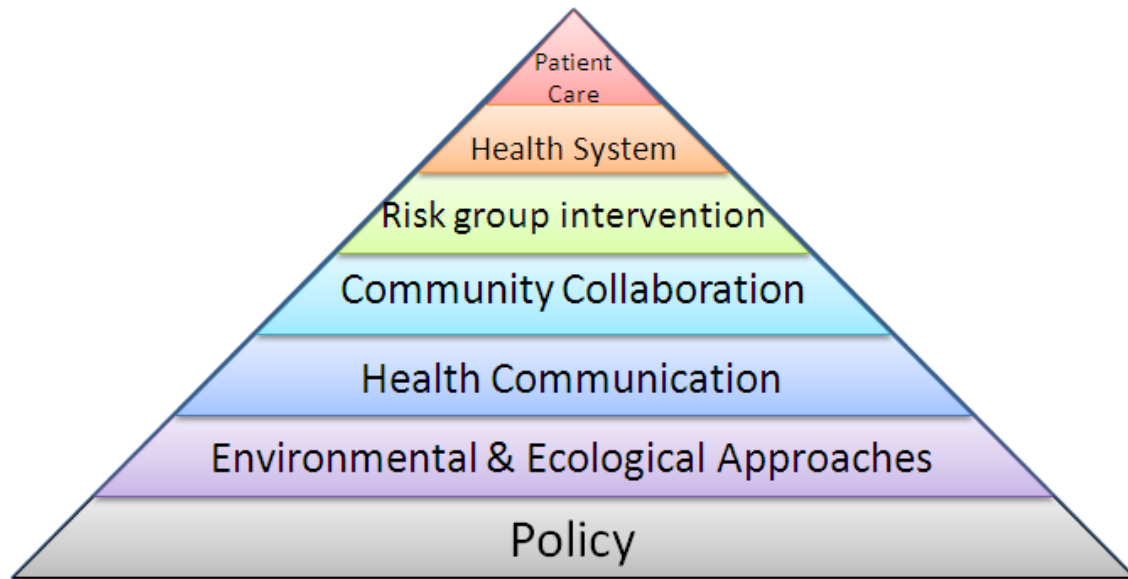


Figure 1. Health Impact Pyramid

The AFMH is responsible for managing the health and performance of assigned subpopulations to include direct patient care (or nuclear family) and mission support (or the extended family) as well as occupational medicine services. Part of this responsibility is the identification of Mission Essential Tasks/Activities for Line Support (METALS). METALS are the evidence-based intervention sets targeted at specific Airman subpopulations. The goal of METALS is to maximize Airman Availability, or the probability that an Airman, under stated conditions in an operational environment, will be able to perform satisfactorily when necessary (U.S. Air Force Medical Service, 2014a). These METALS correlate to the layers of the 7-tier health impact pyramid to optimize population health and performance.

C. BASE OPERATIONAL MEDICINE CELL

The BOMC was established for the “effective and efficient execution of the prescribed physical exams and standards processes, providing operational and occupational medicine support and return-to-work/duty case management services to installation health care teams” (Tvaryanas, 2013). In addition, the

BOMC organization also must coordinate with primary care medical teams for continuity of care to subpopulations. A *Flight and Operational Medicine Clinic Workflow Analysis* study was conducted for observation and further analysis of the BOMC, which included several document reviews, interviews with subject matter experts, and visits to six different Air Force installations. Part of the analysis was the identification of active failures (or waste) and latent failures. “Active failures are those actions or inactions of individuals that are believed to cause the error/waste; latent failures (or conditions) are the errors that exist within the organization or elsewhere in the supervisory chain of command that affect the sequence of events characteristic of the error/waste” (Tvaryanas et al., 2014). The Department of Defense Human Factors Analysis and Classification System (DoD HFACS) was used to determine the root cause of these failures. Four categories of waste were found to be most prevalent as defined in Table 4.

Table 4. Active Failure/Waste Observations (Tvaryanas et al., 2014)

Category	Flight & Operational Medicine Clinic (FOMC) Wastes/Failures
Over-processing	<p>Over-processing: Individuals are dedicated to the development of Deployment Availability Working Group slides because of limited reporting capabilities within the current health IT systems. This is a labor intensive task.</p> <p>Over-processing: Electronic forms are printed to paper for signature and then scanned back into electronic format for storage.</p>
Over-production and/or rework	<p>Over-production: USAF Forms are used when sister Service members are seen, which are then transcribed into an Army or Navy form.</p> <p>Re-work: Health IT systems are not interoperable, necessitating that the staff replicates coding and documentation in several places during a single clinical encounter.</p>
Waiting	<p>Staff Waiting: Staff often waited to accomplish documentation because of unavailability of health IT (attributed to low system reliability); frequently occurring health IT system bugs which necessitate application restart and caused staff to wait for the application to reload; latency in EHR required staff to wait for functions to execute and screens to refresh.</p> <p>Patient Waiting: Walk-in sick calls result in service members waiting in a queue until a provider is available.</p>

Non-utilized staff/confusion	<p>Confusion: Variation in workflow execution across providers and locations led to support staff role confusion, particularly for new technicians.</p> <p>Non-Utilized Staff: Nurses often lacked clear job descriptions and were not utilized in a nursing capacity; they were primarily used to “put out fires” rather than for population health, case management, and/or referral tracking.</p>
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There were also eight latent failures identified during the workflow analysis as shown in Table 5. These were identified and linked to the active failures or areas of waste identified above.

Table 5. Latent & Active Failures (Tvaryanas et al., 2014)

Latent Failures	Active Failures	Description	Example
1. Health IT System Limitations	Over-production and/or Re-Work, Waiting	Health IT systems not interoperable and no single data repository	The lack of interoperability between systems required the same information be manually reentered multiple times (re-work) to complete an Initial Flying Class exam.
2. Inadequate Personnel Training	Over-production and/or Re-Work, Over-processing	Limited IT system training; limited clinical training	Clinic staff had limited training on exam workflows, medical standards, and associated health IT systems, resulting in exam packages being submitted with errors; these exam packages were returned to the clinic for correction (re-work).
3. Poor Coordination & Communication	Waiting, Non-Utilized Staff/ Confusion	Communications barriers between staff; lack of coordination in completing tasks	Teaming and coordination varied, depending on the day of the week or who was running the clinic, which resulted in medical technicians being confused about which provider they were assigned to and the tasks they should accomplish for that provider.
4. Limited FOMC Experience	Non-Utilized Staff/ Confusion, Waiting	Limited number of experienced staff members	Lack of experience in flight medicine and primary care workflows led to a novice flight surgeon not understanding (confusion) the requirements to complete a profile.

5. Lack of Career Tracks	Non-Utilized Staff/ Confusion, Waiting	Staff not familiar with workflows	Medical technicians rotating into the clinic did not have an understanding of the processes and forms, which caused them to rely on more experienced staff to accomplish tasks and were unable to proceed without direction (resulting in waiting).
6. Lack of Doctrine	Non-Utilized Staff/ Confusion, Waiting	Issues with classroom training and sharing of best practices	The absence of a systemic means for codifying best practices contributed to the failure to share an Inspector General recommended program utilizing nurses to manage dependent population health (nurse underutilization).
7. Inadequate Clinic Supervision/ Oversight	Non-Utilized Staff/ Confusion, Waiting	Different clinics working toward different goals	Clinic management emphasized different organizational goals, such as eliminating Preventive Health Assessment (PHA) backlogs versus minimizing Duties Not Involving Flying rates, resulting in some medical technicians being over-utilized completing PHAs while others assigned to different tasks had idle time (under-utilized staff).
8. Inadequate Clinic Resources	Non-Utilized Staff/ Confusion, Waiting	Daily variations in staffing assignment or scheduling	Assignment of medical technicians to only perform certain exams resulted in some technicians being over-utilized and others under-utilized based on the demand for exams (non-utilized staff).

In addition to the identification of the “failures,” the primary functions or workflows of the organization were categorized and illustrated in process maps. As a result of the workflow analysis, several recommendations for improvements were provided and subsequently implemented at the Keesler BOMC test site. As part of the conclusions and recommendations of the workflow study, a Doctrine, Organization, Training, materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTmLPF-P) analysis was conducted to determine whether or not non-materiel approaches could be used to satisfy any of the capability gaps (i.e., failures) identified during the workflow analysis study. The elements of the DOTmLPF-P construct are closely aligned to some of the HSI domains (i.e.,

Manpower, Personnel, and Training). DOTmLPF-P recommendations are identified in Table 6.

Table 6. DOTmLPF-P Recommendations

D	<p>RECOMMENDATION D-01 Gather and analyze best workflow practices, factoring in outcomes that matter to the Airman and the line commander; appropriate manpower utilization; training staff in clinic operations; and effective use of health IT.</p> <p>RECOMMENDATION D-02 Publish doctrine for executing the Aerospace Medicine Enterprise (AME) across all FOMCs, based on the evidence collated in Recommendation D-01.</p> <p>RECOMMENDATION D-03 Identify affected Air Force policy documents and instructions to be rewritten or replaced in order to reflect doctrine (see recommendation under Policy).</p>
O	<p>RECOMMENDATION O-01 Organize the FOMC around the Four Habits of High Value Health Care Organizations.</p> <p>RECOMMENDATION O-02 Adopt and accommodate the recommended future workflows in this report. Because a robust health IT/EHR system is unavailable, analyze the best way to institute new workflows with incongruent technology while annotating future requirements.</p> <p>RECOMMENDATION O-03 Perform manpower, personnel, and training tradeoff analyses. Workflows and their associated outcomes are facilitated by a team approach. Therefore, a study of the proper mix of clinical staff, Technicians, and administrative personnel with core knowledge and requisite team training is mandatory. There should be a strategy for stabilizing the workforce over time (maintaining consistency and experience by modifying ops tempo, PCS, and career-broadening AFSC-specific moves within the medical group). Closely tied to a tradeoff analysis is the institution of a cost/value matrix.</p>
T	<p>RECOMMENDATION T-01 Conduct training for all FOMC clinic personnel, incorporating the outcomes of the three Organizational recommendations: clinic protocols and metrics, patient population, workflows, clinic teams, and a learning environment. Include protocols defining the roles and responsibilities of the team members, rules for communicating and decision-making, an understanding of individual duties and how they contribute to clinic success and patient outcomes, and the effective use of health IT. Such training should be transportable across FOMCs. This recommendation is facilitated by Recommendation L-01.</p>

m	<p>RECOMMENDATION M-01</p> <p>Acquire an integrated electronic health record that accounts for the scope of the AME. Given that acquisition of an EHR resides at the DoD level, and that the DoD is currently opting for a commercial off-the-shelf solution, then a module incorporating the needs of the AME should be specified. An EHR should be interoperable with the larger health IT and facilitate FOMC workflows, data capture, and analysis requirements.</p>
L	<p>RECOMMENDATION L-01</p> <p>Develop professional education for leadership Medical Group Commander (MDG/CC), Squadron Commander (SQ/CC), SGP and Flight Commander (FLT/CC), and NCOIC) in the functioning of the FOMC, incorporating the four habits of high-value health care organizations. The effect of the training should be reproducible across all FOMCs. This recommendation should facilitate Recommendation T-01.</p>
P	<p>RECOMMENDATION P-01</p> <p>With the outcomes of Recommendation O-03, formulate an AFMS-level strategy and plan for improving the utilization of manpower and personnel to fit the mission of the AME as carried out by the FOMC. This requires an understanding of the ideal team mix for executing the mission at the FOMCs across the entire enterprise and ensuring the capability of the local leadership to manage the workforce.</p>
F	<p>RECOMMENDATION I-01</p> <p>An AFMS central medical facilities board should deliberate on the minimum requirements for clinic space predicated on a team-based, medical home model with the goal of standardizing FOMC facilities across the enterprise.</p> <p>RECOMMENDATION I-02</p> <p>Institute a tiger team at each FOMC to analyze the physical infrastructure and make requisite changes within budgetary allowances to accommodate future workflows. Where infrastructure change is too costly, other mitigation strategies should be introduced with a future years' plan for renovation or new construction.</p>
-P	<p>RECOMMENDATION PO-01</p> <p>Write and publish policy for operating the FOMC. AFD 48-1, AFI 48-101, and AFI 48-149 will likely be affected and should be rewritten, replaced, or deleted. Policy should be coherent with doctrine published as a result of recommendation D-02.</p>

D. AFMS HSI GUIDEBOOK

The Workflow Analysis study revealed the benefits of HSI and provided the foundation for implementing an HSI program within AFMS. “HSI identifies waste in the system, reduces overall cost, and maximizes value to the Airmen and other beneficiaries” (Booz Allen Hamilton, 2014). The AFMS HSI Guidebook

identifies several areas within its current processes to insert HSI: requirements generation, research/test and evaluation (T&E), acquisition, materiel/equipment modifications, and healthcare delivery. HSI touch points and supporting activities are identified on where HSI can have the most impact as illustrated in Table 7.

Table 7. AFMS HSI Touch Points (Booz Allen Hamilton, 2014)

AFMS Process	HSI Touch Point	Support Activities
Requirements Generation	Integrated Product Team (IPT)	Identify issues, coordinate supporting analysis, and contribute to project outputs.
	High Performance Team (HPT)	Generate sound HSI technical requirements, and guide HSI technical requirements into materiel and non-materiel solution alternatives.
	Capabilities Based Assessment (CBA)	Ensure gaps and requirements are written with HSI included.
	Initial Capabilities Document (ICD)	Ensure the requirements are written with HSI included.
	Capabilities Development Document (CDD)	HSI can be included in the System Capabilities Required for the Increment, Other DOTmLPF and Policy Considerations, and Other System Attributes.
	Review USAF Form 1067 for Applicability	Ensure modification is written with HSI included.
	White Paper Requirements Review Requirements Working Group (RWG) Review for Rapid Requirement Applicability Requirements Matrix Development	Ensure the requirements are written with HSI included.
Research/T&E	Research Studies and Analysis Council (RSAAC)	Ensure each proposal is reviewed for HSI applicability. An HSI related question could be added to the Proposal Review Criteria and Considerations. If HSI is applicable, a POC could be identified to assist with HSI related concerns during the research effort.
	Test Plans	Ensure HSI is integrated into the process and analysis of each item being tested.
	Integrated Test Team (ITT)	Identify the HSI issues, support analysis, coordinate, and contribute to project outputs.

	Non-Traditional Assessment (NTA) Course	Educate testers on HSI so they can use HSI principles and framework while conducting testing.
Acquisition	IPT	Identify issues, coordinate supporting analysis, and contribute to project outputs.
	HPT	Generate sound HSI technical requirements, and guide HSI technical requirements into materiel and non-materiel solution alternatives.
	Commercial-Off-The-Shelf (COTS) Government-Off-The-Shelf (GOTS)	Prevent increased risk of high human-related costs and/or poor overall system performance.
Materiel/ Equipment Modifications	USAF Form 1067 Creation and Review	Requirements personnel can ensure the requirements are written with HSI included.
Healthcare Delivery	IPT/HPT	Ensure HSI is included in the decision-making process. Insertion of logistics and HSI expertise early will maximize impact on budget, schedule, etc. HSI also needs to be included in research, testing, source selection and capture/dissemination of lessons learned.
	Front End Analysis (FEA) Identify "As-Is" Create "To-Be"	Utilize HSI and systems engineering approaches to re-align work to eliminate waste, improve performance/quality, and save resources.
	Algorithms Business Rules Clinical Decision Aids	HSI should be used to build clinical decision aids, algorithms, and business rules into HIT/EHR. As a system, HIT should be able to provide the means for making decisions about population health, manpower utilization, workflow efficiency, access, and continuity of care when carefully designed using HSI principles.
	Lessons Learned Best Practices	Lessons learned and best practices need to be captured to ensure innovation can exist in a broad community and avoids "stovepiping" of ideas.
	Design Management	Intentionally designing and managing facilities based on the defined subpopulation affects staff, information technology, and policies that combine to deliver healthcare and human performance.

The AFMS HSI Guidebook provides valuable information for where to inject HSI in the AFMS system. While this is an important first step, this does not provide a framework for developing organizations like the AFMS system. Without

a documented framework, these HSI touch points have no basis for implementation.

Manpower, Personnel, and Training (MPT) concerns in particular, are going to be paramount in a framework for designing and developing organizations. For the Keesler BOMC organization and other human activity systems within the AFMS to work effectively, early MPT considerations must be considered and integrated throughout an organization's life cycle.

E. SUMMARY

An extensive review of the conceptual design activities for a new AFMS FoS provided the foundation for identifying the requirements for an HSI-focused framework for organizations. Active/latent failures in the BOMC were identified, providing the specific capability gaps to address, which evolved into requirements for the framework. Further, initial DOTmLPP-P recommendations were identified and considered in the development of the framework.

With an understanding of the AFMS and BOMC systems and prior work that has been accomplished to date, the next step was to conduct a macroergonomic analysis of the Keesler BOMC organization.

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III. METHODOLOGY

There are two tasks for this project: 1) conduct a macroergonomic analysis of the Kessler BOMC organization and make recommendations for optimizing BOMC system performance, and 2) develop an HSI-focused framework for the BOMC with the intention that it becomes the standard for complex workplaces and organizations. The first step involved compiling and assessing the current set of requirements in order to determine how AFMS is broken. Tvaryanas et al. (2014) conducted a workflow study of six different USAF Flight and Operational Medicine Clinics, highlighting where the organization was committing errors and how these could be eliminated or reduced. The results of this study, which are discussed in the previous section, provided enough information to conduct a macroergonomic analysis of the Kessler BOMC, and thus provided the details for an HSI-focused framework for organizations. The final step was to develop a framework for optimizing BOMC system performance. This framework aims to specify how the BOMC system must operate in order to meet the SG's goal and to deliver high value healthcare to airmen and their dependents. The framework can be used in subsequent macroergonomic interventions as the standard for assessing organization and workplace systems.

A. MACROERGONOMIC ANALYSIS

Though new processes and procedures have been published by the AFMS, there are still serious concerns on how the AFMS is going to achieve the SG's goal. I conducted a macroergonomic analysis using data acquired during the literature review process and extracted insights pertaining to characteristics of successful organizations and the domains of HSI for inclusion in the HSI framework.

“Macroergonomics, also referred to as human-organization interface technology, is concerned with the analysis, design, and evaluation of work systems and human-organization interface (HOI) technology” (Hendrick, 2002).

Work systems are similar to human-activity systems or organizations. Macroergonomics focuses on sociotechnical system elements - technological subsystem, personnel subsystem, and relevant external environment - which interact and impact the organization. The technological subsystem consists of the technological elements (hardware, software, and tools) of an organization; whereas, the personnel subsystem consists of an organization's people and their characteristics. The relevant external environment includes all those external factors that the organization is dependent on for its survival and success (Hendrick, 2002). The interaction of these elements must be understood in order to affect organizational change and optimize design.

Analysis of sociotechnical elements guides proposals for the redesign of the organizational structure. The structure of an organization is described in terms of its complexity, formalization (or standardization), and centralization. Complexity is defined according to the level of differentiation, whether vertical, horizontal or spatial, and integration. Strong or high levels of differentiation require equivalent levels of integration, and vice versa. Formalization is defined in terms of an organization's standardization of processes and procedures. Centralization refers to how decisions are made within an organization. Centralized decision-making happens at the senior management level, whereas decentralized decision-making is delegated to the lowest employee level having requisite knowledge (Hendrick, 2002).

Large-scale organizational change is defined in terms of improvements to performance. "Macroergonomics can change an organization's culture and can achieve 60% to 90% performance improvements" (Kleiner, 2002). While organizational change is challenging, it is possible with the right set of tools. A macroergonomic analysis of the sociotechnical elements of an organization can help to lay the right foundation for organizational change. Understanding an organization's culture is also important in implementing organizational change. Culture can be changed in several ways, by mandate, changing the behavior of

organizational leaders, selection and training, or by changing the organization itself.

B. SYSTEMS ENGINEERING PROCESS

Throughout the course of this project, I used an agile, systems engineering (SE) approach to ensure that analysis starts with the user needs and that these needs get transitioned into requirements and ultimately into the final design of the HSI framework. SE ensures a quality product, produces requirements that can be verified and validated, and it allows for a flexible design. The inputs of the SE process include the needs and objectives of the Keesler BOMC as well as the initial conceptual design for a new family of systems (FoS) for the AFMS. Tasks and subtasks are as follows:

- Analysis
 - BOMC Macroergonomic Analysis
 - HSI Implications
 - Current Vs Preferred BOMC Organizational Structure
 - DOTmLPP-P Analysis
 - BOMC Requirements Analysis
- HSI Framework Requirements
- HSI Framework Design
 - System Design and Development (transform HSI Framework requirements into a physical design)
 - Evaluation Measures (develop evaluation criteria)

The output of this process should translate as the baseline specifications for the HSI framework of organizations.

C. HUMAN SYSTEMS INTEGRATION

Human systems integration (HSI) is an element of SE which ensures that human requirements and limitations are considered throughout the system life cycle to optimize system performance and minimize system costs. The USAF organizes HSI around nine domains: Manpower, Personnel, Training, Human

Factors Engineering, Survivability, Environment, Safety, Occupational Health, and Habitability.

HSI will be a critical mechanism in the implementation of the new AFMS FoS. Manpower, Personnel, and Training (MPT) are key drivers in the development of organizations. While human factors engineering is also an important element, MPT concerns are paramount. For the BOMC organization in particular, to work effectively, early MPT considerations must be considered and addressed to ensure an optimal organizational or team structure. Throughout the course of this project, I identified and highlighted key areas of HSI, to include HSI activities, issues, and benefits.

IV. MACROERGONOMIC ANALYSIS

The macroergonomic analysis identified the sociotechnical elements and their interactions of the Keesler BOMC resulting in the identification of an appropriate organizational design.

A. SOCIOTECHNICAL ELEMENTS

1. Technological

The technological subsystem of the Keesler BOMC most closely resembles Perrow's (1967) knowledge-based classification scheme for technology. Perrow defines technology as "the action one performs on an object in order to change the object" (Hendrick, 2002). For this project, technical systems are viewed as equivalent to human activity systems or organizations; therefore, the definition can be modified to be "the action one performs on an individual in an organization in order to change the individual."

The Keesler BOMC is comprised of both routine and craft technologies based on the provision of health and performance services and outcomes. Most of the clinical services provided – pre-placement examinations, periodic health assessments, evaluating impairment and fitness for duty, return to work evaluations, etc. – are well defined and analyzable. Routine tasks favor organizations that have high centralization and formalization (Hendrick, 2002). These characteristics describe the Keesler BOMC. Standard workflows are already being utilized at the Keesler BOMC and with successful results.

Other services, such as the diagnosis and treatment of occupational and environmental injuries and illness, are more of a 'craft,' and require personnel with a certain amount of expertise. In craftwork like that performed at the Keesler BOMC, decision making relies on "the experience, judgment, and intuition of the individual 'craftsperson'" (Hendrick, 2002). These types of tasks favor organizations that are decentralized with low formalization. This structure is also characteristic of the Keesler BOMC even though it is the complete opposite of

the structure for routine tasks. This disparity in structural forms (both high and low centralization and formalization) indicates that there are two distinct organizations within the BOMC. One organization is focused on routine medical administrative services and the other is focused on clinical craftwork.

a. *HSI in Technological Subsystem*

HSI considers the human factors, occupational health, habitability and personnel issues and concerns as they relate to technological subsystems like the Keesler BOMC. Human factors includes the challenges or constraints of the work space; IT system display, operability and maintainability; impact to the interfaces; workload and time limitations; and accuracy requirements for task accomplishment. Occupational health concerns with respect to the BOMC technological subsystem include the impacts on personnel from acoustical energy (noise) and temperature extremes. Habitability includes any unacceptable conditions from technology that affect human performance. Personnel considerations include the knowledge, skills, and abilities appropriate for performing technological tasks (U.S. Air Force Human Systems Integration Office, 2009).

2. Personnel

The personnel subsystem is characterized by an organization's degree of professionalism, demographics, and psychosocial elements. The Keesler BOMC organization is characterized by the following:

- A highly professional workforce with specific training and education needs;
- Changing demographic factors, such as a more mature and experienced workforce, value system shifts, cultural diversity;
- An influx of women in the workforce; and
- Psychosocial factors that are developing a more cognitively complex workforce.

Keesler BOMC personnel include physicians, nurses, and technical assistants, all of whom are highly skilled and qualified and who thrive in organizations with

low formalization (Tvaryanas, 2013). Professionals are needed when “dealing with unique, non-routine or unanticipated situations”; however, for those routine tasks following standard workflows, this level of professionalism is unnecessary (Hendrick, 2002). The demographic and psychosocial characteristics of the Keesler BOMC lend themselves to an organization that is decentralized, providing for greater participation in decision-making.

a. *HSI in Personnel Subsystem*

The HSI domains of manpower, personnel, and training are important considerations for the personnel subsystem. Manpower includes the right mix of military, civilian, and contractor personnel, and whether or not current manpower levels need modified. Personnel considerations include knowledge, skills, and abilities; existing personnel pool; whether or not new AFSCs are required; recruiting, retention, and career development; and pay, bonuses, and incentives. Training considerations include the increase, decrease, or necessary changes to training based on personnel characteristics (U.S. Air Force Human Systems Integration Office, 2009).

3. *Relevant External Environment*

The external environment is also an important element to consider for work system design. External environments can be socioeconomic, educational, political, cultural, and/or legal, and can have positive or negative impacts upon the organization’s performance (Hendrick, 2002). The combination of these external environments comprises an organization’s specific task environment. Socioeconomic and educational environments of the Keesler BOMC are stable with no competition and a healthy supply of personnel and educational resources. There is, however, some concern with the lack of IT materials/resources. The need for better IT and decision support technological elements has been identified in prior analyses conducted by AFMS. Once employed, these systems will serve as important integrating mechanisms for the Keesler BOMC.

Political, cultural, and legal environments can have a strong and at times negative impact on the Keesler BOMC organization. This task environment is mostly determined by an organization's domain, or "the range of products or services offered," and stakeholders who have an interest in the organization (Hendrick, 2002). The Keesler BOMC domain is the provision of health and human performance services and outcomes; stakeholders include the BOMC staff, patients, and other USAF agencies. The scope of domain and stakeholders influence an organization's complexity. Considering the narrow domain and number of stakeholders of the Keesler BOMC, I would estimate the task environment to have low-to-average complexity.

An examination of the environmental uncertainty or degree of change and complexity of tasks of the Keesler BOMC reveals a moderately low level of uncertainty. Although the AFMS is currently experiencing a restructuring and redirection of their focus on healthcare, in general, the environment remains quite stable over time. Still, the Keesler BOMC task environment is complex based on the amount of interactions with other organizations. Based on its environmental factors, the Keesler BOMC favors an organization that should be "differentiated into separate subunits (departmentalization) for effective functioning" (Hendrick, 2002).

a. *HSI in Relevant External Environment Subsystem*

HSI considers human factors issues and concerns related to the interactions and interfaces of the Keesler BOMC with various organizations of the AFMS. These include the design, display, usability of the IT and decision support systems. The interface design is important for communication and coordination with other systems and organizations.

B. ORGANIZATIONAL STRUCTURE

1. Current

Currently, the Keesler BOMC organizational structure, like most organizations in the USAF, has (1) a high level of complexity with respect to vertical and horizontal differentiation and (2) insufficient integration. The complexity of the Keesler BOMC requires a substantial number of integrating mechanisms to ensure adequate communication, coordination, and control across the organization. Vertical differentiation refers to the number of levels of management between workers and top-level, executive staff; horizontal differentiation refers to the number of departments and specialized entities within an organization. The BOMC currently reflects high vertical differentiation when it should be lower and low horizontal differentiation when it should be higher. There are multiple levels of management to include not only BOMC management, but also the AFMH and AFMS. While the AFMS and subordinate organizations are relevant external environments, the Keesler BOMC is its own distinct organization and should function as such.

Based on “inherent efficiencies in the division of labor,” horizontal differentiation provides the best structure for the Keesler BOMC (Hendrick, 2002). As a result of previous analysis within the AFMS, they are in the process of designing specialized organizations and departments based on functions and services provided (e.g., occupational medicine services versus primary care, and routine medical administrative services versus craft clinical services). Within the BOMC, there should be two distinct departments: one for routine, medical administrative services that can be conducted quickly with relatively low/few skills and a department for craft, clinical services that may have a longer time orientation and need to be conducted by professionals. This horizontal differentiation of functions improves efficiency and effectiveness. By performing these tasks with the right personnel within the right time orientation, the BOMC can increase its operational efficiency.

The Keesler BOMC also has many standardized processes and a centralized decision-making structure. Technologies and tasks of the Keesler BOMC are a combination of routine and craft, and personnel are highly professional, cognitively complex with diverse demographics. The environment has low-to-moderate levels of uncertainty as a result of its complexity and a relatively stable degree of change. The preferred organizational structure for the Keesler BOMC, based on sociotechnical characteristics, and its current organizational structure are illustrated in Table 8.

Table 8. Current Keesler BOMC Organizational Structure

Sociotechnical Elements	Current BOMC Characteristics	Current Organizational Structure	Preferred Organizational Structure	Disparities
Technological	Routine technologies for repetitive administrative services Craft technologies for the diagnosis and treatment of injury/illness	High formalization for routine tasks Low formalization for craft tasks Centralized decision-making only	For routine tasks: High formalization, centralization For craft tasks: Low formalization, decentralized decision-making	Decentralization for craft tasks
Personnel	Professional, cognitive complexity and diverse	Professional workforce performing both routine and craft tasks High vertical differentiation	For routine tasks: non-skilled personnel For craft tasks: professional personnel Low vertical differentiation High horizontal differentiation	Low/non-skilled personnel for routine tasks Low vertical differentiation High horizontal differentiation
Relevant External Environment	Routine task environment characterized by low uncertainty (stable and simple environment) Craft task environment characterized by moderate uncertainty (moderate stability and complex environment)	High vertical differentiation High formalization for routine tasks Low formalization for craft tasks Centralization Professionalism	For the routine task environment: mechanistic structure (low vertical differentiation, high formalization and centralization) For craft task environment: organic structure (low vertical differentiation and formalization, decentralization, and professionalism) (Hendrick, 2002)	Low vertical differentiation Decentralization for craft tasks

2. Best Fit for Keesler BOMC

For an organization to function effectively, its structure needs to be designed to match its technological, personnel, and external environment subsystems. A fully harmonized organization design considers the interfaces between personnel and technology, personnel and the system/subsystems, and personnel and environment (Hendrick, 2002). HSI considers the human factors engineering domain of the BOMC organization, to include communication needs of personnel, task workflows and IT system configuration. After analyzing the BOMC organization, understanding its current structure, and conducting a macroergonomic analysis, I found that there are two different subsystems (or departments), each of which supports different organizational behaviors. The Keesler BOMC has two distinct functions: routine medical administrative services and craft clinical services (i.e., healthcare diagnosis and disease prevention). These distinctions make up the two separate BOMC subsystems.

The subsystem for the Keesler BOMC Routine Medical Administrative Services should have high formalization and vertical differentiation, horizontal differentiation, and centralized decision-making in support of routine tasks that can be administered by personnel with few skills. One key aspect of formalization is to not make it so high so as to hamper personnel motivation and ambition (Hendrick, 2002). Personnel still need to feel a sense of purpose, that their skills and qualifications are important to the success of the organization. In contrast, the Keesler BOMC Craft Clinical Services subsystem should have low formalization and vertical differentiation, horizontal differentiation, and decentralized decision-making in support of craft tasks that need to be administered by a highly professionalized workforce.

The Keesler BOMC is already establishing horizontal differentiation to better address their technologies and task environments; therefore, no changes are necessary in that regard. There has also been implementation of standardized workflows so that routine tasks can be done quickly regardless of

the BOMC location. This high formalization, in addition to the Keesler BOMC's centralized decision-making process, provides the appropriate structure for the technological element of the Routine Medical Administrative Services subsystem. These routine services are best suited for non-skilled personnel and high vertical differentiation. The Keesler BOMC is already structured with vertical differentiation; however, the employment of additional technicians or those personnel with a lower skillset should be considered. For routine tasks, professionals are unnecessary and their skills are better reserved for performing craft tasks.

For the Craft Clinical Services subsystem, changes will be needed to implement a technological element structure of low formalization and decentralized decision-making. The personnel element structure already provides a highly professionalized workforce; however, the current vertical differentiation of the organization should be lower.

As a result of these discrepancies between the BOMC's current structures and the preferred structures, organizational change is recommended. The structures best suited for the Keesler BOMC are *mechanistic* for the Routine Medical Administrative Services subsystem and *organic* for the Craft Clinical Services subsystem. Mechanistic structures are reflective of organizations performing routine tasks that have high to moderately high vertical and horizontal differentiation and formalization and centralization. Conversely, professional, organic structures are reflective of organizations performing craft tasks that have low vertical differentiation and formalization, decentralization, and professionalism.

C. ORGANIZATIONAL CHANGE

An important aspect of facilitating organizational change is to understand the organization's culture (i.e., core values). The surface core values of the Keesler BOMC are to "deliver consistent standards-based occupational health assessments and operational dispositions, as well as maximizing individual

availability for work/duty, across the whole of the installation workforce” (Tvaryanas, 2013). There are no issues here. However, what are “unseen” are the unwritten rules and practices that provide special treatment to one patient over another (e.g., Colonel over a Senior Airman), or encourage poor planning by the patient by allowing walk-in appointments that should have been scheduled (Kleiner, 2002). All of these conditions can create frustration among staff and customers and a bottleneck in the daily activities of the organization, and need to be changed to better align with the Keesler BOMC’s values.

Culture can be changed in several ways, (1) major policy changes, (2) changing the behaviors of organizational leaders, (3) personnel selection and training, and (4) comprehensive work system (organization) design change (Kleiner, 2002). I recommend employing all of these methods for the greatest chance of effective, lasting change and performance improvement in the Keesler BOMC.

1. DOTmLPF-P Analysis

The methods used for cultivating culture change within organizations reflect the Doctrine, Organization, Training, materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTmLPF-P) process for non-materiel solution technology systems. For human activity systems or organizations, this same analysis applies. DOTmLPF-P analysis generally results in one or more DOTmLPF-P Change Recommendations (DCR). Culture change will need to start with the AFMS and transfer to lower organization levels to include the BOMC. Changes (DCRs) to the AFMS and BOMC culture must include changes to Doctrine (D), Organization (O), Training (T), Leadership and Education (L), Personnel (P), and Policy (P).

- *Doctrine* specifies the way BOMC provides healthcare to Airman (ACQuipedia Web Site, 2014). Changes to doctrine need to identify and facilitate the shift to population health, patient-centered and continuous care, from care that just focused on the individual and that one interaction.

- *Organization* specifies how the BOMC is organized to provide healthcare to Airman (ACQuipedia Web Site, 2014). Changes to organization need to identify the reorganization of teams to provide specialized care to specific subpopulations. In addition, the division of labor between routine medical administrative and craft clinical services needs to be established and managed appropriately.
- *Training and Personnel* go hand-in-hand. Training specifies how the BOMC prepares their personnel to perform tasks and activities (ACQuipedia Web Site, 2014). Personnel specifies the availability of qualified people for healthcare operations (ACQuipedia Web Site, 2014). Changes to training and personnel need to identify new Air Force Specialty Codes (AFSC) for occupational health specialties which do not currently exist in the AFMS. Scope of practice and corresponding training needs to be pushed to the lowest level. This is also reflective of the division of labor identified in the changes to organization. Professional personnel should be assigned to and trained in craft clinical tasks and non-professional personnel should be assigned to and trained in the routine medical administrative tasks. Furthermore, centrally developed job descriptions and training packages should be bundled as part of standardizing BOMC processes and workflows.
- *Leadership and Education* specifies how the BOMC prepares leaders to lead the healthcare services provided to Airmen (ACQuipedia Web Site, 2014). The BOMC needs to have the right leaders in place and personnel that have been selected and trained based on the organization's values and their commitment to Airmen population health and performance.
- Policy specifies DoD, USAF, and AFMS policy that impacts the other DOTmLPPF-P elements (ACQuipedia Web Site, 2014). Changes to policy need to identify the capability of managing the health and performance of "populations." HSI also needs to be added to medical Air Force instructions. In addition, there needs to be integrating AFMS policy and processes for a SE approach to purposeful innovation, test/evaluation, and dissemination of innovative processes.

HSI also considers the personnel and training domains of systems. For the Keesler BOMC, personnel need to be educated on the sociotechnical characteristics of the organization, results of the macroergonomics analysis, and upcoming changes. Personnel with the right knowledge, skills, and abilities should be used to best support the BOMC organization. They also need to be trained on their roles and responsibilities and how they interface with technology,

other systems/subsystems and the environment. These changes will foster the other design changes identified during the macroergonomic analysis.

V. BOMC REQUIREMENTS ANALYSIS

The literature review and macroergonomic analysis provided a good basis for conducting a requirements analysis of the Keesler BOMC organization and designing an HSI-focused framework for organizations. Sound systems engineering (SE) and HSI principles were used to ensure traceability of the requirements and consideration of the human element throughout the process.

A. MACROERGONOMICS

The results of the macroergonomic analysis provide the current and preferred characteristics of the Keesler BOMC with respect to technology, personnel, and environment sociotechnical subsystems. As there are two distinct subsystems within the BOMC organization, there are also two preferred organizational forms. The organizational form best suited for meeting the needs of the Routine Medical Administrative Services subsystem is the *machine bureaucracy* having the following characteristics:

- Narrow division of labor (horizontal differentiation),
- Well-defined hierarchy (vertical differentiation),
- High formalization (i.e., standardized workflows and templates),
- High centralization, and
- Career tracks for employees (Hendrick, 2002).

Machine bureaucracies ensure “administrative efficiency, stability, and control over the work system’s functioning” (Hendrick, 2002).

The organizational form best suited for meeting the needs of the Craft Clinical Services subsystem is the *professional bureaucracy* having the following characteristics:

- High degree of professionalism,
- Broad division of labor (horizontal differentiation),
- Fewer (than machine) levels of hierarchy (vertical differentiation), and

- Centralized decision-making for strategic decisions and decentralized decision-making for tactical decisions (Hendrick, 2002).

While not as efficient as machine bureaucracies, professional bureaucracies provide better support for non-routine tasks and complex environments.

B. CHARACTERISTICS OF SUCCESSFUL ORGANIZATIONS AND WORKPLACES

1. Collective Mind

Weick and Roberts (1993) discuss the importance of understanding the social dynamics of organizations in order to identify solutions that optimize organizational performance. They emphasize safety-critical organizations like an aircraft carrier (or the BOMC) that must instill a sense of collective mind and heedful interrelating among operators in order to be successful. Collective mind is defined as “a pattern of heedful interrelations of actions [contributing, representing and subordinating] in a social system” by individuals acting as a group (Weick & Roberts, 1993).

In the machine bureaucracy subsystem of the BOMC, collective mind might be revealed by the pattern with which routine medical administrative tasks and functions are provided by non-professional personnel. This type of social structure is characterized by high formalization or standardized workflows with contributions funneled through centralized decision-makers. Likewise, in the organic bureaucracy subsystem, collective mind might be revealed by the pattern with which craft clinical services and functions are provided by professional personnel. This type of social structure is characterized by low vertical differentiation and formalization with decentralized decision-making allowing personnel to be flexible in their contributions. By departmentalizing the different functions and personnel of the BOMC, individuals are more able to share and interrelate information.

Heedful interrelating is an assembly of behaviors constructed intelligently that capture important qualities of the collective mind. To be heedful, each

activity is dependent on and adaptive to previous activities. Heed in a BOMC might be revealed by the standardized workflows for routine tasks. These workflows ensure that everyone in the organization understands the overall process and what tasks need to be completed and by whom. Organizations with more heed reflect a more developed collective mind, and thus are better performing. Weick and Roberts (1993) argue that when heed declines, performance declines. Once the actions and attitudes associated with collective mind and heed become integral components of the organization's culture, performance can be optimized.

2. Teams

There has been a great deal of research on teams, team performance, team cognition, and team effectiveness. This research stresses the importance of understanding team roles in organizations and how to make them successful. Numerous variables can influence teams and ultimately their success (or lack thereof). Understanding teams and what influences them becomes increasingly important as the use of teams continues to grow. Salas, Cooke and Rosen (2008) highlighted several important concepts for successful teams.

Shared cognition is a key driver in team performance. In the BOMC, shared cognition is illustrated by the standardized workflows for routine tasks. *Measurement* of shared cognition or team knowledge is possible through the "aggregate of individual knowledge or the collection of task- and team-related knowledge held by teammates." Teams and performance should be monitored and evaluated. Measures can be used to capture team performance and effectiveness. For the BOMC, performance measures include Airman Availability, task completion time and success rate, time to complete or process various services, etc. Advances in *team training* promote teamwork and enhance team performance. Training and technological interventions are being designed with an "understanding of team needs and capabilities." In addition to individual

training, the BOMC should implement team training in order to improve team performance and effectiveness.

3. Teamwork

The team environment is ever-changing. As team members learn and grow, the team becomes more effective and cognizant of the right mixture of variables needed for success (i.e., teamwork). It is important to understand and incorporate these variables into the design of your organization and team training program. Salas, Sims and Burke (2005) identified the most frequently observed variables, or core aspects of teamwork, and characterized them into what they refer to as the “Big Five” framework – team leadership, mutual performance modeling, backup behavior, adaptability, and team orientation.

For the BOMC, it will be important to identify the right team leaders and their expected behaviors. Team members should look out for each other, pick up the slack when others make a mistake, support each other to ensure tasks are completed appropriately, and provide helpful feedback to members who may be off track. BOMC personnel should be selected or trained to be adaptive to unexpected tasks and to work well with others.

This framework of teamwork also includes coordinating mechanisms – shared mental models, closed-loop communication, and mutual trust – that tie them together with the “Big Five” for an effective (successful) team. BOMC personnel need to “share” the same team goals and expectations, understand each other’s roles and abilities, and be aware of available resources. These behaviors lead to more effective communication and better performance. The BOMC should practice closed-loop communication for the effective exchange of information and to ensure that the correct message is received and understood. This becomes increasingly important in high-stress situations which can occur in medical facilities like the BOMC. There also needs to be a sense of mutual trust among personnel in the BOMC. This creates a bond among team members, mutual care and respect. Teams with mutual trust look out for each other, ensure

that other members have the information they need to be successful and get the job done. It's an understanding that when individual members are successful, the team is successful.

The integration of coordinating mechanisms and the "Big Five" factors is key to ensuring successful teams. All of the "Big Five" factors are interrelated and integrated and all must be present in order for teams to be effective. The whole is only as good as the sum of its parts.

4. Team Structure

Another important characteristic of teams is team structure. Team structure and task types also influence team performance. Stewart and Barrick (2000) examine the relationship between team structure and performance. Structure is described in terms of interdependence (the extent of cooperation among team members) and team self-leadership (the extent of individual autonomy among team members). Conceptual types of tasks are comprised of planning, deciding, and negotiating work; and behavioral types include executing work. The effects of task differences can be assessed by examining the amount of time teams spend on behavioral tasks versus conceptual.

Different team structures should be used depending on the types of tasks being performed (Stewart & Barrick, 2000). Teams performing conceptual tasks benefit from high and low levels of interdependence and a high level of team self-leadership; whereas, teams performing behavioral tasks benefit from moderate levels of interdependence and a low level of team self-leadership. Similar factors were considered during the macroergonomic analysis of the Keesler BOMC organization. The BOMC's craft task environment supports a structure that has low vertical differentiation and formalization, decentralization, and professionalism. Conversely, the BOMC's routine task environment supports a structure that has high to moderately high vertical and horizontal differentiation and formalization and centralization.

5. Team Member Selection: Personality Variables & Effective Teamwork

Many researchers believe that personality factors also have an impact on teamwork. Different personalities and their potential for conflict can lead to a “personality clash,” and thus impact team effectiveness. Cannon-Bowers & Bowers (2011) use the “Big Five” to categorize personality traits and predict job performance: Openness to experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism (or OCEAN for short). When selecting BOMC personnel, the following are important personality traits to pursue:

- Conscientiousness refers to taking responsibility for one’s own work, being self-disciplined and organized;
- Extraversion refers to those who are out-going and prefer to work with and be around people;
- Agreeableness refers to someone who works wells with others, is cooperative and likable (Cannon-Bowers & Bowers, 2011).

Those who have openness to experience are more than likely not a good fit for the BOMC environment as their daily tasks are not going to change much over time. There is more chance for these personality types to get bored, lose motivation, and suffer from low morale. In addition, those who are emotional or neurotic are also probably not a good fit for the BOMC. Medical environments can stir up many emotions, not all of which are bad, which can be an impediment to performance. Those who are relatively impassive and can focus on getting the job done are best suited for the BOMC.

6. Effective Team Training

Effective team training results from the knowledge of individual differences and personality traits and their subsequent supporting strategies. Understanding these concepts optimizes the team role in an organization. This becomes increasingly important as the use of teams continues to grow. The BOMC should identify competencies for team selection, measure team effectiveness, and design training around these characteristics for effective teamwork.

Cannon-Bowers and Bowers (2011) identify several different strategies for effective team training. For organizations that have flat or horizontal structures (as has been recommended for the BOMC), *cross-training* is encouraged. The BOMC should consider cross-training for the Routine Medical Administrative Services subsystem so that personnel are trained with respect to their role as well as the role of other team members. Understanding the roles and responsibilities of other members facilitates team cohesion, shared knowledge, and better enables members to read and interpret the needs and issues of other members.

For the Craft Clinical Services subsystem, *scenario-based training* should be considered. This type of training provides personnel with a realistic training environment where team members go through actual scenarios and situations that they would encounter on the job. Training in this manner enhances how well team members work together and allows for members to learn from and get support from each other.

For both subsystems of the BOMC, *team leader training* and *team coordination and adaptation training* should also be considered. Team leader training “focuses on training team leaders in specific behaviors that support team performance” (Cannon-Bowers & Bowers, 2011). Part of this training is to encourage team leaders to prepare prebriefs before and debriefs after a particular activity. For the BOMC, it might be beneficial to have a morning and afternoon huddle to ensure personnel are “on the same page.” This prepares team members for the day’s activities and provides them status on the day’s outcomes. Team coordination and adaptation training strategy provides training to increase team members’ use of implicit coordination (i.e., be able to anticipate the needs of others) versus explicit coordination or verbal communication among members. This could be very important to the BOMC organization which is already time-constrained due to its fast-paced nature.

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VI. HSI FRAMEWORK REQUIREMENTS

Based on the assumption that the Keesler BOMC is representative of all BOMCs in the USAF as well as other organizations in the AFMS, I expect the analysis and requirements to generalize across the AFMS. To that regard, I expect the analysis and requirements can be used to develop a framework that can be representative of all organizations and workplaces, like the BOMC and AFMS.

Information from the AFMS current structure and prior research in addition to the results from the BOMC macroergonomic and requirements analyses have been translated into requirements for an HSI Framework for the AFMS. The intent of this framework is that “AFMS” and “BOMC” could be replaced with any organization or workplace system that one is supporting. Requirements for the HSI Framework for AFMS have been decomposed into the following hierarchy: input and output, functional, non-functional, and external system requirements.

A. REQUIREMENTS HIERARCHY

The top level system requirement is to apply HSI to AFMS. System Requirements for the HSI Framework for AFMS, written in hierarchy format, are identified in this section. As these requirements are written generally, they cannot be directly inserted into a requirements document.

1. Input / Output Requirements

a. *Input Requirements*

- The BOMC organization shall accept AFMS strategic objectives.
- The BOMC organization shall accept standardized workflows and templates.
- The BOMC organization shall utilize Health Information Technology (HIT) or Electronic Health Record (EHR) systems provided by the DoD.

- The BOMC organization shall utilize inputs from a macroergonomic analysis identifying the appropriate sociotechnical elements, current organizational structure and recommendations for organizational change, in order to optimize system performance. (Note: Organizational structure is defined in terms of an organization's complexity, formalization, and centralization. For an organization to function effectively, its structure needs to be designed to match its technological, personnel, and external environment subsystems.)

b. Output Requirements

- The BOMC organization shall predefine operational decisions.
- The BOMC organization shall predefine desirable outcomes.
- The BOMC organization shall predefine human performance requirements to perform the mission.
- The BOMC organization shall internally derive metrics to assess processes and performance.
- The BOMC organization shall measure outcomes and cost.
- The BOMC organization shall measure team performance and effectiveness. For the BOMC, performance measures include Airman Availability, task completion time and success rate, time to complete or process various services, etc.
- The BOMC organization shall contribute measurement results to the AFMS for continued improvement and job satisfaction.
- The BOMC organization shall centrally accumulate and analyze human performance data to disseminate to other organizations.
- The BOMC organization shall document and publish human performance sustainment doctrine based on best historical practices and evidence accrued from tests of new concepts.
- The BOMC organization shall predefine requisite team composition to optimize Manpower and Personnel. (Note: This includes the optimal mix of staff, i.e., civilian, military, and contractor personnel. Personality variables, core knowledge and requisite training should also be considered. The BOMC needs to have the right leaders and personnel that have been selected and trained based on the organization's values and their commitment to those values.)
- The BOMC organization shall identify Mission Essential Tasks/Activities for Line Support (METALS) in order to manage human performance.

- The BOMC organization shall disseminate Lessons Learned and Best Practices to other organizations.
- The BOMC organization shall develop professional education for leadership Medical Group Commander (MDG/CC) in the functioning of the BOMC.
- The BOMC organization shall predefine facilities and physical infrastructure needs.
- The BOMC organization shall predefine the technological, personnel, and relevant external environment subsystem characteristics of the organization in order to support an appropriate organizational design. (Note: The interaction of these elements must be understood in order to affect organizational change and optimize design.)
- The BOMC organization shall predefine its culture/core values.

2. Functional Requirements

- The BOMC organization shall implement AFMS strategic objectives.
- The BOMC organization shall implement AFMH value-generating functions.
- The BOMC organization shall adhere to the 7-tier health impact pyramid for ensuring the sustainment of health and performance.
- The BOMC organization shall work with primary care medical (PCM) teams for continuity of care to subpopulations.
- The BOMC organization shall utilize standardized workflows and templates.
- The BOMC organization shall conduct training for all personnel on the roles and responsibilities of team members and other systems/subsystems of the environment, rules for communicating and decision-making, an understanding of individual duties and their contributions to successful BOMC operations and outcomes, and the effective use of health IT systems and interface with other technology.
- The BOMC organization shall determine the most effective methods of team training to promote teamwork and enhance team performance. (Note: Effective team training results from the knowledge of individual differences and personality traits and their subsequent supporting strategies.)

- The BOMC organization shall educate personnel on the sociotechnical characteristics of the organization, results of the macroergonomics analysis, and any upcoming changes.
- The BOMC organization shall support education programs for those in leadership positions.
- The BOMC organization shall include HSI early in research, testing, source selection and capture/dissemination of lessons learned.
- The BOMC organization shall participate in front end analyses (FEA) and utilize HSI and systems engineering approaches to realign work, eliminate waste, improve performance/quality, and save resources.
- The BOMC organization shall utilize HSI principles when building decision aids, algorithms and business rules into HIT/EHR systems.
- The BOMC organization shall intentionally design and manage facilities.
- The BOMC organization shall incorporate the “Big Five” teamwork framework for successful teams: team leadership, mutual performance modeling, backup behavior, adaptability, and team orientation. (Note: This framework also includes coordinating mechanisms – shared mental models, closed-loop communication, and mutual trust – that tie them together with the “Big Five” for an effective team.)

3. Non-Functional Requirements

- The BOMC organization shall be sustainable.
- The BOMC organization shall be interoperable with other systems in the AFMS.
- The BOMC organization shall address manpower capabilities and limitations. (Note: Manpower includes the right mix of military, civilian, and contractor personnel, and whether or not current manpower levels need modified.)
- The BOMC organization shall address personnel capabilities and limitations. (Note: Personnel considerations include the knowledge, skills, and abilities appropriate for performing technological tasks; existing personnel pool; whether or not new AFSCs are required; recruiting, retention, and career development; pay, bonuses, and incentives; and personality variables.)
- The BOMC organization shall address training capabilities and limitations. (Note: Training considerations include the increase,

decrease, or necessary changes to training based on personnel characteristics.)

- The BOMC organization shall develop job descriptions and corresponding training packages.
- The BOMC organization shall address human factors engineering capabilities and limitations. (Note: Human factors include the challenges or constraints of the work space; IT and decision support system design, display, usability and maintainability; impact to the interfaces; workload and time limitations; and accuracy requirements for task accomplishment. The interface design is important for communication and coordination with other systems and organizations.)
- The BOMC organization shall address environment capabilities and limitations.
- The BOMC organization shall address safety capabilities and limitations.
- The BOMC organization shall address occupational health capabilities and limitations. (Note: Examples of occupational health concerns for the BOMC might include the impacts on personnel from acoustical energy (noise) and temperature extremes.)
- The BOMC organization shall address survivability capabilities and limitations.
- The BOMC organization shall address habitability capabilities and limitations. (Note: Habitability includes any unacceptable conditions from technology that affect human performance.)
- The BOMC organization shall foster and institutionalize innovation and the dissemination of human performance sustainment knowledge throughout the enterprise.
- The BOMC organization shall participate in Integrated Product Teams (IPT) as appropriate, to identify issues, coordinate supporting analysis, and contribute to project outputs; and to ensure HSI is included in the decision-making process.
- The BOMC organization shall participate in High Performance Teams (HPT) as appropriate, to generate sound HSI technical requirements, and guide HSI technical requirements into materiel and non-materiel solution alternatives; and to ensure HSI is included in the decision-making process.
- The BOMC organization shall participate in Capabilities Based Assessments (CBA) as appropriate, to ensure gaps and requirements are written to include HSI.

- The BOMC organization shall participate in Initial Capabilities Documents (ICD) as appropriate, to ensure requirements are written to include HSI.
- The BOMC organization shall participate in Capabilities Development Documents (CDD) as appropriate, to ensure HSI is included in System Capabilities required for the increment, other DOTmLPF-P and Policy Considerations, and Other System Attributes.
- The BOMC organization shall review for applicability USAF Form 1067s as appropriate, to ensure requirements or modifications are written to include HSI.
- The BOMC organization shall participate in the development of white papers as appropriate, to ensure BOMC requirements are written to include HSI.
- The BOMC organization shall participate in requirements reviews as appropriate, to ensure BOMC requirements are written to include HSI.
- The BOMC organization shall participate in Requirements Working Groups (RWG) as appropriate, to ensure BOMC requirements are written to include HSI.
- The BOMC organization shall participate in reviews for Rapid Requirement Applicability as appropriate, to ensure BOMC requirements are written to include HSI.
- The BOMC organization shall participate in Requirements Matrix Development as appropriate, to ensure BOMC requirements are written to include HSI.
- The BOMC organization shall participate in Research Studies and Analysis Councils (RSAAC) as appropriate, to ensure proposals are reviewed for HSI applicability.
- The BOMC organization shall participate in the development of Test Plans as appropriate, to ensure HSI is integrated into the process and analysis of each item being tested.
- The BOMC organization shall participate in Integrated Test Team (ITT) activities as appropriate, to identify HSI issues, support analysis, and coordinate and contribute to project outputs.
- The BOMC organization shall participate in Non-Traditional Assessment (NTA) Courses as appropriate, to educate testers on HSI so they can use HSI principles while conducting testing.

- The BOMC organization shall participate in the reviews of Commercial-Off-The-Shelf (COTS) and Government-Off-The-Shelf (GOTS) to prevent increased risk of high human-related costs and/or poor overall system performance.
- The BOMC organization shall identify Lessons Learned and Best Practices to ensure innovation and to avoid “stove-piping” of ideas.
- The BOMC organization shall identify how personnel can develop a sense of collective mind and heedful interrelating with others for successful operations.
- The BOMC organization shall facilitate shared cognition and mental models of team goals and expectations for effective communication and better team performance.
- The BOMC organization shall practice closed-loop communication for the effective exchange of information and to ensure that the correct message is received and understood.
- The BOMC organization shall facilitate a sense of mutual trust among team members.

4. External System Interface Requirements

- AFMS leadership shall provide oversight and substantive input to the BOMC to ensure success.
- AFMS leadership shall define career tracks for occupational health specialties.
- HIT and EHR shall be seamlessly integrated into the infrastructure design to facilitate BOMC operations and delivery of services.
- Health IT systems shall be interoperable.
- Health IT systems shall be reliable.
- Health IT systems shall be available.
- Health IT systems shall be sustainable.
- The DoD shall provide training on Health IT systems to BOMC personnel.
- The AFMS shall invite BOMC personnel to participate in CBAs, ICDs, CDDs, white paper development, requirements reviews, RWGs, reviews for Rapid Requirements Applicability, and Requirements Matrix Development as part of the requirements generation process.

- The AFMS shall invite BOMC personnel to participate in RSAAC, development of Test Plans, ITTs, and NTA courses as part of the research and test and evaluation process.
- The AFMS shall invite BOMC personnel to participate in IPTs and HPTs as part of the requirements generation, acquisition, and healthcare delivery processes.
- The AFMS shall invite BOMC personnel to participate in the development and review of USAF Form 1067s as part of the requirements generation and material and equipment modifications processes.
- The AFMS shall invite BOMC personnel to participate in the reviews of COTS and GOTS as part of the acquisition process.
- The AFMS shall invite BOMC personnel to participate in the following activities as part of the healthcare delivery process: FEA; development of decision aids, algorithms, and business rules into HIT/EHR systems; identification of Lessons Learned and Best Practices; and design management.

VII. RECOMMENDATIONS

The scope of this project was two-fold: 1) conduct a macroergonomic analysis of the Keesler BOMC organization and make recommendations for optimizing BOMC system performance, and 2) develop an HSI-focused framework for the BOMC with the intention that it becomes the standard for complex workplaces and organizations. These efforts resulted in several recommendations for the Keesler BOMC organization (as well as other BOMCs).

A. RECOMMENDATIONS FOR THE KEESLER BOMC

To improve operations and performance, the following recommendations are being provided to the Keesler BOMC organization.

1. Organizational Structure

- Establish two separate subsystems or departments within the BOMC according to their two distinct functions, (1) Routine Medical Administrative Services and (2) Craft Clinical Services.
- Structure the Routine Medical Administrative Services subsystem/department like a *machine bureaucracy* (mechanistic structure) having the following characteristics:
 - Narrow division of labor (horizontal differentiation),
 - Well-defined hierarchy (vertical differentiation),
 - High formalization (i.e., standardized workflows and templates),
 - High centralization, and
 - Career tracks for employees.
- Structure the Craft Clinical Services subsystem/department like a *professional bureaucracy* (organic structure) having the following characteristics:
 - High degree of professionalism,
 - Broad division of labor (horizontal differentiation),
 - Fewer (than machine) levels of hierarchy (vertical differentiation), and

- Centralized decision-making for strategic decisions and decentralized decision-making for tactical decisions.
- Change the culture by submitting DOTmLPP-P Change Requests (DCR) against Doctrine (D), Organization (O), Training (T), Leadership and Education (L), Personnel (P), and Policy (P). Culture change starts with the AFMS and transfers to lower organizational levels to include the BOMC.
- Practice closed-loop communication for the effective exchange of information and to ensure that the correct message is received and understood.
- Consider establishing morning and afternoon huddles to ensure personnel are “on the same page” and prepare them for the day’s activities and inform them of the status on the day’s outcomes.

2. MPT and Team Structure

- Educate personnel on the sociotechnical characteristics of the organization, results of the macroergonomics analysis, and upcoming changes.
- Monitor and evaluate (measure) teams, their performance and effectiveness.
- Implement team training to improve team performance and effectiveness.
- Identify the right team leaders and personnel and their expected behaviors.
- Select and train personnel to be adaptive to unexpected tasks and to work well with others.
- Encourage and train BOMC personnel to “share” the same team goals and expectations, understand each other’s roles and abilities, and be aware of available resources, and to show mutual trust to others.
- Select personnel based on important personality traits: conscientiousness, extraversion and agreeableness.
- Identify competencies for team selection and design training around these characteristics for effective teamwork.
- Consider *cross-training* for the Routine Medical Administrative Services subsystem so that personnel are trained with respect to their role as well as the role of other team members.
- Consider *scenario-based training* for the Craft Clinical Services subsystem to provide personnel with a realistic training

environment and actual scenarios and situations that they would encounter on the job.

- *Consider team leader training and team coordination and adaptation training.*

In order for these changes to be successful, leadership must be fully engaged and supportive of these efforts. Their buy-in and participation is critical for these changes to be successful. Early cooperation with leadership will make them feel like they are an important element of the change process and not just taking orders. If they feel like it is part of their own idea, then they will be a champion and advocate for the changes. In addition, it is important to engage the rest of the organization. This includes personnel at all levels (physicians, nurses, technicians, etc.). The same philosophy applies here – when their involvement is valued, personnel will feel like they are part of the change.

B. RECOMMENDATIONS TO EVOLVE THE HSI FRAMEWORK

It is also my recommendation that the HSI framework requirements be further analyzed in support of a final design. While many of these requirements are specific to the BOMC and AFMS organization, they are general enough to facilitate a standard HSI framework for organizations. I will continue to work with the 711 HPW/HPAM to further evolve this framework. Activities will center on systems engineering processes. First, I will develop an input-output diagram and functional decomposition to ensure all of the critical HSI and macroergonomic elements have been captured. Then, I will reiterate through the requirements summary identified in section VI of this document. Based on the requirements summary, I will perform some tradeoff and sensitivity analyses to identify a preferred solution set. Once the requirements are stable, I can develop a functional architecture for the HSI Framework. The HSI Framework will be tested and evaluated at the Keesler 81st Medical Group (MDG) which is currently being used as the initial test site for implementing improvement measures. It is intended that this framework will support the AFMS and BOMC organizations as

they proceed through the design and deployment of their new family of systems (FoS) for managing the health and performance of “populations.”

In support of these follow-on activities, I will review the DoD’s Architecture Framework (DoDAF) and similar frameworks developed by other countries. The United Kingdom’s Ministry of Defence (MoD) has also developed an architecture framework (MODAF) modeled after the DoDAF, but with the inclusion of seven complementary Human Views (HV). “HVs model the people-related elements of enterprises that need to be specified as part of socio-technical system development” (Ministry of Defence, 2008). Canada’s Defence Research and Development has also developed human views as an extension of the DoDAF.

VIII. CONCLUSIONS

The USAF SG has the vision that “our supported population is the healthiest and highest performing segment of the U.S. by 2025” (U.S. Air Force Medical Service, 2014a). In support of this goal, the AFMS has made great strides in designing a new family of systems (FoS) to achieve the capability of managing the health and performance of “populations.” Rather than focusing on the entire AFMS, this project put the microscope on the Keesler Air Force Base’s Base Operational Medicine Cell (BOMC). The Keesler BOMC has also been involved in making improvements to support the SG’s mission. While these efforts have been a great start, more must be achieved in order to reach the SG’s mission. The DoD’s framework for developing technology systems is not sufficient to support the AFMS as it proceeds through the design and deployment of their new organization. Based on suggestions by those supporting the AFMS, it was determined that an HSI framework for human activity systems or organizations was needed.

In order to develop an HSI framework, I reviewed current literature and research that has been documented on the AFMS and BOMC organizations. With this knowledge in mind, I conducted a macroergonomic analysis of the Keesler BOMC organization to identify sociotechnical elements of the organization, its current organizational structure and made recommendations for a new organizational design. I also identified characteristics of successful organizations based on appropriate teamwork, team effectiveness, and team performance, and how these can be implemented within the BOMC organization. All of these results were used to identify requirements for an HSI framework for the BOMC organization with the intent that these requirements generalize to other organizations. These requirements provide the foundation for designing an HSI Framework for organizations. Recommendations have been provided to further evolve the HSI framework for planning and addressing HSI activities in the AFMS and thus ensuring “our supported population is the healthiest and

highest performing segment of the U.S. by 2025” (U.S. Air Force Medical Service, 2014a).

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