Becoming a MANPRINT Team Player

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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

HUMAN SYSTEMS INTEGRATION CAPSTONE

BECOMING A MANPRINT TEAM PLAYER

by

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September 2014

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REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** September 2014	**3. REPORT TYPE AND DATES COVERED** HSI Capstone

4. TITLE AND SUBTITLE
BECOMING A MANPRINT TEAM PLAYER

5. FUNDING NUMBERS

6. AUTHOR(S) Jared J. Sapp

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey, CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES)
N/A

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB Protocol number ____N/A____.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
DISTRIBUTION STATEMENT A. Approved for public release;distribution is unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT (maximum 200 words)

MANPRINT efforts have the greatest impact when initiated early in the acquisition process, when changes to a system can be made most easily. At this point in time, MANPRINT activities are funded directly by the Program Manager (PM)/Program Executive Office (PEO), who do not tend to allocate appropriate funding for early MANPRINT efforts. For this reason, HRED FE personnel must become MANPRINT salesmen and promote the value of their inclusion and market themselves to the acquisition managers. As support of acquisition programs early in their lifecycle has the greatest need for guidance, this document will largely discuss methods for moving MANPRINT “to the left” that can be undertaken at the HRED FE working level. Specifically, this document will detail how to become part of the PM’s team and what activities would best support the PM once included.

14. SUBJECT TERMS MANPRINT, Human Systems Integration, HSI, ARL-HRED, HRED, Defense Acquisition	**15. NUMBER OF PAGES** 43
	16. PRICE CODE

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

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ABSTRACT

MANPRINT efforts have the greatest impact when initiated early in the acquisition process, when changes to a system can be made most easily. At this point in time, MANPRINT activities are funded directly by the Program Manager (PM)/Program Executive Office (PEO), who do not tend to allocate appropriate funding for early MANPRINT efforts. For this reason, HRED FE personnel must become MANPRINT salesmen and promote the value of their inclusion and market themselves to the acquisition managers. As support of acquisition programs early in their lifecycle has the greatest need for guidance, this document will largely discuss methods for moving MANPRINT “to the left” that can be undertaken at the HRED FE working level. Specifically, this document will detail how to become part of the PM’s team and what activities would best support the PM once included.

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I. INTRODUCTION

The Army Research Laboratory Human Research & Engineering Directorate (ARL-HRED) is the Army's lead organization for science and technology programs in human performance, human factors, simulation and training technology. In addition to the extensive research that ARL-HRED performs, the field elements (FE) of ARL-HRED are tasked with programmatic Manpower & Personnel Integration (MANPRINT) support of the various PEOs and PMs as well as performing MANPRINT evaluations and assessments. There currently exists documentation on what is required to perform a MANPRINT assessment, as well as some programmatic guidance on how to conduct a Human Systems Integration (HSI) effort, but much of this information is not geared specifically to HRED FE personnel. It is intended that this document provide working level guidance on how HRED FE personnel can provide HSI support to the warfighter, through support of PEOs, PMs, and associated research & development efforts.

One of the major gaps in guidance is early in the acquisition process. Traditionally, MANPRINT activities began just prior to Milestone B. The previous version of DoDI 5000.02 (December 8, 2008) specifies that one purpose of the EMD phase is to implement Human Systems Integration (HSI). Although this has led to many positive results, insertion of HSI support earlier in the acquisition process will lead to more effective systems, reduced costs, and streamlined efforts. Some changes to DoD and Army regulations have noted a need for earlier HSI implementation in the acquisition lifecycle. For instance, the current DoDI 5000.02 states that "The Program Manager will plan for and implement human systems integration (HSI) beginning early in the acquisition process and throughout the product life cycle" (DoDI 5000.02, 2013, p.115). In addition, AR 602-2 states that "MANPRINT assessments will be conducted prior to milestone decision reviews to ensure MANPRINT has been properly applied and to identify impacts thereof" (AR-602-2, 2014, p.1)

Although MANPRINT activities are intended to begin earlier in system development, they unfortunately do not begin early, or at least not in earnest, until later in development. At this point in time, MANPRINT activities are funded directly by the PM/Program Executive Office (PEO), who do not tend to allocate appropriate funding for early MANPRINT efforts. For this reason, HRED FE personnel must promote the value of their inclusion and market themselves to the acquisition managers. As support of acquisition programs early in their lifecycle has the greatest need for guidance, this document will largely discuss methods for moving MANPRINT “to the left” that can be undertaken at the HRED FE working level. Specifically, this document will detail how to become part of the PM’s team and what activities would best support the PM once included.

II. THE ARMY'S MANPRINT RESOURCES

A. G-1 MANPRINT

The U.S. Army G-1 describes MANPRINT as follows: "MANPRINT is a practice that the U.S. Army uses to make sure human factors such as capabilities and limitations are incorporated into all of the steps during the system acquisition process. MANPRINT is the voice of the Soldier, and was initiated in recognition of the fact that the Soldier is a key component of the total system. In order for a system to function optimally, the Soldier must be able to perform required tasks efficiently. Decisions made with the Soldier in mind enhance overall effectiveness and reduce long-term cost. MANPRINT helps to ensure that our Soldiers can operate our systems to accomplish their missions to defend our nation" (www.manprint.army.mil).

The mission of the MANPRINT Directorate of the US Army G-1 is to: "optimize total system performance, reduce life cycle costs, and minimize risk of soldier loss or injury by ensuring a systematic consideration of the impact of materiel design on Soldiers throughout the system development process" (www.manprint.army.mil). The MANPRINT Directorate achieves this mission by coordinating and reviewing MANPRINT assessments and addressing these issues at Army systems acquisition review councils, Army OIPTs and other acquisition decision reviews. The G-1 MANPRINT Directorate also serves as the proponent for the Army MANPRINT program by providing training, workshops, policy, and guidance on all things MANPRINT.

B. ARMY RESEARCH LABORATORY – HUMAN RESEARCH AND ENGINEERING DIRECTORATE

According to Army Regulation 602-2, Manpower and Personnel Integration in the System Acquisition Process, the U.S. Army Research Laboratory – Human Research and Engineering Directorate (ARL-HRED) has the following MANPRINT related responsibilities:

“(1) Serve as the central MANPRINT point of contact for coordinating domain support to the CAPDEVs and IPTs.

(2) Provide technical advice and assistance to CAPDEVs and IPTs.

(3) Conduct human factors engineering assessments for PMs.

(4) Conduct manpower, personnel capabilities, and training assessments for PMs.

(5) Conduct Soldier survivability assessments for selected non-acquisition category (ACAT) I and II systems.

(6) Develop draft MANPRINT assessments on all ACAT I, II, and III acquisition systems (to include the integration of all of the individual domain assessments) for DCS, G–1 (DAPE–MR). Conduct appropriate staffing with individual MANPRINT domains and other interested parties (PM, TCM, CAPDEV). Provide draft assessments to DCS, G–1 (DAPE–MR) not later than 30 days prior to a key IPR or milestone review.

(7) Provide manpower, personnel capabilities, training, and Soldier survivability expertise to force modernization and/or branch proponents and IPTs on nonmajor systems.

(8) Provide MANPRINT assistance to the U.S. Army Test and Evaluation Command (ATEC) in the development of system evaluation plans, detailed test plans, test reports, and conduct MANPRINT evaluations based on operational testing.

(9) Conduct applied research for the development of new MANPRINT concepts, techniques, and analytical tools, and research into Soldier capabilities and needs driven by emerging technologies.

(10) Ensure that MANPRINT parameters, objectives, and thresholds have been cross-walked from the CDD to the RFP, system specification, and TEMP.

(11) Provide MANPRINT assistance to TRADOC to assure that MANPRINT is considered in early concept studies and analyses.

(12) Through the capabilities requirements determination and IPT process (in conjunction with TRADOC, PMs, and DCS, G–1 (DAPE–MR)), develop plans and strategies for implementing MANPRINT in selected system acquisition processes” (AR-602-2, 2014).

To fulfill these various responsibilities, ARL-HRED has located personnel in field elements around the country to directly support PMs, centers of excellence, and other organizations in need of MANPRINT support. The following map shows the distribution of ARL-HRED field element personnel.

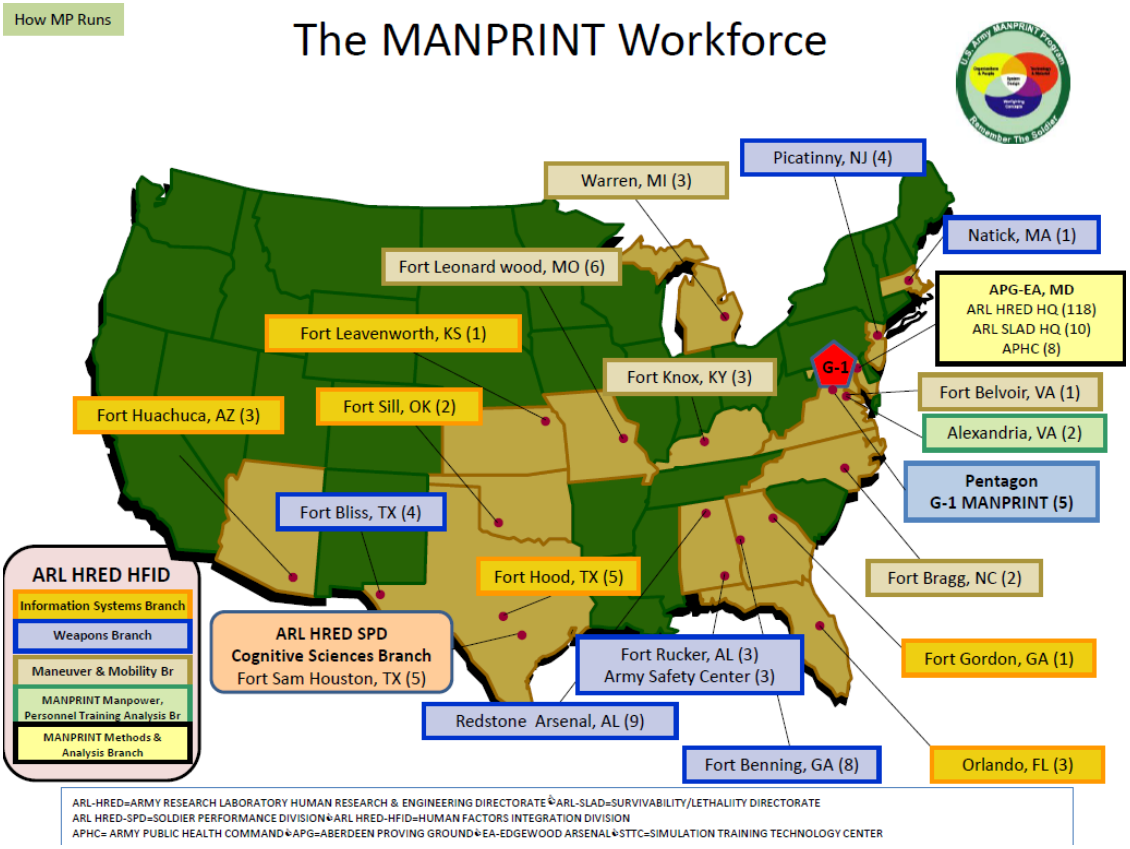

Figure 1. Distribution of ARL-HRED field element personnel

It is at these field elements that the majority of MANPRINT practitioners are found. As specified in AR 602-2 these MANPRINT practitioners have the following responsibilities:

> "a. Conduct a proactive MANPRINT Program for all systems assigned.
>
> b. Support the assessment of domain-specific and cross-domain MANPRINT issues using methods that support the evaluation of the impact of MANPRINT considerations on total system ownership

and/or life cycle costs, Soldier safety and survivability, and the integrated Soldier-system performance.

c. Support the inclusion of all required and appropriate MANPRINT requirements and opportunities in the best value trade-off analyses associated with source selection.

d. Conduct technical and programmatic tasks necessary to resolve MANPRINT issues and concerns to the greatest extent possible before each MDR.

e. Apply MANPRINT methodologies to hardware and software development, modification and acquisition programs.

f. Maintain a MANPRINT issues log in order to resolve MANPRINT issues and concerns during the acquisition program life cycle.

g. Support the identification of MANPRINT-related program dependencies on other systems.

h. Lead MANPRINT working groups. In cases where a MANPRINT working group is not necessary, represent MANPRINT on another appropriate IPT.

i. Crosswalk MANPRINT performance parameters, objectives, and thresholds from the capabilities documents to the RFP and TEMP.

j. Develop funding and resourcing requirements for effective MANPRINT Program implementation, testing, and maintenance" (AR-602-2, 2014).

III. MANPRINT IN THE ACQUISITION LIFECYCLE

The Defense Acquisition Lifecycle consists of 5 major phases: Material Solution Analysis, Technology Maturation and Risk Reduction, Engineering and Manufacturing Development, Production and Deployment, and Operations and Support. There are 3 milestone decision reviews (A,B, and C) which are conducted during the system lifecycle which allow the program to proceed to the next phase.

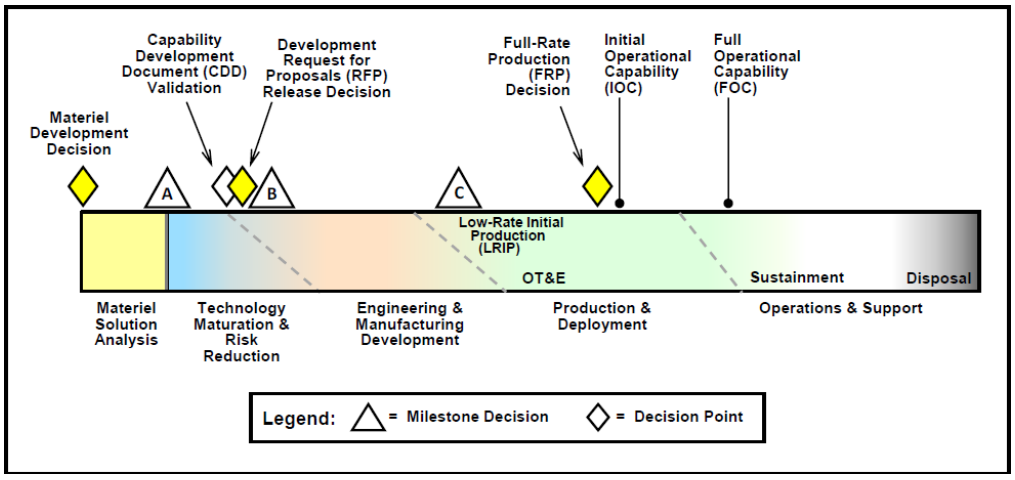

Figure 2. Acquisition Lifecycle (DoDI 5000.02, 2013, p.9)

During the acquisition lifecycle, MANPRINT assessments are required prior to Milestone Decision Reviews (MDRs). These assessments describe any MANPRINT issues and recommend whether or not a system should proceed to the next phase. Between these assessments, MANPRINT practitioners should work with the PM to mitigate these issues as illustrated in the right half of the Figure 3 below.

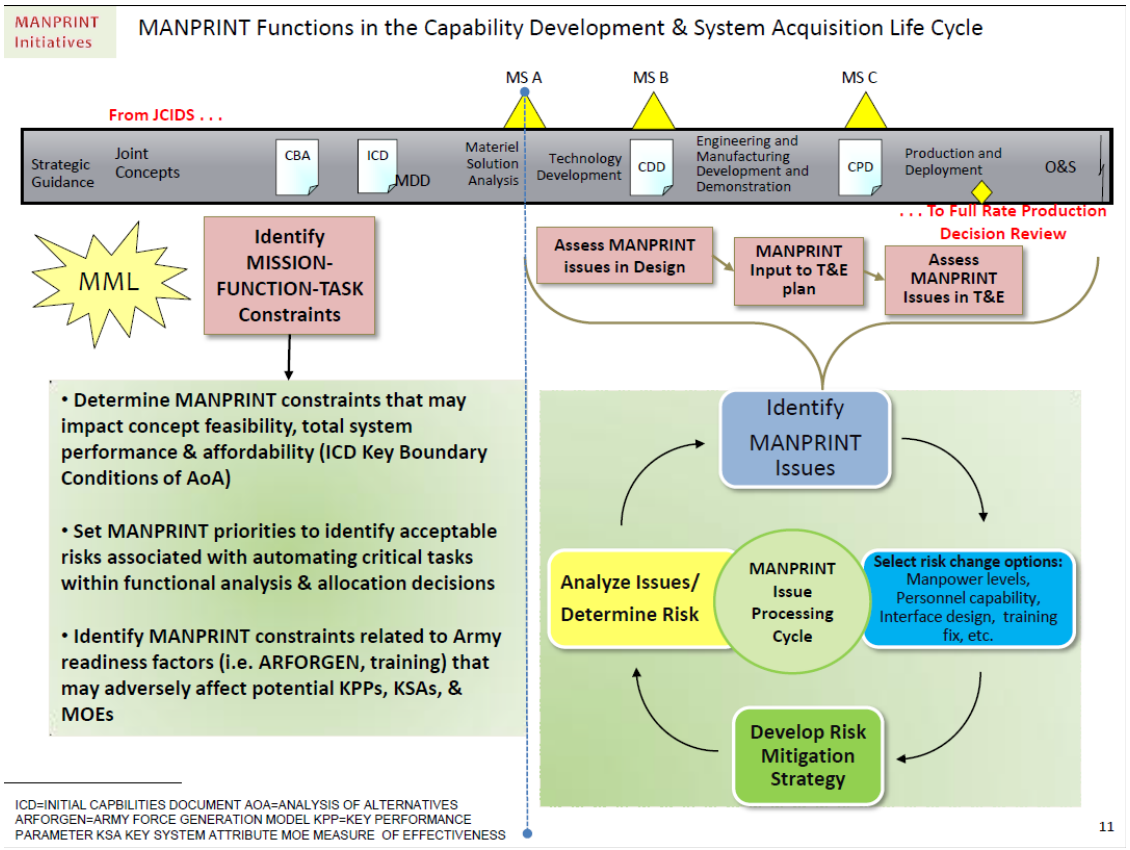

Figure 3. MANPRINT in the Acquisition Lifecycle (Knapp, Army MANPRINT Perspective, 2012)

In addition to MANPRINT assessments, MANPRINT is also involved in the test and evaluation process as seen in Figure 4 below. MANPRINT practitioners from ARL-HRED are assigned to Army Test and Evaluation Command efforts to evaluate systems for MANPRINT issues before fielding. MANPRINT practitioners are most involved in the logistics demonstration and operational tests where users can be observed maintaining and operating systems. These allow MANPRINT practitioners to observe issues that were not predicted from analysis of design plans and prototypes as well as allowing practitioners to survey Soldiers to obtain information not readily garnered otherwise.

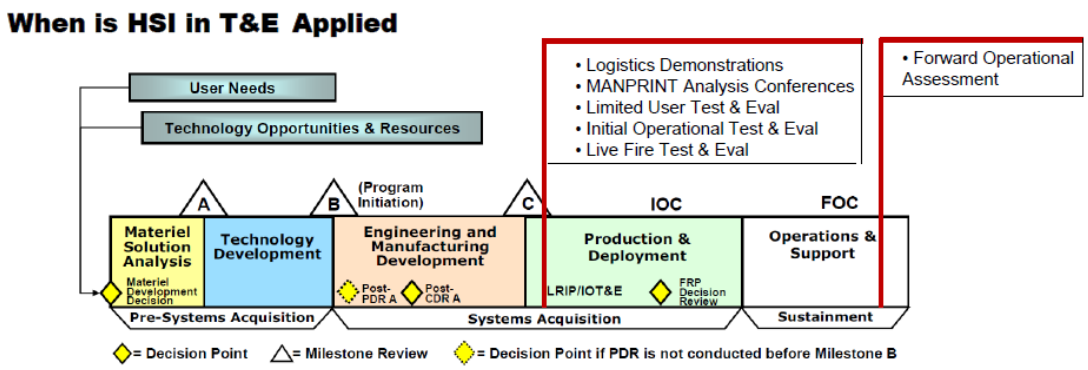

Figure 4. HSI in T&E (Knapp, MANPRINT (HSI) in Test and Evaluation, Moving MANPRINT Left Human Availability Metric Acquisition Reform, 2011)

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IV. CURRENT PRACTICES

Guidance on early MANPRINT efforts exists, such as Enclosure 7 of Interim DoDI 5000.2, which states, “The PM shall have a comprehensive plan for HSI in place early in the acquisition process to optimize total system performance, minimize total ownership costs, and ensure the system is built to accommodate the characteristics of the user population that will operate, maintain and support the system” (DoDI 5000.02, 2013, p.115). Unfortunately, this sort of guidance is not accompanied by any mandate that will absolutely ensure this is performed, unlike the requirement for a MANPRINT assessment at milestone reviews. This can lead to the unfortunate situation where materiel developers are not implementing an HSI plan during the early development of a system. As the proponent for MANPRINT within the Army, it is necessary for ARL-HRED MANPRINT support personnel to reach out to materiel developers, educate them on the benefits of early HSI efforts, and guide these efforts to achieve a system design that supports the Soldier. In addition, funding for MANPRINT activities is provided by the materiel development organizations, and thus ARL-HRED MANPRINT practitioners must be able to convince PMs of the value of these services.

A. MANPRINT ASSESSMENT

The MANPRINT Assessment is an independent review of the MANPRINT status of the system intended to present any unresolved MANPRINT risks to the PM and decision makers at milestone decision reviews, and full rate production decision review. Although an HSI effort should be conducted throughout the lifecycle of the system, it is at these decision reviews that the issues described in the MANPRINT Assessment will be used to help determine if the acquisition program can move forward, and thus carry a greater level of interest and significance to the PM.

ARL-HRED prepares the draft MANPRINT assessment from the various domain assessments. These assessments are: Manpower, Personnel Capabilities, and Training (MPT) Domain Assessments; Human Factors Engineering Domain (HFE) Assessment; System Safety (SS) Domain Assessment; Health Hazard (HH) Domain Assessment; and the Soldier Survivability (SSv) Domain Assessment. Depending on the Acquisition Category (ACAT) of a program, these domain assessments will be performed by different government organizations as seen in Table 1. ARL-HRED will always be the preparer of the MPT and HFE Domain Assessment, and will perform the SSv Domain Assessments for non-major programs unless otherwise determined by ARL Survivability and Lethality Analysis Directorate (ARL-SLAD).

Table 1. MANPRINT Domain Assessment Agencies (AR602-2, 2014, p.11)

Table 3–2
Manpower and Personnel Integration domain assessment agencies by acquisition category

Assessment	ACAT ID, IC, and II	ACAT IA (IAM, IAC)	AT III, IIIAC and IV
Manpower, personnel capabilities, training	U.S. Army Research Laboratory Human Research and Engineering Directorate		
Health hazards	Army Public Health Command		
HFE	U.S. Army Research Laboratory Human Research and Engineering Directorate		
Soldier survivability	U.S. Army Research Laboratory Survivability and Lethality Analysis Directorate (lead); U.S. Army Research Laboratory Human Research and Engineering Directorate (assist)		
System safety	U.S. Army Combat Readiness/ Safety Center *	U.S. Army Communications-Electronics Command	AMC LCMC Safety Office
Draft DCS, G–1 MANPRINT Assessment (Domain Integration)	U.S. Army Research Laboratory Human Research and Engineering Directorate		

1. Planning a MANPRINT Assessment

A MANPRINT Assessment typically takes a minimum of 6 months to be performed for assessments due to the need to identify and coordinate assessors, physically inspect systems, determine testing needs and perform tests, demonstrate hardware with trained Soldiers, write domain assessments, and allow for final review by the G-1. A request for a MANPRINT Assessment must be formally initiated by the PM. As ARL-HRED is responsible for preparing the draft assessment from the different sources, it is important that the ARL-HRED MANPRINT assessor notify the PM of the need to request the MANPRINT

assessment early. This will also prevent a rush effort to create a MANPRINT assessment that does not adequately address MANPRINT issues. Often, if early in the acquisition cycle of a program, the ARL-HRED MANPRINT assessor will need to explain the purpose of the MANPRINT assessment as well as the regulations that require a MANPRINT assessment to be performed. Additionally, the PM will need to be informed that each of the supporting agencies will need funding to perform this MANPRINT Assessment.

2. Coordinate the team

As seen in Table 2, the domain assessments are created by different agencies, with the overall integration of the MANPRINT Assessment conducted by ARL-HRED, and the final approval and review conducted by the US Army G-1. Although the PM can formally request the participation of each of these agencies, as the MANPRINT Assessment integrator, it is beneficial to initiate contact. This allows the integrator to leverage previously established relationships and identify points of contact for each domain assessment.

Table 2. MANPRINT Subject Matter Expertise (AR602-2, 2014, p.11)

Table 3–1
Representative Manpower and Personnel Integration domain subject matter expertise for integrated capabilities development teams and integrated product teams

Domain	ACAT ID, IC, and II	ACAT IA (IAM, IAC)	ACAT III
Manpower	U.S. Army Research Laboratory Human Research and Engineering Directorate; Capability Development Integration Directorate; TCM; proponency office		
Personnel capabilities	U.S. Army Research Laboratory Human Research and Engineering Directorate; Capability Development Integration Directorate; TCM; proponency office		
Training	U.S. Army Research Laboratory Human Research and Engineering Directorate; TCM; training developer		
Health hazards	Army Public Health Command (lead); AMEDDC&S (assist)		
HFE	U.S. Army Research Laboratory Human Research and Engineering Directorate		
System safety	U.S. Army Combat Readiness/ Safety Center; AMC Life cycle Management Command (LCMC) Safety Office	U.S. Army Communications-Electronics Command	AMC LCMC Safety Office
Soldier survivability	U.S. Army Research Laboratory Survivability and Lethality Analysis Directorate, U.S. Army Research Laboratory Human Research and Engineering Directorate		
MANPRINT (domain integration)	DCS, G–1 (DAPE–MR); U.S. Army Research Laboratory Human Research and Engineering Directorate		

3. Determine when data can be gathered

There are many possible times for collecting data during the acquisition of a new system. Specifically, test events that involve Soldiers are one of the most efficient and effective venues for gathering MANPRINT information. Operational Test events often allow inspection of the system relative to all seven MANPRINT domains. These events will illuminate issues that Soldiers encounter with the system, and allow for surveying of the Soldiers to get their specific feedback. Another valuable test event is the logistics demonstration. This event also involves Soldiers interacting with the system, but from a maintainer's perspective. Additionally, MANPRINT data can be gathered throughout the acquisition cycle as issues are noted by the assessor during meetings, design reviews, or any other data collection points of opportunity.

a. Operational Test events

Operational Test events are arguably the best event for observing MANPRINT issues. These events are often the first time that the system is used by Soldiers without strict supervision by materiel developers. For this reason, issues in the seven MANPRINT domains become readily apparent. For example, deficiencies in training are easily noted when the Soldier does not have the opportunity to turn to a field support representative or materiel developer for quick guidance. It is absolutely crucial that these events are observed to thoroughly examine a system through the lens of a MANPRINT Assessment. There are several ways for MANPRINT practitioners to get involved in operational test events.

(1) Coordinate with Operational Test Command. The Operational Test Command (OTC) establishes tight controls over the majority of their test events to ensure that the participating Soldiers are not being aided by anyone in a manner that would not be available once the system is fielded. Also, OTC ensures that the participating Soldiers are not unfairly influenced by the opinions of outside influences. For these reasons, coordination with OTC is

required to gain access to Soldiers and to confirm with OTC that these controls will not be violated.

(2) Observe operations during Operational Test Event. Observation of the system in use by Soldiers during the operational test events often leads to the identification of multiple MANPRINT Issues. Often, issues are encountered by the Soldiers but may not be identified as issues by the Soldiers themselves. For example, the system may be operated in a manner that poses a safety hazard, but the Soldier may not notice this hazard due to a lack of adequate notification (human factors issue), lack of understanding (training issue), or other reasons. These types of issues can be some of the most dangerous to the user in that they may not be noted until it is too late. For this reason, vigilant monitoring of operations is needed by MANPRINT Assessors.

(3) Survey Soldiers. Observation of all Soldiers performing all tasks during an OTC test event is impossible due to assessor manpower constraints, time constraints, and the fact that some tasks simply may not be observable due to space constraints or other factors. Also, Soldiers may encounter issues that were not noted by the assessor, and are often the best source of information for MANPRINT issues. For these reasons, Soldiers should be surveyed to garner feedback on possible MANPRINT issues.

Surveys and questionnaires need to be tailored to each system and test event. Overly long surveys or surveys that have multiple irrelevant questions will not be received well by participants, and will render the response data suspect. The ARI Questionnaire Construction Manual provides detailed guidance on the development of questionnaires that are unbiased and palatable to participants. In practice, a mix of Likert-type survey questions about the usability of the system followed by open-ended comment sections seems to capture good data about the system under test. Surveys that are to be answered after each shift or mission should be kept to under a 15 minute response time, while surveys conducted at the end of the test should be kept under an hour (preferably shorter for less complex systems).

b. Logistics demonstration

The Logistics Demonstration (LOGDEMO or LD) is the opportune time to examine the maintenance tasks that Soldier maintainers will have to perform. This event is similar to the Operational Tests in that it may be the first time the Soldier maintainers will perform the tasks without strict supervision, but often does not have the same level of separation between Soldiers and materiel developers. During the LD, procedures may be discovered that need to be rewritten, requiring cooperation between the maintainers and the materiel developer. There are several ways for MANPRINT practitioners to get involved in LD events.

(1) Coordinate with PM's Logistics Lead. The PM's Logistics Lead will be responsible for planning the LD and tight coordination will be needed. Often, the MANPRINT assessor will need to stress the importance of the maintainers attempting the maintenance tasks without outside intervention to be able to determine if MANPRINT issues exist. One of the key items to coordinate with the Logistics Lead is tracking the LD. There should be procedures in place to track whether a maintenance task has been demonstrated, any issues encountered, the time required to perform, and if the demonstration was successful.

(2) Determine tasks that need to be demonstrated. All maintenance tasks that need to be performed on a system should be demonstrated to determine that they can be adequately and safely performed. Often, some large tasks incorporate many sub-tasks which need to be performed. Thus, an LD task list can be created which includes all the necessary maintenance tasks at least once. These sub-tasks must still be carefully tracked during the course of the LD.

Some tasks may need to be performed in the field while wearing cold weather gear or nuclear, biological, and chemical (NBC) protective gear. The list of tasks for which this type of gear is applicable should be

developed with the TRADOC Capabilities Manager. Specific tasks for which this gear could be expected to interfere with maintenance procedures should then be sub-selected by ARL-HRED personnel and recommended for additional LD testing with the required gear.

(3) Observe Tasks. Just as in the Operational Test, observation of the tasks by the MANPRINT Assessor will allow for the identification of issues. This also educates the MANPRINT Assessor on how procedures are actually performed which can make analyzing written feedback much easier.

(4) Collect Soldier feedback on issues. Soldier feedback on issues can be collected multiple ways for an LD. If the tracking of the LD is through a database, it is often best to allow Soldiers to directly enter issues encountered into the tracking database. Alternatively, written issue feedback forms can be administered to document issues.

(5) Make recommendations to procedures. Many of the issues that are encountered during a LD are due to inadequate or inaccurate procedures. For example, a procedure might tell a maintainer to lift a piece of equipment that requires a two-man lift, or, a component may need to be removed before the task can be performed. For these types of issues, a change to the procedure may be all that is necessary to make the task possible. These new procedures can then be tested.

(6) Document Issues. Some issues may require redesign of the system, changes to training, or other more involved risk mitigation strategies. These must be documented as part of the LD process. In addition, tasks that were accomplished, but could be made faster, safer, better, etc. with non-procedural modifications should be noted for further improvement efforts.

(7) Track time improvements. The ability to track time improvements during the LD process is often overlooked by MANPRINT assessors, as it is not something that the MANPRINT assessor is specifically required to track. Tracking the time saved by the implementation of a new

procedure, process, system change, etc. that was suggested by the MANPRINT assessor is a concrete, quantifiable method of showing the impact of MANPRINT efforts. The amount of time saved on a single maintenance task can be converted into man-hours saved over the life of a system, or if large enough, into the reduced manpower required over the life of the system. This can then be converted into an actual cost savings. This simple task of tracking the time saved by MANPRINT issue resolution can allow the MANPRINT assessor to justify their role many times over with an explanation of the overall time and money saved.

4. Develop the assessment

As the data are gathered by the MANPRINT domain assessors, the MANPRINT assessment can be developed. As the system is assessed, it is important to keep the PM informed on issues that have been discovered, as this will allow the PM as much time as possible to develop risk mitigation plans. It is extremely important to remember that the assessment process is foremost a method of ensuring the delivery of the best product to the Soldier by meeting their needs, and thus should not be unnecessarily contrived as adversarial to the materiel developer. Keeping the materiel developer informed and aiding in the development and execution of risk mitigation plans is the best method of supporting the Soldier through this process.

The MANPRINT Assessment will detail any MANPRINT issues that have not been remedied, drawing special attention to those critical issues that do not have an adequate risk reduction strategy. Obviously, at early milestones, critical issues are much rarer, in that the system development is so immature that there is more time left to develop risk mitigation strategies before fielding the system. Often, in early assessments, the MANPRINT Assessor simply points out potential pitfalls and issues to be addressed as the system matures. The MANPRINT Assessment is intended only to document the MANPRINT issues with a system. These recommendations are often desired by the PM; the best methods for

providing these will be discussed in the Becoming a MANPRINT Team Player section of this paper.

B. ATEC MANPRINT EVALUATOR

ARL-HRED MANPRINT practitioners often also serve as the ATEC MANPRINT Evaluator for many programs. This process is separate from the MANPRINT Assessment process, but often uses the same data sources and can have similar results. Some programs, such as rapid initiatives or block upgrades, will not require a MANPRINT assessment, but will require an ATEC MANPRINT evaluation. The documentation of the MANPRINT Evaluation will differ depending on the ATEC product being generated, but the following steps outline general practices that are applicable to the ATEC MANPRINT Evaluator role.

1. Coordinate with the ATEC Systems Team Chair

The ATEC Systems Team Chair (AST Chair), is responsible for coordinating the various test elements, including the MANPRINT evaluation. In the same manner that it is important for the domain assessors to work closely with the MANPRINT assessor on a MANPRINT Assessment, it is important that the MANPRINT evaluator work closely with the AST Chair. The AST Chair will be the best source for information on test events, funding, and other important information needed to conduct a MANPRINT evaluation.

2. Determine data sources

For an ATEC MANPRINT Evaluation, the main data sources will be the Operational Test Events. As discussed before, these provide a great opportunity to see the system in operation and see MANPRINT issues that might exist in any of the seven domains.

3. Complete Human Factors Engineering Evaluation

A Human Factors Engineering Evaluation is a helpful document to track all MANPRINT issues. This document will detail even the smallest MANPRINT

concerns to aid the materiel developer in future system improvements. The convenience of this document is that it readily translates to the MANPRINT assessment format if one is required; or, information can be easily pulled from this document in order to generate other products that ATEC requires.

4. Rapid Fielding Initiatives

Rapid Fielding Initiatives pose particular challenges to the MANPRINT evaluator. Funding is extremely limited, little documentation is available, requirements may be ill-defined, end-users may not be identified, and other problems related to rapid acquisition may be present. For these programs the MANPRINT evaluator should push strongly for a test event with Soldier operators. These events can show that the system is not adequate for the expected usage, or that the requirement does not match the operational need. These programs require quick response by MANPRINT practitioners. One of the benefits of these rapid initiatives is that, due to the limited need for documentation, extensive contracting, etc., some MANPRINT related changes to the system may be implemented very quickly.

V. BECOMING A MANPRINT TEAM PLAYER

Up to this point, this document has primarily focused on the traditional MANPRINT roles of assessment and evaluation. Although this serves an extremely important protective role for the Soldier, more proactive HSI efforts can yield better system performance and more efficient acquisition. By including HSI practitioners early in the acquisition cycle, materiel developers are able to save time and money, as well as increase overall performance, by addressing HSI issues when changes to the system are still relatively easy. This part of the document will discuss how to provide MANPRINT support earlier than the traditional assessment and evaluation stage.

A. HOW TO BECOME A MEMBER OF THE TEAM

"As a human factors engineer, injecting oneself into the system development decision cycle is not a given" (Morelli, Savage-Knepshield, Mitchell 2013) . In order to be included in the early acquisition stages of a system, MANPRINT practitioners need to effectively become HSI salesmen. Earlier stages in the acquisition cycle have limited funding, and without the regulatory requirement for early inclusion, MANPRINT practitioners need to be able to show what they can "bring to the table." When performed effectively, MANPRINT personnel will be welcomed as part of the team and included when they can have the greatest effect. This also has the benefit of beginning the MANPRINT/PM relationship on good terms. Often, when MANPRINT issues are first identified during the later evaluation of a system, it can be a frustrating experience for all involved as changes are harder and more expensive to make at this time. This section will discuss MANPRINT "salesmen" methods that can be used to integrate the MANPRINT practitioner into the materiel developer's processes early in the acquisition lifecycle.

1. Desk-side brief

One of the most direct methods of ensuring that a PM understands the benefits of an HSI program and how ARL-HRED can assist in developing a system is to simply explain these benefits. This method is applicable at any time, but should be tailored to the current development phase. Once a PM, project manager, or other entity requiring MANPRINT support has been identified, this method consists of providing the PM with a desk-side briefing on how the inclusion of an ARL-HRED MANPRINT Action Officer would be of assistance to his or her program. For this briefing, it is critical to have examples of MANPRINT success stories, complete with previously gathered data on how a MANPRINT program has helped reach cost, schedule and performance goals. The main goal of this desk-side briefing is to educate the PM on how early investments in MANPRINT will result in significant savings, improved system effectiveness, and avoidance of schedule overruns.

This briefing needs to be updated over time to provide current examples and to remain relevant to the newest acquisition policies and practices. This is one of the many reasons that it is extremely important for MANPRINT practitioners to track MANPRINT success stories and, specifically, to collect metrics on how HSI efforts benefited a program. These can be added to this briefing to create a compelling story that will answer the hardest PM question "What can you do for me?"

2. Applied Research

ARL is the Army's corporate laboratory, intended to support the various Research, Development and Engineering Centers (RDECs) with the basic research they need to transition technology to the acquisition workforce to support the warfighter. Much of the work performed at any RDEC is designed to transition to a specific PM, or the PM has at least indicated that it would be interested in knowing the results of an RDEC effort. Thus, the culmination of research efforts is often demonstrated or reported to the PM. At this time, it is

important to stress the support ARL-HRED provided in the area of HSI, and future areas of concern.

The final demonstration of a research effort to a supported PM is an opportunity to explain the capabilities of ARL-HRED and how these capabilities can be further leveraged in support of the system under development. In practice, any opportunity to directly address the PM should be thought of as an opportunity to "suggestive sell" the benefits of an active MANPRINT effort. When the results of an applied research effort are presented, the MANPRINT practitioner should devote some time to future issues that are envisioned for the system, and how these issues might be overcome through MANPRINT activities.

These research efforts can also involve other agencies, and it is important to maintain and cultivate these relationships. Continued involvement in collaborative projects helps to gain exposure and positive relationships for ARL-HRED that can lead to early involvement in programs of record.

Given ARL's capability to conduct human systems integration research, there are often opportunities for research to be performed that would directly aid a PM's system development, or that could inform the design of future systems. When a question is posed by a PM about some aspect of human performance, an effort should be made to answer the question with the available literature, if possible. If the question cannot be answered in this manner, then a discussion should begin about the possibility of researching this problem. If this question is of critical importance to the PM, this is an important way of providing immediate results to the PM.

As a word of caution, some PMs may be critical of a so-called "science experiment" and may require a careful presentation of the need for research. This can often be accomplished by simply suggesting the idea without further explanation. If there is interest in performing research, then further discussion can lead into the details of how this would be performed, which is more likely to be accepted than a full research proposal. Another method is to wrap this

research up in the form of a user jury. For example, two proposed system interfaces could be presented to users and feedback could be given as to which system they prefer. In addition, actual performance data could be gathered to determine if the overall system performance would be greater regardless of preference. Most PMs are extremely receptive to gathering user feedback, and the data gathered can help verify the feedback and quantify the importance.

The goal of the PM to create an effective system while managing cost and schedule must be kept in mind when developing proposals for applied research efforts. These applied research efforts should be aimed to answering specific questions that the PM needs answered. This may often result in a need to compromise on aspects of the research effort, such as reducing experimental control for the sake of realism, or accepting lower statistical confidence levels due to limited resources and time constraints.

3. Integration Events

Integration events and other events designed to show the interoperability of systems are often a great venue for capturing the input of Soldiers. This "method for influencing design and product development… provides a powerful benefit – the ability to observe and gain insight into how a particular system interacts with other systems being employed by teams of Soldiers in an operational setting and to uncover deep-seated user needs" (Morelli, 2013). These events provide useful opportunities to identify unforeseen integration issues and to address all parties involved with the various systems to be integrated. These also help to give the MANPRINT practitioner an understanding of the actual operational environment, which can yield great insights into how systems are actually used.

4. Requirements writing

During the development of a new system, the materiel developer will need to create a set of requirements for the system. In practice, these requirements are normally written using a previous program's requirements as a template. At

this point in time, the materiel developer may request assistance in development of HSI related requirements. This is a great time to show the value of HRED support, and also to draw attention to the HSI considerations needed for the system to be developed. HRED personnel should have access to requirements written for other systems that may be applicable to the system of interest. Some requirements such as HSI documentation requirements for the system developer or general anthropometric fit requirements will easily translate from one system to another. System specific requirements will require a more detailed inspection of the system that is to be developed.

Military standards can often be used for reference in requirements, but it is important to understand the limitations of these documents. MIL-STD-1472 is an excellent resource for Human Engineering information, but is not necessarily up to date with the newest user interfaces and thus requirements to follow such standards should be caveated with exceptions as needed.

For some programs, there may even be a need for HSI practitioners to develop HSI guidance documents for system developers. These efforts require significant research, but may be necessary to achieve the desired results.

5. Analysis of Alternatives

When an analysis of alternatives is being performed and multiple candidate systems are available, the HSI tradeoffs that exist for each alternative can be analyzed to aid in the PM's decision. For example, one system may require more manpower than another or a system may require more involved control and thus greater personnel capabilities. Serious HSI issues that may be encountered with an alternative can be brought to the PM's attention. This type of information will greatly assist the PM in making an informed decision.

For an analysis of alternatives in which the alternatives are less defined, or more flexibility is possible in approaches to finding the military solution, a HSI tradespace analysis may be conducted to help the PM. This type of analysis will help the PM understand, and quantify in terms of estimated cost, the effect of

various HSI tradeoffs. Significant effort is needed develop an accurate estimate of the effects of these tradeoffs, but may be warranted for sufficiently complex or costly programs.

6. Assessor turned ally

At some point during the development of a system, a lead MANPRINT Assessor will be assigned; or in the case of rapid initiatives, a MANPRINT evaluator will be assigned from ARL-HRED. This is an opportune time to explain the assessment role of ARL-HRED, and if any potential MANPRINT issues are glaring, to note them immediately. Explaining the assessor role will help the materiel developer realize the importance of paying close attention to HSI issues. At this point, it is crucial to emphasize that this relationship is not intended to be adversarial, and that including ARL-HRED as a member of the team will help to identify and ultimately to remedy MANPRINT issues sooner, resulting in lower cost and less impact to schedule.

For all levels of acquisition programs, ARL-HRED is the sole performer of the Human Factors Domain Assessment. A helpful practice is to create a Human Factors Engineering Evaluation after each major data collection event. This document will inform the PM of HSI issues that are present. At this time, recommendations for possible approaches to remedying these issues should be given. This will aid the PM in outlining definitive steps to remedy these issues.

7. When issues arise

Despite the best efforts to become part of the team, there can be instances where a materiel developer does not believe it is in their best interest to collaborate with ARL-HRED or adopts an adversarial stance, believing that the issues identified are not as severe as the MANPRINT assessor believes them to be. Often, this situation can develop when a materiel developer believes it does not have enough funding to include personnel from HRED or does not have funding/time to implement the types of changes that HRED recommends to the system. Unfortunately, if the MANPRINT issues are serious enough in nature,

these issues will need to be addressed despite the impact to the program's budget and schedule. At this point, it is often useful to illustrate how the MANPRINT issues that have been identified can be used to request additional funding or relief from specific system requirements in order to develop a system that is adequate for Soldier's needs. It also is critical to inform ARL-HRED management and the G-1 that the PM intends to disagree with the MANPRINT assessment. This will allow all to prepare a thorough response to critiques and for additional support to be provided as necessary to help remedy issues.

8. You are not on our team

In extremely adversarial situations, conflicting personalities or other extenuating circumstances, personnel from HRED may find themselves unable to be included on the materiel developer's team. This may be an opportune time to bring in a fresh face to the program. This is the least desirable method to become a member of the team but it can prove to be a turning point in the HSI program for a system. At this point, additional personnel may discuss with the materiel developer how MANPRINT issues can be resolved, offer fresh explanation of issues, or offer to examine issues in more detail in a different setting (lab, trainer, etc.) Often, this can be initiated at the working level by simply stating the desire to bring some fresh eyes to the issues. In more extenuating circumstances, this can be driven by ARL-HRED management or even the G-1. If brought onto a program in such a manner, an adversarial stance should be avoided and instead, one should offer to hear all sides of the discussion first before lending assistance.

9. Repeat business

Once HRED has successfully supported a PM in their materiel development, becoming a part of the team for future endeavors is often relatively effortless and often requires only a reminder that you are available to support. Even in situations where the relationship with the MANPRINT assessor became adversarial, becoming a member of the team for later endeavors can be smoother, as the PM may now realize the benefit of including HRED earlier. This

is the most favorable method of being included in acquisition efforts, as the benefits of HRED inclusion are already understood by the PM and can be reinforced simply through good MANPRINT work.

Once a MANPRINT practitioner has proven his/her capability to thoroughly determine MANPRINT risks in a given materiel solution, the practitioner may often be called on to examine equipment when the materiel developer has a feeling that a system has a risk that is not being addressed. Often, this type of HSI risk is one that is easily identifiable, such as an object that is too heavy to lift, and can be addressed rather readily, but opens the door to a more thorough examination of the system. These types of opportunities should not be ignored and can show the PM that HSI expertise could be useful earlier than they had imagined. These initial looks are often done as quick favors in practice but often quickly escalate into fully funded, involved efforts.

B. WHAT TO DO WHEN ON THE TEAM

Besides the activities detailed in the current practices section of this report, there are many activities that can be performed by MANPRINT practitioners that can help the materiel developer to get the best system to the Soldier.

1. Task Analysis

One of the most useful tools in the HSI practitioner's arsenal is the task analysis. It is an unfortunate reality that many people who are working on the development of a system do not fully understand how a Soldier will actually use it. The general concept of operation may be known, but the details may be misunderstood. These details can often have a large, unforeseen impact on how the system should or could operate. A task analysis can be performed which will flesh out these details as well as provide a reference document for others. Performing this task analysis will aid the MANPRINT practitioner in understanding the details of the system use and determine areas that need further investigation, such as where time is wasted, which tasks are difficult, etc.

As most systems are improvements to capabilities that are already possessed, a task analysis can be performed on previous systems to give a thorough understanding of the tasks that the user must perform. For truly novel systems, this task analysis can be theoretically developed with the input of the operational requirement developer, though the task analysis may not have the same level of detail.

For many systems, the level of detail required for an initial task analysis can be developed from a simple talkthrough or walkthrough by Soldiers who have used a similar system. The tasks performed by the Soldier can be directly documented, and can serve as a baseline for specific questioning about more detailed use cases, for example, when an error occurs. Establishing a relationship with knowledgeable end users will also allow for quick clarification of details and provide a useful sounding board for ideas.

2. Design Support

The traditional MANPRINT assessment and evaluation roles focused on finding the problems that existed with a system, but the PMs desire is to not just identify, but solve these problems in order to provide a useful capability to the Soldier. To this end, aiding the PM in the design of the system will aid in delivering the best product to the Soldier.

a. Usability Analysis / User Jury

As a system is developed, the design should be reviewed by the intended user. This will provide valuable feedback on what is good and bad about the proposed design. As mentioned before, collecting performance data when users use the system will provide data on how system design influences overall performance. This is needed to separate preference from impact, which can be very important to differentiate. For example, Soldiers might indicate that they have little preference for one design or another, without realizing that one design led to much better performance. The opposite situation could be true, in which a design does not yield better performance but is greatly preferred. This is

not to say that this preference should be ignored, as user acceptance of a system has larger implications that may justify cost or time expenditure. In addition, when selecting members of a user jury, diversified experience is beneficial in avoiding feedback that is only relevant to a limited subset of intended users. In essence, the opinions of an end user must be understood to be just his or her opinion, and possibly of interest, but opinions that are more widely held should carry more weight.

b. Human Performance Simulation

Simulation of human performance, be it through cognitive, biomechanical, or stochastic simulations, is greatly beneficial in aiding in the design and evaluation of systems while reducing costs. Many tools, such as JACK, IMPRINT, ISMAT, etc. are available to perform HSI related modeling tasks. This type of modeling can be performed well before systems are fully designed, which can result in system design changes at a point in the acquisition life cycle in which they can be implemented at minimal cost.

c. Heuristic Evaluation

The most common task required of a MANPRINT practitioner by a PM is a heuristic evaluation. Often an HSI subject matter expert is asked to look at a concept, design, or system and point out what needs to be changed. At other times, a MANPRINT practitioner will be asked to answer specific design related questions. For this type of information, MANPRINT personnel should aim to be well-versed in HSI best practices, including keeping up to date with the latest research into human performance. Of course, it is impossible to know every bit of information possible, so MANPRINT personnel should aim to establish a network of subject matter experts who can aid in specific areas. The ability to provide instant feedback on designs, or quickly gather the information necessary to provide adequate feedback, will make the MANPRINT practitioner an invaluable member of the PM's team.

3. Metric Collection

The collection of HSI-related metrics has at least two benefits: to develop a data set that can be used to “sell” MANPRINT to future customers, and to give the PM feedback on the utility of their investment. The latter of these two benefits is that the PM is not only able to justify future HSI expenditure, but can use these metrics to help illustrate the successful management of his or her program. When HSI efforts yield great savings, the PM can use these data to tout the success of the program which helps “spread the word” about early HSI involvement, and gives the PM to the basis for claiming success.

As discussed earlier in this document, the Logistics Demonstration permits easy collection of maintenance time savings that are relatively easy to convert into direct cost savings. Additional cost savings can be easily calculated if HSI efforts can eliminate the need for specific tools or equipment, or time savings can be identified elsewhere such as by reducing the length of training. There are many other metrics that can be collected that are harder to convert directly to cost but are worthy of collection. By keeping a MANPRINT issue tracking database, the MANPRINT practitioner should be able to quickly identify how many issues were identified and how many were resolved. In addition, lesser items can be tracked(such as procedures rewritten, number of Soldiers surveyed, number of comments logged, etc.) and can be useful for painting the picture of the utility in integrating HSI efforts early in the acquisition lifecycle.

4. Ensure Future Support

The MANPRINT practitioner should be focused on continuing to provide HSI support to PMs and ultimately the Soldier. Through the methods discussed in this document, continued support of any PM should take very little effort to initiate, given one caveat: the MANPRINT practitioner must do his job WELL. In an environment where MANPRINT practitioners must perform the job of HSI salesmen, they are doomed to fail if they cannot provide a product worth buying. For this reason, all HSI experts must provide proactive, thorough support, while

also making sure to wisely use the funding provided. By working diligently to aid the PM through the application of concerted HSI effort, the opportunities for MANPRINT personnel will continue to expand.

VI. FUTURE IMPROVEMENT TO ARMY HSI

One of the greatest difficulties with moving MANPRINT to the left is the lack of funding for MANPRINT activities at early stages in the acquisition cycle. During early acquisition stages, PMs have limited funding to conduct analysis of alternatives, so it is often understandable that they have little to no funding available for MANPRINT activities, despite the advantages to early MANPRINT efforts. In order to remedy this situation, direct MANPRINT funding to support pre-milestone A efforts could be provided.

Although current DoDI 5000.2 indicates that PMs “will plan for and implement human systems integration (HSI) beginning early in the acquisition process and throughout the product life cycle,” (DoDI 5000.02, 2013, p.115) there is not any regulation or doctrine that truly ensures the PM performs early HSI activities. A MANPRINT assessment is required prior to Milestone A, but this assessment often has little more than a description of possible MANPRINT issues that the system may encounter during development. Changes to DoD or Army policies could require that certain MANPRINT activities actually be conducted in early stages, such as the development of a task analysis or a tradeoff analysis. This could also be affected by changing the MANPRINT Assessment format such that the lack of these analyses would be considered a critical issue, and thus a system would not be recommended for transition to the next phase until these are complete.

Without changes to regulations and policies, there are still many things that can be done to improve the practice of HSI within the acquisition lifecycle. HSI professionals can continue to perform the role as HSI salesmen, and can improve this role by sharing their success stories. The development of the desk-side briefing for PMs can be raised to the ARL-HRED Field Element, Directorate, or even G-1 level to create a concise presentation of the greatest successes.

The simple continuation of providing useful and effective support to PMs and spreading the good news of the results of this work will also help improve Army HSI. As each PM is successfully supported, explaining the benefits of HSI becomes easier, and the demand for HSI support from previously unsupported groups is increased. By collecting metrics as well as success stories, the benefits of HSI simply sell themselves and eventually, not including HSI early in the acquisition cycle will be considered folly. In essence, the best method for improving Army HSI is to provide the best HSI support that one can muster.

VII. LIST OF REFERENCES

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