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Sustainable Human Performance in Large People-Oriented Corporations: Integration of Human Systems for Next-Generation Metaverse

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ABSTRACT

Human systems integration (HSI) involves Human Factors and Ergonomics (HFE), Human-Machine Interaction (HMI), engineering, and domain experience, which are the initial components of systems engineering (SE) in all industries' economies: wellbeing, transportation, energy, IT, retail, finance, manufacturing, and production. HSI can be achieved by combining virtual prototyping with Human-In-the-Loop (HIL) simulations. HMI is typically a model-based and patented innovation; it uses HIL and requires a homogenized systemic reflection with feedback. Virtual Reality (VR) Human-Centered Design (HCD) is sustainable. VR-controlled HCD acts as a definitive Key Enabling Technology (KET) concept in considering the full range of system Life Cycle Assessments (LCAs) and whether the process is sustainable. To this end, on the planet earth, human organizational elements are not only assessed during the design process but the whole LC of a system. Against intuitive education, it has been stated that conservative and narrow LCA should not be implemented in a sustainable world but instead Cradle-to-Cradle (C2C) design from social, economic, or environmental terms; the objective is to increase positive impacts, not reduce negative ones as in LCA. By enabling virtual environments, digital tools enable these new capabilities, which should be realized as sustainable by Digital Twin (DT) formable as a Sustainable Model Based HSI (SMBHSI) concept with high-level Artificial Intelligence (AI) and C2C consideration forming the level of the metaverse, straining from VR. DT-based Internet of Things (IoT) solutions enable investigators to test scenarios for future foresight, give corporations abilities to benefit from performance metrics based on domain experience, and are a crucial concept in SMBHSI. A case on this proceeding instance will display an example for SMBHSI when the method is scoping review to the strategic objective to form an up-to-date linear outlook. Integrating HSI on AI and C2C thinking methodologies helps to save resources and move towards the globalized green level of circular economies, representing the economic integration of the economy of the human system by indirect resources utilization suggestion as indicative as inference and adaptation to blockchains.

Keywords: Human systems integration, Systems engineering, Back-end theories, Front-end theories, Craddle-to-craddle

INTRODUCTION

History

Development of HSI for HCD started during the Second World War when Human Factors and Ergonomics (HFE) started to impact people's minds. American occupational healthcare specialists' were observing how lethal working conditions, such as injuries because of humidity, noise, and heavy physical load, affect people (Adaptation from Heilala 2022a; advanced into Boy 2022). Just before the 1980s – Science, Technology, Engineering, and Mathematics (STEM) based Mechanical and Industrial Engineering (ME/IE) were the most weighted disciplines (Boy 2022 continues) until the European Association of Cognitive Ergonomics (EACE) raised interest with HFE across the Atlantic (Khayal 2019). Work safety has been occasionally measured, observed, and analyzed in many systemic contexts; when a new system is built, the evaluation of the system from HFE is essential. It isn't easy to place an HFE specialist in the same room with an ME cognizant. When the praxis views easily differ, the design principles result in an unreached competency as "uncertainty" (Heilala 2022b), predicting increased injury statistics. Preventive actions and plans are usually devised too late after the activity or planning budget has already been used (Boy 2022), creating an opening for public debate on the systemic constraints connecting to governing and setting laws for safety protocols at the systems level.

Research Questions

To cover the objectives of the study, the following research questions (RQs) were defined by selecting a case company:

1. What are the functional integration area and basic information of the selected company?
2. How do the selected company's operations respond from the point of view of system integration?
3. What is the sustainability agenda of the chosen large company mirrored in the supplier decision?

To respond to the abovementioned research questions, company selection had basis in manufacturing industries largest players, and was selected by with convenience sampling. Research is carried out by conducting a literature review on relevant data exploring the company concerning RQs objectives. The following section discusses the selected company and proceeds to respond to each research question.

Now we feel cognitively awake and curious and can take off to the worldwide multi-industry.

LOCKHEED MARTIN'S HUMAN SYSTEMS INTEGRATION CASE

Great Solutions From Large Corporation

Lockheed Martin (LM) is a worldwide multi-industry whose annual turnover increased from 42B to 67B ($M \approx 50$ $SD \approx 8.5$) with around ($M \approx 110$ $SD \approx 9$) thousand employees on the 15 years scale (LM 2007; LM 2021).

LM has developed an enterprise architecture to define the next-generation method on the Object-Oriented approach that was primarily withdrawn for enhancing human-system performance. They have become key for solving employees, customers, stakeholders, communities, and environmental problems by reviewing the performance of primary products, positioning natural resources for global security, and taking sustainability success to the next level. The stated uncertainties go above arctic political discussions about how the melting ice over polar areas changes everything (LM 2008 cited Roston & Migliozzi 2017).

The Product Portfolio is Anything Else but Fighters

LM is responsible for surveillance and information processing for the CIA, FBI, IRS, NSA, Pentagon, Census Bureau, and Postal Service. They received $36B from the government and made historical withdrawals for DoD, DE, DA, and EP, creating the corporation which are the best place for innovations. Even while technologies developed by LM may be watching you at home being the big brother, everyone always wanted to supply weapons to conflicts areas, capturing information for precise mass assassination operations of terrorists suspected by US intelligence for good political sake, where government and many quasi-governmental agencies are below its actual reach (Hartung 2011).

Experimental Receptive-Actively Computed Steering

LM introduced an integrable SMART protocol that uses cognitive neuroscience to maximize overall human-system performance on multiple, stressful, complex tasks because it senses individual readiness. SMART allows developers to implement strategies, processes, and designs to avoid poor performance through various strategies: delegating tasks, presenting vital information in multiple modalities - audio and visual alerts - when sensors indicate boredom or drowsiness or collecting relevant information into a summary panel that supports rapid, time-sensitive decisions. Needless to say, KETs remarkably reduces human inefficiency-caused errors based on Human-Computer Interfaces (HCIs) feedback. SMART is deployed to ensure the safety of critical components and systems, such as air traffic control and management: segmented into civilian and military applications. Environmental difficulties still vary. Human factor engineers had to evaluate alternative designs for human-computer interfaces for advanced fighter jets. Because the HCIs combine multidimensional actuators to provide real-time sensor data streams so that they can interact with the HCIs. The pilots' mental workloads can be compared with baseline and new interface designs before and after performing the same tasks, giving scientific evidence for development. The pioneering version of SMART from 2006 assisted warfighter information intake under stress for advancing into new research areas (LM 2008).

Development projects in various areas are represented by the intuitive complex system design methodology encompassing system design integrity. Adapting the thinking methodology to the specialty engineering model will keep all projects, procedures, and agencies busy and energized by sharing

similar understanding based on standardized drawings. Using basic systems engineering is covered by Object-Oriented System Engineering Methodology (OOSEM). It is the precursor to SysML and is heavily involved in MBSE and SysML for HCD.

Cognitive Computing for Human-Centered Design

Transferring consciousness to an AI? Yes, but how?

HSI, including AI design flexibility, combines multiple Ptolemy modeling framework hierarchical actors: process networks, discrete events, dataflow, synchronous/reactive, 3D and continuous time-based models for interoperating communication. Hybrid System Visual modeler (HyVisual) has hybrid systems applicability; Kepler corresponds in scientific modeling and Viptos in actuator-based networks (Ptolemy 2022). The overall AI network relies upon Docker containers and can be built in Jenkins CI/CD, an automation server written in Java. The utilities act as repository manager Artifactory, communicating with the Git server, and the base server authenticates LDAP for a separate server. The acquisition and front-end design integration through Gitolite add committed code to the Jenkins and can build the program. Cloud stationing integration allows storing acquired use data (pay-per-use/pay-per-performance based). Thus, separating the system definition surfaces in different contexts on the server emphasizes decentralization. Supervisory Control and Data Acquisition (SCADA); a communication process gateway; communication between agents; WebSocket: to set up write/read process in accordance to communication protocol OPC classic or UA enabling flexible manufacturing systems, total factory control applicable to integrated manufacturing systems including Simulation and Data Analysis (SDA) – amplifies the requirements to plan systems integration of sociotechnical systems during its LC for its manufacturing perspective integrating web technologies (Hoorn 2018). To this entry, the programmatic approach for HCD has evolved toward a virtual DT for Rapid Prototyping (RPs). This is doable in a digitalized simulation that can mimic reality by designing digitally commissioned RPs for appropriate environmental constraints (Boy 2022).

Front-End Human-Systems Integrative Innovation

Expanding awareness of VR and widening consciousness over GUI-based data processing since the U.S. army HSI program emphasizes front-end effectiveness as a critical component to maximize system design (Savage-Knepshield et al. 2021). The system design skeletal code generation is based on the system's information. Case example, Nvidia Ampere on developing HSI for processable data as ingredients for HCI web applications with MS/Linux/OSX operating system (OS) or Linux Cygwin/GCC C/C++ for embedded hardware platforms running (Kemsaram 2021); which is integrable with Python virtual web environment of Flask compiled algorithms for each skeletal core created in sequence for universal machine vision system requirements, e.g., Mongo/MariaDB. To this end, IBM Engineering Systems Design Rhapsody (ESDR) is a favorite tool for general modeling to simulate

advanced human systems for building, linking, and debugging its meta-level compilation. Key points for each assembly:

1. Cross-platform development in C/g-variants in 64-bit computing on Cygwin/GCC uses conventional command lines for GNU compiler collection (OS independence). It allows multi-threaded CPU core optimization for long-term sequential use for fork-profiled programs and libraries, including parallax optimized Machine Learning (ML) adoptions for off-the-self Artificial, Deep/Convolutional Neural Networks (ANN, D/CNNs) and Deep Learnings (DLs) (Logan 2008) through, e.g., Python (Ren 2022).
2. Development OS built for mobile backend API, which uses HCI development, takes microframework for the web as the best option because it does not require special tools or libraries to deploy containerized applications. The development environment is lightweight, and whose prerequisites are Git Actions, Python framework, GNU command utilities simplified architecture patterns: used by, e.g., LinkedIn, Uber, Reddit, Netflix, Airbnb, Red Hat, Samsung, Nginx, Zalando (PythonistaPlanet 2022), unarguably because of the unintrusive multiplatform communication.
3. ESDR includes complex engineering processes, successful management, and discipline to adopt and drive Project-to-Project (P2P) references adding more projects for referencing more P2P extensions for further development and synchronizing changes in design for real-time embedded applications in source-specific Unix/Linux-based systems environments (IBM 2022; Microsoft 2022). The OOSEM has significant variations and customizability in approaching the cross-discipline elements and needs special tools. Hierarchical Task Analysis (HTA) ensures that the data and modeling interchange is possible; thus, the development process must be fully involved in the information economy, contributing to tasks, operational processes, and procedures. Optimizing HMI can ensure safe operation and timely response, particularly in safety-critical systems.

This paper further explains that HCI development strategies for models can be used as a bridge between task analysis results and SysML models including the corresponding elements as a joint of standard, which SE process XML output can communicate with ESDR GUIs for integrating consciously large conglomerate size knowledge divisions datasets for Machine Mission Engineering (MME) on any occasion form of ML (e.g., Digital, see Ansys 2022). The objective of HSI is to build dynamic and data-driven modern mobile learning that is human-data-centric and lives from the data by adapting either human or system compliance.

BACK-END ARCHITECTURES FOR CENTRALIZED APIS

Considering application development on large-scale utilization in large corporations, the 21st-century key concepts for SoS development are captured in Table 1, respecting mobile learning optimization for latency-free Responsive

Table 1. Definition of Centralized Software Architecture (Päivärinta 2019, 20 cited Clements et al. 2003; Garlan & Perry 1995; Perry & Wolf 1992); Microservice Pattern (ibid., 20 cited Medvidovic & Taylor 2010); Virtualized Docker Containers (ibid., 20 cited Docker 2019); API transport (ibid.,); Authentication (ibid., 38-40); Application Portal (ibid., 41-46); Virtual Machines (ibid., 50-51).

Subconcept	Abbr.	Structural explanation
Centralized Software Architecture	CSA	A system diagram shows the system's components and any boundaries outside the scope of the system. Achieves a convergence between components, minimizes the definition of purpose, and enables conformity to constraints.
Microservice Pattern	MP	Modularized architectures ensure that the system complexity is split into multiple services independent of each other, providing opportunities to use a different technological programming language to ensure the best fit to containerize individually. Microservices are a series of modularized components (libraries and classes) that can be called from anywhere in the application, scaled horizontally for instances arranging each accordingly to multicore capacities.
Virtualized Docker Containers	VDC	Virtualized High-Performance Computing (HPC) resources over serial connection enable various production applications because it enables staying in lightweight local microcontroller resources when HPC is running on the upper layer of an arbiter managed by a hypervisor. Virtualized Layer uses a virtual reflection of microservices patterns.
API transport	APIT	Intrinsic APIs' interdimensional communicativeness and data storability are irrelevant because when the use is demand based, each API should be decentralized with correctly stated non-persistent semantic actions for safe requests.
Authentication	AUTH	API is a closed system until receiving valid authentication (AUTH) that is traceable time-point-to-time-point (T2T), discriminating users' by API key, requirements based on user input and prioritizing service: large corporations can commit abuse/misuse because of lack of service level knowledge which can be prevented holding privileged AUTH usage internally; for example granting API endpoints for paid customers; while the endpoint tracing is necessary from a cost perspective to deliver invoice according to the business model, for example, pay-per-use/performance.
Application Portal	AP	Developing a single, accessible frame acting as an application portal that is refreshed from the range of centralized applications produced in any RWD: Django, Express, React, Vue.JS, or Angular Bootstrap - for multiplatform support considering modern device requirements.
Virtual Machines	VM	As applications and services are increasingly deployed in the cloud, they can be deployed in various ways on servers or virtual machines (VMs). VM deployed application service docker integrates API but is limited by the VMs tools meaning its range of variety is scalable and more relevant for the business model pay-as-you-go.

Web Design (RWD). The way through RWD follows monolith disabilities unless developers' application service concepts focus on a microservice basis for improved functionalities and business capacities. Python Django and Flask are the most common for deployability to web framework servers -

following Amazon's and many other brands' MP's success of maximum size of a service defined as two pizza concepts. Amazon defines the maximum size of service by the size of the team as the "Two Pizza Team" concept. Consider that one developer is given one slice of pizza, and the entire development team, i.e., a dozen developers, are given two pizzas at most (Päivärinta 2019 cited Fowler & Lewis 2014). Providing application service through the pipeline from big ideas to the initial Minimum Viable Product (MVP) is easiest by relying on the cloud servers or Virtual Machines (VMs) shared pizzas: the key is the HSI scalability.

Software architecture scope has multidimensional perspectives: how the HSI SoS must perform and what components it has to hold from an architectural angle. The scalability of the HSI is an entry question. For client-server architecture, whereas agents act as clients and API for servers, the governance relationship from constrained configuration defines the use patterns of the service (adaptation to Päivärinta 2019 cited Garlan & Perry 1995).

Returning to the governance plan mentioned above and leaving the meta-level service development design for a case example of cradle-to-cradle (C2C) sustainability thematics.

SUSTAINABILITY – CRADLE-TO-CRADLE DESIGN INTEGRATION

From cradle-to-grave (C2G) or -cradle (C2C) design, LM corporation emphasizes the net ton CO2 reductions, social cognitive, and economic side load alleviations with HSI global design for operations. At the same time, the projects in the general world led to change in the narrative around energy efficiency tied to climate change (Crehan 2022). The LM's objectives and idealized example for all SMEs as the front-end innovation (FEI), leading a formally structured sequence for introducing its process nonchaotically, achieving SMBHSI design that does not reduce future generations' living environment. C2G angles have been prevalent for portfolios that require rigorous change management.

For instance: Net zero ambition for Green House Gas (GHG) by the end of 2050 or sooner sets a meaningful vision as a goal to arrange the design and development of air and missile defense systems to healthcare innovations more air-to-ground precision from the sustainability aspect. Approximately 600 LM's corporation facilities' operation efficiencies are essential for reducing environmental emissions and harmful social impacts and increasing financial efficiency (Adaptation from LM 2008 with LM 2018). Small changes in the workflow can save a lot of $E=mc^2$. The company calls Advanced Technology Laboratories (ATL) software-based SMART Technologies for improvement from the social aspect in critical HFEs audience.

Let us examine the pillars for their implications for suppliers' outlooks.

Environment Life Cycle Assessment (E-LCA)

C2C is a minimal scientifically reviewed design methodology in HSI, often in narrow contexts, that targets one or two sustainability pillars. From Environment LC Assessment (E-LCA), the C2C objective is targeting zero-emissions and environmentally friendly design in various industrial sectors with the

intention requiring rearranging and redesigning (generally in subject change areas) concerning the whole Global Supply Chain (GSC) greener. The meaningful design methodology (MDM) key point is to maximize harmful effects caused by manufacturing and consumption of the products for the environment during supply, which for systemic resilience is the long-term EU global leadership vision (Popkostova 2022), in which the C2C governing approach design teams and asset managers are required to manage all material flows between GCS from Product Manufacturing Process (PMP) with an established eco-effective ingredient management plan (Adapted Saari et al. 2021 with Heilala 2022a: such as VSM).

Social Life Cycle Assessment (S-LCA)

Social LC Assessment (S-LCA) is quite a new social cognitive processing optimization algorithm at the governing level in human organizations for reframing products' social impacts over their lifetimes. S-LCA guidelines publication began in 2009 for United Nations Environment Program LC Initiative (LCI). Since its start, the methodology indicators and methods have been under development, and the first global guidelines are being maintained annually (Traverso et al. 2022). Considering S-LCA for impact on humans emphasizes the use of cyber-physical technologies: employee to outsourcing, e.g., drug or other substances testing to occupational institutions; environmental monitoring using technological surveillance: access control, camera surveillance, electronic log analyses, e-mail, and network and location monitoring. The energy and emission intensity of a surveillance system; following the C2C perspective helps to maintain the organizational climate and communication traffic anomalies, which could impact the organizational S-LCA significantly in terms of reputation because imago cannot stand the stigmas in accredited and respected levels (Adapted to Mulrow et al. 2022).

Financial Life Cycle Assessment (F-LCA)

Financial LC Assessment (F-LCA) emphasis is on reality to virtual SDA reflection by considering Monte Carlo-based LC Analysis (LCA) based LC Costs (LCC) estimation from the given productivity and cost. The LCA costs for maintaining assets, even in likely scenarios (as Heilala 2022c), to cope and survive energy poverty are higher to target the maximum for a given interval in the regulation range because downsizing below minimum constrains the other pillars without adding value will cost a fortune). Thus, F-LCA is usually associated with other pillars because financial asset allocation requires capital in acquisitions or to prevent specific environmental hazards, e.g., organizational or technological restructuring or/and innovation. Sustainability in Europe is particularly emphasized during the Europe-wide scarcity period, which on the one hand, encourages C2C innovations as European Green Deal (EGD) flagship program. However, uncertainty increases when the usual E/S/F-LCA innovation does not sell or produce added value in a crisis. It could hinder decarbonization when the other pillars in economics and social sectors are unbalancing (inductive outcomes adapted from Popkostova 2022; Wijnants et al. 2016).

After delivering the C2C LCAs to political discussions, conlusions thought bubbles pop up.

CONCLUSION

The largest corporation's systems-level – HSI, performs a major role in engineering. Employees are expected to maintain high performance for daily tasks for best returns and support for the organization. Large industries like LM emphasize the number of employees' statuses on their current work and well-being. Programs alleviated cognitive load has had significant needs for long-term working people to prevent behavioural consequences of hard work contributing to occupational problems, in extreme cases: injuries. SMART is a great example of optimizing cognitive load and helping to share workflow loading and tension with colleagues, balancing workflow in extreme environments. From scorecards to testing brainwaves and following pressed keys to emails, it is clear that financial corporations have always emphasized management and organizational practices to improve productivity (Montequín et al. 2013) or weight the S-LCA from sustainability aspect. A corporate employee's well-being is the backbone of the organization. If the organization does not take care of its employees, it is not operating on an SMBHSI basis. Enterprise Resource Planning (ERP) systems and numerous integrations to factory-level automation and cognitive performance measures of employees to build DTs – the perspective on research and development for life-cycle specific input/output captures what can be utilized in the general data-driven organization and its environment for screening outputs in accessible and automated manner that gives the Manager or anyone dependent on being charge an absolute arbiter position to go for set visions. Managing the system design is sequential from the situational human communication ad hoc nature: interoperability emphasizes simplicity from the meta-level because the whole orchestra is complex for this short conference processing, speaking of which for programmers even starting to type the code has great barriers - "where should we start!". Visionary motives, the long-term endurance is achievable by interventions for an SMBHSI outcome portfolio (adaptation to the HSI domain LM 2018) while improving the narrowed scope for specific his. It is a puzzle to build on standardized modules. Given the current system from LM, the renovation and expansion of the SoS return more energy, considering the full range of LCA stand-alone innovations that are not realized financially. Thus, the changes must be sustainable when discussing systems where productivity could be affected. Integrating SoS on the assets designing level is working in complex environments. Usually, the integration is done retrospectively, emphasizing huge learning gaps for arranging changes in legendary corporation pieces of machinery. This marks the design's easiness and independence as off-the-shelf algorithms for the applications programming level would suggest weighting the multi-platform design for market sustainability.

Given the example, LM has developed an enterprise architecture to define the next-generation missions driven-cognitive support using pieces of resources. *Other interesting applications* are the long-range strikes supporting

combat operations by modeling KET in an object-oriented and management manner with the SysML modeling language using Systems Engineering (SE) methods. LM's diverse portfolio weights standardized modeling work; to this end, N-dimensional representation from architecture gives not just knowledge for a team to process but enables integration after estimated human work years are budgeted to enable financial supply consideration at the monetary institution level. For this, Meilich et al. (2007) confirmed the product portfolio approach from the point of view of Systems of Systems (SoS) behavioral analysis and simulation integration, which can be used to validate and demonstrate the product's performance in the human system integration architecture. Now it seems that a corporation like LM reduces problems by tens of percent annually compared to previous years' CO2 loads, and the intuition is that the S-LCA and F-LCA are heavily affected. Since 2022, in the sustainability aspect, they have reported improvements on the business plan level: creating, e.g., business integrity, employee well-being, product impact, and resource efficiency to sustain the balance indicating that the processes are legendarily engineered and deployed. However, reliable GSC for flagship products has a generalizable annual theory: the products are always delivered late (Weisgerber 2022). Large-scale production suffers greatly from supply cuts if the case corporation is healthy from another angle. Considering the GCV uncertainties (Heilala 2022a), we have to set further research aims if the systems are not widely used: Blockchain.

Blockchains Help With Late Deliveries, Sustainability – for Further Research

In a small environment, flexibility and originality allow for bigger changes and efficiency in the workflow. Monitoring and cognitive performance improvement must be made automatically and without compromising privacy, giving employees programmatically monitored freedom for the peaceful mind while the process transparency influences changing working life requirements. There has been a rise in new ambiguous emphasis on optimizing all E/S/F-LCA sensitive perspectives, accordingly UN emphasizing reality deployment. The blockchain is a niche in the HSI domain for any transparent PMP. In the future, blockchain technologies in manufacturing any product will follow the process from the beginning to the end precisely in a cost-effective, automatic, and controlled manner. Monitoring the production of this manufactured product, even at the individual blank level, is possible from the moment the customer orders a product batch. It leads to automatic results, with KET integrated into the ordering system and marketed to the customer in real-time; when this technology makes it automatic to follow the production phase of this batch, no humans (sales representatives) are needed. The logistics connected to this can cover the entire GSC. By preparing the order for the product, we get to the point where we can monitor the state of the technologies at each manufacturing step with the accuracy of the device and component so the production lead time of that product can be monitored, which also integrates automation technology. Automation can

also be introduced in the production of larger building complexes, for example, apartment buildings, airplanes, or all manufacturing, e.g., brainwaves representing cognitive processes, in the future, with the help of these network protocols using blockchains which is the fruit of the market economy.

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Correspondence of authoring goes to DSc.C. Janne Heilala. Finland, University of Turku, Faculty of Technology, Department of Mechanical Engineering. Janne is a Finnish Dissertation researcher in the technology domain. Specializing in innovative, sustainable, and educative research. The current issue explicitly narrows the human system by elaborating on no-compromising standardization for global platform research.

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