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Wide Scope of Applications of the SSAT Toward Optimization of User Experience

Inna Bedny

United Parcel Service, Wayne, NJ 07470, USA

ABSTRACT

In this paper we are demonstrating application of the Systemic Structural Activity Theory (SSAT) to a wide range of spheres of research and development of human-system integration. We will show how SSAT has been applied for the reduction of task complexity, to the enhancement of the efficiency of performance, to the improvement of user friendliness of various applications, to the reliability of performance, etc. Our purpose here is to firstly demonstrate how the founder of SSAT Gregory Bedny applied his theory and demonstrated it efficiency. We will also show how other scientist implemented SSAT in their research in a wide range of areas such as medicine, decision making, human-computer interaction, Web design, AI, healthcare, etc. Our goal here is also to show that SSAT has great potential for future application in a variety of research areas. We, for example are considering to apply this theory to the study of the user friendliness of cell phone apps that have their own specific restrictions and user demands. SSAT is a high-level generality theory. There are a number of methods of task and human performance analysis that have been developed within this framework. Our paper will briefly describe these methods and mention examples of utilizing these methods in order to enhance product quality, improve user experience, minimize human errors and increase the probability of successful results of human activity in a variety of areas. SSAT provides a deep understanding of the relationship between external motor and internal cognitive action that are basic elements of human activity. Suggested by SSAT methods can be applied to traditional and computer based human activity. This paper will also discuss motivational aspects of human activity and the role they play in success or failure of an enterprise. We will touch on such aspects of human activity as its complexity and difficulty and their correlation with motivation. SSAT pays special attention to the cognitive components of human activity and demonstrates the methods of making the activity less complex and reducing the memory load. These aspects are equally important in both production and non-production environments. The SSAT methods can be successfully utilized in the design of a variety of products from apps and AI to kitchen appliances because they allow to take into account human emotions, motivation, memory load, usability aspects, etc. They can also be applied to devising the most efficient methods of work or non-work-related tasks. We will discuss the analytical level of product design and the implementation of the suggested methods to the training process. This paper will cover the existing applications of SSAT and the opportunities of using its methods in the future research.

Keywords: Systemic structural activity theory, Apps, AI, Usability, User experience, Efficiency, Cognition

INTRODUCTION

Theoretical advances of SSAT are very well know and widely used. In this paper we want to discuss past, current and future application of this theory. When Gregory Bedny started developing his theory in the late 70-es the production work environment looked very different comparing to the current one and personal computing was non-existent. Although, some traditional industries are still there, a lot of the basic elements of the work environment are different today. Here we want to demonstrate how this theory has been successfully applied by the SSAT creator and his coauthors, and many other scientists in a variety of the areas of human activity. The limitations on the size of this paper don't allow us to cover all the areas that the SSAT touched. So, we are going to mention just some of them leaving the more advanced study of this topic for the future research. Here we just want to emphasize that new advances in various areas that use SSAT demonstrate its efficiency and that this approach is going to continue providing innovative methods for human systems integration.

APPLICATION OF SSAT BY ITS CREATOR AND HIS FOLLOWERS

We will list here just some of the areas Bedny and his coauthors covered including but not limited to traditional types of work, aircraft controllers and pilots' performance, unmanned underwater machines, computer-based tasks, computerised tasks, efficiency of new types of communications, etc. (Bedny et al., 2012, 2018, 2019). The systemic-structural activity approach has been also applied to modelling user performance in human-computer interaction tasks. The human operator's eye and computer mouse movements were analysed and their interrelationship was investigated in the framework of the SSAT (Bedny et al., 2008). Some of the methods developed within this framework include but not limited to creating a human algorithm of task performance, modelling a probabilistic event tree of the process, calculating the complexity of the task and determining the critical points of failure or error in the process. One of the important methods of task analysis developed within the framework of SSAT is the evaluation of task complexity. Objective task complexity vs. subjective task complexity, and task complexity vs. task difficulty attract attention of a number of scientists. This method is especially critical for human activity that is performed under stress. We find that medical experts utilise complexity evaluation methods in their studies. Complex patient cases lead to information overload and decision uncertainty even for expert clinicians (Islam, Weir, Del Fiol, 2016). Table 1 below is just an example of the complexity of the tasks faced by medical professionals.

SSAT has also been applied for the assessment of the reliability of success of medical procedures (Suhir, Bedny, 2022). It is also utilized in paramedicine that has been identified as a high dynamic system (Hunter et al., 2020). The authors are trying to analyse the empirical data related to paramedicine and SA and the SSAT approach from a theoretical perspective. Our recommendation would be to use both. Instead of looking for contradictions the authors should find the points where these too theories can benefit their study.

Table 1. Clinical complexity contributing factors (CCFs) and specific definitions (Fragment) (Islam et al., 2016).

	CCFs	Definitions
Task complexity contributing factors	Unclear goals	Objective is unclear or vague, less clear or specific goals
	Large number of goals	Multiple goal elements, higher or larger number of goals
	Conflicting goals	Achieving one goal has negative effect or outcome on another goal
	Confusing information	Unclear, missing, ambiguous or contradictory information cues
	Unnecessary information	Large quantity of not useful information
	Changing information	Unpredictable events, high rate of information change
	Urgent information	Information about very acute patient situation
	Multiple decision-making options	Large number of options to make a decision
	Large number of decision steps	More than two steps or actions to attain the objective
	Decision conflict	Two or more actions that are incompatible or competing, conflict between task components
	Lack of expertise	Unique situation requiring additional knowledge, novel and non-routine decisions, treatment or disease uncertainty
	Lack of team coordination	Coordinating activities and creating shared decision-making within and between healthcare teams
	Time pressure	Situations that need immediate attention due to scarcity of time

Professional and sport training is another area of applying SSAT not just by Bedny. The following authors stated that in order to understand an activity it is necessary to study the "significance, which derives from personal sense, influences made by the selection of specific information by an operator, develop strategies and criteria for the evaluation of task performance". This means that in order to understand an activity it is necessary to study the "significance, which derives from personal sense, influences the selection of specific information that effects athletes' performance" (Récopé, Fache, Beaujouan, Coutarel, Rix-Lièvre, 2019). This emphasises the importance of such aspects of SSAT as positive and negative motivation, significance of the result for the individual, complexity of the task and its subjective difficulty.

Sanda stated that results from the analysis of miners' motor actions during rock drilling activity showed that by using procedurally driven strategies, they were able to perform simultaneously two specific tasks that required high levels of concentration of attention. The miners simultaneously combine their mental actions and motor actions in recognising and remedying the constraining effects of unfamiliar stimuli during the rock drilling task

(Sanda et al., 2014). Motivational aspects of SSAT helped in making teaching and learning efficient during COVID pandemic (Sanda, 2022). Cognitive Task Analysis (CTA) is an important methodology in ergonomics for studying workplaces and work patterns for work designs that improve complex work performance, reduce work stress, and promote work satisfaction (Durugbo, 2021). Group of researchers at the Leeds University Business School whose work is concerned primarily with the investigation of mobile information systems in the emergency services in the UK such as police forces, ambulance services and fire and rescue services considered the challenges of the services and the stress involved in providing them (Wilson, 2006).

In the behavioural design area researchers are challenged to find the ways to make complicated activity less complex to perform by a design intervention with various degrees of change demand and behavioural constraint (Cash et al., 2020).

The listed above method is applied in Systemic Functional Linguistics for text reinforcing the credibility of the text descriptions (Jinyi, Xuanwei, 2022) and for the risk assessment in the airspace domain due to the human factors such as pilots performance in stressful conditions (Salotti, Suhir, 2019). It involved an activity analysis that focused on the individual workers' functions and behaviour when carrying out their tasks in a metallurgy electrolysis unit (Menezes et al., 2022). Fatigue and complexity in traditional kinds of work was analysed and the effect on maintenance of task complexity on muscle fatigue and perceived workload was evaluated (Alhaag et al., 2022). The following research strived to evaluate task complexity of the on-orbit tasks (Ge et al., 2020). The results of the following study further suggest that if high complexity issues are identified and replaced by low complexity solutions the assembly related action costs in manual assembly are likely to decrease (Falck et al., 2017).

The following authors propose a six-component task model for identifying noticeable complexity contributory factors and ten dimensions of complexity structure (Liu, Li, 2012).

SSAT methods has been utilized for the analysis and enhancements of AI, Chatbots, Websites efficiency (Bedny, 2022, 2023), patients decision making (Yemelyanov, 2022) and even when facing social inclusion and IT literacy issues (Kieran et al., 2014). The following authors studied the "intelligent" technologies promise for the customers in individualization, adaptation, guidance, and assistance in problem solving (Breven, Synytsya, 2014).

Current and Future Development in the Framework of SSAT

Gregory Bedny and many other researchers demonstrated that SSAT methodology can be successfully applied in a variety of production and non-production environment to minimize human errors, optimize performance, improve human system integration, reduce complexity of the tasks, help to make right decisions in complicated and stressful situations, etc.

We see future implementation of SSAT in such areas as robotics, human-robot interaction, AI, WEB and App development and enhancement to ensure successful human systems integration.

The Robotic Systems Technology Branch at the NASA is developing robotic systems to reduce burden on astronauts. Robonaut is one of such systems that can act as an assistant to the human, providing and accepting tools by reacting to body language. SSAT methods of detailed task analysis have a great potential in optimizing such interface. The effort is made to make such robots look like humans, especially when they wear space suits. But when working on human-robonaut interaction it's necessary to keep in mind the real difference in physical and memory capacity, and complete absence of emotions and motivation of the latter.

AI and WEB design are the areas in which SSAT has been already utilized. Work in these areas has great potential and will continue. The APP development and optimization is another area with great promise for SSAT methods application.

CONCLUSION

Systemic Structural Activity Theory is widely utilized in numerous arias of Human Systems Integration (HIS). This paper just recorded some of these areas and also listed some of the potential areas of the future development in quest. SSAT is especially effective when it is a need to reduce complexity of the task or decision making, to lower the cognitive load, to elevate the stress and minimize errors caused by the human factors. Utilizing SSAT methods of analysing such characteristics of the task as complexity and difficulty, positive and negative motivations, etc. pinpoints the critical areas of HSI and allow to work on the ways of stress reduction. From Human-Robonaut communication to complex medical procedures, to patients' decision making the areas to improve the user/human experience is wide and promising.

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