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Utilizing System's Communication and Principles as Drivers for Effective System Development

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Abstract

In this paper, the author identifies different key drivers of human activity systems by viewing communication from a system's perspective. These drivers include signs of meaning, behaviours, structure, and process. These signs can assist system designers/analysts in identifying these four elements (meaning, behaviours, structures and process), both conceptual and concrete. By pinpointing these signs, the authors posit that it becomes feasible to assess any misalignment among elements of the human activity system and thereby enhance its success in achieving its purpose. Consequently, the interplay between conceptual and concrete systems can be more strategically engineered to elevate system effectiveness and efficiency.

With the advent of Natural programming Language (NLP) and artificial intelligence (AI), the author posits that it is now possible to bridge the gap between physical or discrete systems and human activity systems. System designers or analysts can train prompts to register and recognise human activity systems' signs to enable AI (Artificial intelligence) to learn from them without having to write mathematically inspired lines of code but using a natural human language.

It is the aim of the author to improve system's literacy amongst practitioners and academics through this work. This paper builds on the author's recent work on the conceptualisation of decision-making as a human activity system (D'MHAS) and presents key drivers of the human activity system within the concept of system, signs and purpose.

Keywords: System; Signs; Human activity system; Purpose

Introduction

The International Council on Systems Engineering (2014, p. 40 [41]) has highlighted the imperative for systems engineering to integrate not only systems science but also methodologies derived from social, organizational, and psychological sciences alongside its established foundations in mathematical, statistical, and physical sciences. In recent years (published peer-reviewed journals on systems thinking between 2010 -2023 on the EBSCO library repository), there has been an increase in the body of literature addressing the utilization of systems thinking to impact policies and programs with over 2 million publications. This author aims to contribute to the continuous growth of systems literacy amongst academics and practitioners in organizations.

The initial work by Haynes et al (2020 [42]) and the subsequent discussions have specifically concentrated on the relationship between enhancing the capacity for systems thinking and making decisions informed by systems perspectives, particularly in practice and in academics. Lamont suggests evidence systems literacy impact can come in the form of stories of impact, given that stories are a form that allows for nuance and are important tools for moving knowledge to action (Lamont, 2020 [43]). But it is hard to use stories to construct an evidence base, especially in the absence of an appropriate framework (Rutter, 2017 [44]). As Greenhalgh and Fahy demonstrated when the dominant framework is the linear logic model, the impacts of system thinking do not emerge (Greenhalgh &

Fahy, 2014 [45]). These authors did a manual content analysis of 162 impact narratives submitted to the public health, health services and primary care section of the 2014 Research Excellence Framework. They found that most of the case studies described quantitative research (most commonly trials and systematic reviews) and depicted a direct, linear link between research and impact. Qualitative and participatory research designs were rare, and only one case study described a co-production model of impact (Greenhalgh & Fahy, 2014 [45]). This poses a significant challenge as these social sciences have evolved independently with extensive bodies of knowledge in different contexts. The author contends that there is a need for an approach that aids systems designers/analysts in discerning the most effective theories, methods, and tools from social, and organizational sciences that align with the specific context and purpose, thereby increasing the impact of systems perspective in system development.

In this paper, the author suggests that by incorporating the operational principles of a human activity system (see Kila, 2023 [22]) and the concept of system's communication (as expounded in this paper), a framework can be devised to assist systems developers/analysts in managing activities within the system/organization in harmony with the intended purpose and context.

While scholars and practitioners have shown continued interest in communication within organizational change efforts (Johansson & Heide, 2008 [1]; Elving, 2005 [2]), there is a notable dearth of literature examining communication from a systems perspective. Nevertheless, understanding and adapting organizational behaviour hinge significantly on communication (Kittelman et. al, 2018[3]). Currently, the convergence of communication and systems theory is exemplified by authors such as Wiener (1948, 1961 [4]) in his cybernetics theory, Ashby (1961 [5]) in relation to requisite variety and behaviours. Despite the contributions of Kittelman et al. (2018 [3]) and Shannon's (1948) mathematical theory of communication systems, much of the systems research on communication lacks an exploration of communication as a system in itself. Although Shannon's (1948 [7]) theory is commendable for its technical and mathematical perspective on communication systems and data transmissions, this work aims to prioritize the practical development of communication systems, with a focus on the identification, transfer and convergence of information.

The following section discusses the research approach adopted by the author, its theoretical underpinnings. This is followed by discussions about the operational principles and of a human activity system and key drivers to help system designers/analysts achieve an effective system fit for purpose.

Method of Approach

Fundamental Systems Theory

The approach adopted by the author in this paper is grounded in systems thinking. Systems thinking is also about interconnectedness, its basic building blocks can be subsumed as 'Emergence, Hierarchy, Communication and Control' (Stowell & Welch, 2012 [8]; Kila & Hart, 2019, p.137 [9]). Systems thinking view all the entities and subsystems within the system as interconnected and that an effect on one will ultimately have a resultant effect overall. This line of reasoning is an improvement on the classical science of cause-and-effect because it is a holistic approach (Dorfman et al., 2004 [10]).

The concept of a 'system' reflects an acknowledgment of the inherent unpredictability in what we perceive, shaped by our experiences. The author characterizes such a system as a specific phenomenon derived from a priori forms of experience rather than deduced afterward from experiments. Keeping this perspective in mind, Stowell (in Stowell & Kramarova, 2023, pp.4-6 [11]) defines the notion of a 'system' as closely tied to the idea of holism, suggesting that any 'phenomenon' we observe is chosen from 'something else' that exists not only in a physical sense but also possesses a sensory existence perceived differently by various observers.

Adopting 'systemic' thinking aids in obtaining a deeper understanding of the 'system' or problem domain of interest; considering something as a system in this context imparts a 'shape' to the phenomenon under scrutiny (Stowell & Kramarova, 2023 [11]). It serves as a tool to help the investigator gain a comprehensive understanding of the situation of interest, enhancing appreciation and understanding of the entire problem domain.

In 1968, Von Bertalanffy [12] advocated for the development of a general systems theory consisting of principles applicable to all types of systems. These principles were envisioned to be scientifically grounded and possess the capacity to predict and explain various aspects of systems. Despite this call going unheeded for many years, Rousseau (2018 [13]), put forth three overarching scientific principles for systems. These principles, offering a general understanding, elucidate the dynamics influencing the emergence of systems. Central to Rousseau's scientific systems principles is the foundational concept of the conservation of properties encapsulated in the first principle.

The conservation of properties principle posits that emergent properties in a new stable system must be offset by submerged ones. This means that when various elements or subsystems combine to create a stable system, they must contribute (submerge) certain characteristics, behaviours, meanings, or processes. The more harmonious this submergence, the greater the stability of the emerged system. Once the emergent system dissolves, the elements or subsystems revert to their suppressed characteristics.

The second principle, universal interdependence, examines the equilibrium between bottom-up emergence and outside-in submergence of system properties. The significance of this principle lies in its emphasis on understanding system properties, structure, and their connection to the contextual environment. It replaces the typical engineering deconstructionist approach with an integrative or holistic perspective.

The third principle, complexity dominance, acknowledges that not all processes of bottom-up emergence and outside-in submergence balance properties and behaviours uniformly. Macro systems may impose more restrictions on the behaviours of their subsystems than others, and vice versa. For example, an aerospace organization reliant on defence contracts may experience stronger outside-in submergence, resulting in stringent compliance with federal and national security policies. This leads to organizational compartmentalization and the necessity for redundant processes. Conversely, a privately funded aerospace entrepreneurial organization may foster collaboration due to weaker outside-in submergence, allowing shared processes and systems.

A crucial insight involves assessing the effectiveness of suppressed behaviours based on their degree and type of complexity. In instances where high-tech solutions are employed to address organizational problems and submerge undesirable behaviours, the outcomes can range from ineffectiveness to exacerbating existing problems (Calvo-Amodio 2019 [14]; Calvo-Amodio et al., 2014 [15]). An example is the implementation of electronic health records to enhance healthcare systems' efficiency, where success depends on addressing inherent process inefficiencies rather than simply adopting new tools.

Emergence and the Role of Signs in a Human Activity System

The author identified a paucity of literature on system communication drivers within a system thinking perspective in contrast with system engineering. The author suggests that it is important to ensure that stakeholders of diverse heterogeneous organizations understand the confluence and interplay of these systems, their emergent properties, and their imperatives to work in a homogenous manner. Within this context, a summarized literature search is presented below (table 1).

The initial terms chosen were in the bid to find works produced on System communication and drivers in general, and from 2013 depicting recent works. As shown in the table above (table 1), the author used the search variable 'PLUS' as an inclusion/exclusion criterion in the EBSCO discovery digital library database which has access to more academic digital databases such as Scopus, Engineering Village, Web of Science etc) to display relevant work in the area of interest. The author used the field tagged 'AB-ABTRACT' as exclusion criteria to show results with specific desired wordings in their abstracts. A manual search and screening was also conducted to filter through relevant ones (System communication and drivers, and also for Emergence and the Role of Signs in human activity system). Some literature found did not explicitly use the tag 'system perspective' or 'human activity system' in the title but referenced it in the discussion or described it in theoretical terms. The relative paucity of literature relating to drivers, communication and signals within human activity systems suggests that there is room for more improvement. The author draws on this relative gap in knowledge by critically discussing emerging properties and signs of systems which are crucial for comprehending the rationale behind the system's behaviours.

Term (In title; or/and in text)	*Plus (in Abstract)*	*Recent General Results (from 2013)*	*Peer Reviewed Results (From 2013)*
System communication and drivers	Nil	2,203,653	668,842
System communication and drivers	Systems Perspective	20,920	11,579
System communication and drivers	system thinking in organization	897	371
System communication and drivers	AND systems perspective OR system thinking in organization	544	442
Emergence and the Role of Signs	Human Activity System	11	5

Table 1: Literature search on system communication and drivers within human activity-related systems.

Discussion

Emerging from the interplay of its components is a system whose characteristics and behaviour transcend the mere summation of its individual elements, as noted by von Bertalanffy (1968 [12]). Each constituent of the emerging system possesses its unique composition and nature, influencing the interactions with other elements. In line with Rousseau's first system principle (2018), each element subdues specific traits or independent behaviours in the emergence of a larger, more intricate system. For example, the autonomy of an individual soccer player to make decisions independently yields to the overarching plan of the coach, emphasizing collective teamwork.

The behaviour of elements within human activity systems significantly contributes to the overall system behaviour (Ackoff, 1981 [6]). Consider a team software developers struggling with a string of failed application launches despite huge funding from investors and stakeholders in the company; in reality, a single toxic team member inducing psychological stress can adversely affect the entire team's success. If the team leader neglects to scrutinize both the member's behaviour and their interactions with teammates, attempting to regulate the entire team through additional training may not yield improvement. The team leader must discern signs of problematic behaviour in both individual players and their interactions. Using similar analogy, system analysts must examine both the behaviour of elements and the interactions among them to comprehend the emerging system's characteristics. According to Skyttner (2005 [20]), a sign, the smallest unit of meaning, can be 'something that stands for anything for somebody.' Signs, lacking inherent units, are subject to the analyst's worldview in collecting and interpreting them. When context, units, characteristics, and/or content are linked to signs, they become information, and their significance is termed signals (Skyttner, 2005 [20]).

It's crucial to acknowledge that signs may pertain to an element, the interaction among elements, and/or the state of the entire human activity system. This distinction, as previously mentioned, depends on where the system analyst delineates the system's boundaries. In alignment with Rousseau's (2018) general system principles, all systems, theoretically, submerge into higher-order systems and emerge from interactions with systems below them. The role of signs is pivotal in assessing a system's success in achieving its purpose. Signs reveal the system's state and offer insight into its trajectory toward the intended goal, both in progression and direction. This concept is exemplified by Sprunger et al. (2016 [21]), where the human activity system aims to enhance performance through organizational culture change, transitioning from an existing state (initial culture) to a future, more desirable state (idealized culture).

Recognizing enduring signs of meaning is crucial for comprehending the rationale behind the system's behaviours. In conceptual systems, meaning generates further meaning, evolving into a more sophisticated form through the interaction of its components. For instance, conceptual systems may involve design ideas for a vehicle or tool categorized as mental models, while diagrams and organizational charts contribute to defining abstracted systems within the conceptual system domain.

Signs in the Human Activity System

Kila (2023 [22]) introduces a framework inspired by Vickers' (1983) appreciative system, influenced by Checkland's (2018 [26]) visualization of Vickers' appreciative system. In this model, the four elements of human activity systems (meaning, behaviours, structure, and process) are incorporated into a flux of occurrences/events (concrete system components) and ideas (conceptual system components) (refer to Figure 1). In this framework, occurrences result from behaviours, processes, and structures designed to achieve a purpose and can signify a shift in state in concrete systems. On the other hand, ideas are shaped by culture, beliefs, and models related to concrete systems, rendering them conceptual systems capable of reflecting changes in the state of concerns. If the process is systemic, meaning is additionally generated through interactions with and feedback from the concrete components of the human activity system. Similarly, behaviour, structure, and process are also engendered by and through interactions with and feedback from the conceptual components of the human activity system. Judgement-making and action-taking are guided by important responses to signs representing operational factors in the perceived human activity system Calvo-Amodio & Rousseau (2019, p.684 [14]).

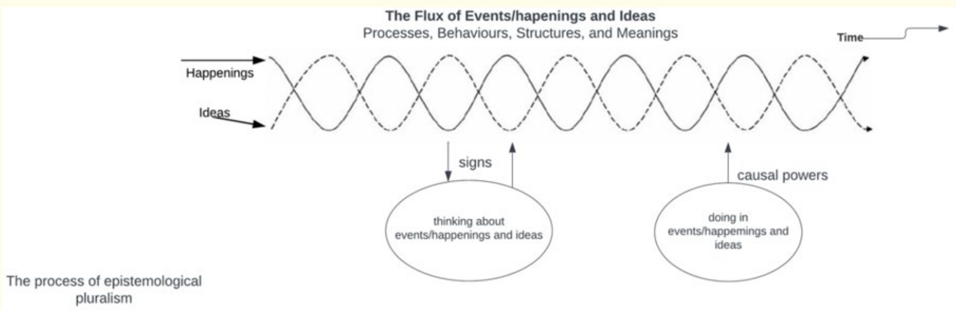

Figure 1: Flux of events and ideas through time.

The operational or influencing factors represent the standards of fact and value (the appreciation shown in Figure 1) and can be updated through feedback received from the thinking phase that allows for epistemological pluralism that provides for several ways of knowing or inquiry before taking action. When a concern arises, the thinking about the conceptual and concrete systems (ideas and events) allows for the accommodation of variability of opinions, judgement, purposes and operational practices; it is a way of managing judgements while aligning the operational systems to serve the organization's purpose. The thinking phase is where the analysis of the conceptual and concrete systems interplay is conducted. The doing phase is where the necessary changes to bring the system back to stability is done.

It is noteworthy that Kila (2023 [22]) human activity system (D'MHAS) diverges from the approach of Checkland and Vickers in a crucial aspect: while Vickers and Checkland adopt a constructivist stance (systems solely exist in our minds), Kila (2023 [22]) employs a moderate realist approach (systems exist in our minds but also have a tangible existence in the real world).

The design of the conceptual system, achieved through engineering (granting of causal powers) of ideas, cultures, meanings, and models about the conceptual system, can facilitate the interaction between thinking about the system and the execution of activities within it. Developing the conceptual system contributes to fostering the interplay between concrete and conceptual systems. Thus, designing the conceptual system in a manner that enhances the interaction between the conceptual and concrete systems can shape the resulting concrete system, behaviours, processes, and structures to enhance the human activity system's trajectory and minimize deviations from the expected path towards its purpose. In essence, the success of the concrete system hinges on the design of the conceptual system, and the realization of the concrete system can inform the design/redesign of the conceptual system.

Signs in Human Activity Systems

There are different signs within a human activity system: Thinking and doing both in terms of social and technical systems (See figure 2). There are signs for meaning, behaviours, structure, and process. These signs can assist system analysts in identifying these four elements, both conceptual and concrete. By pinpointing these signs, the authors posit that it becomes feasible to assess any misalignment among elements of the human activity system and thereby enhance its success in achieving its purpose. Consequently, the interplay between conceptual and concrete systems can be more strategically engineered to elevate system effectiveness and efficiency.

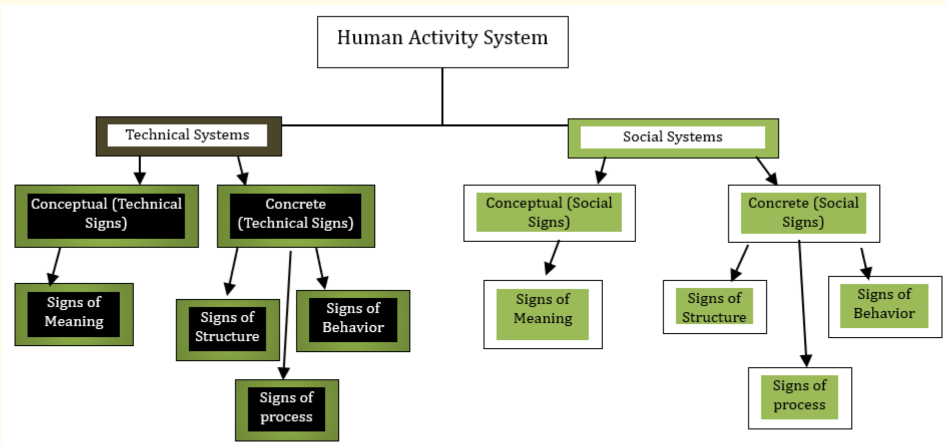

Figure 2: Signs in a human activity system (Adapted from Calvo-Amodio, 2019).

Signs of system's meaning play a crucial role in comprehending the rationale behind the system's behaviour. Meaning generates additional meaning within conceptual systems, evolving into a more advanced form through the interaction of its components. For example, design concepts for a vehicle or a tool might be classified as mental models, while diagrams and organizational charts contribute to delineating abstracted systems within the realm of conceptual systems. Expressions of meaning are evident in the connection and correlation between concepts. This linkage holds a distinct significance for the evolving system. Meaning within a human activity system originates from the conceptual elements of a system, encompassing beliefs, theories, conceptual maps and models. These components endow the system with meaning and dictate its underlying reasons. When delving into the definition of meaning, researchers could find themselves in a predominantly philosophical landscape, spanning from semantics to mentalist theories (Speaks, 2019 [27]). To focus the meaning within human activity systems, descriptors are associated with terms such as organizational culture, perceptions (Rentsch, 1990 [28]), beliefs, weltanschauung, and values (Paul, 2005 [29]). A recurring theme in the exploration of the word 'meaning' in relation to values or norms is the perspective through which something gains meaning for an individual or society, shaped by their worldview. This concept of a worldview is succinctly captured by the German term weltanschauung (Checkland & Davies, 1986 [30]). Checkland (1999 [31]) comments that Weltanschauungen (worldview of individuals and subsystems) are not fixed; this is based on Vicker's concept of the flux of events and ideas and their effect on the individual 'Appreciation'. The individual's Weltanschauungen change depending on the experience; the cultural setting and exercise of the commodity of power may affect how this change becomes evident (Stowell, 2013, p.17 [32]). In a human activity systems, meaning encompasses the social fabric that provides rationale and value to the undertaken tasks (Pettigrew, 1979 [33]). Culture serves as a system of shared reality, constituting meaning that is publicly and collectively embraced by the entire human activity system at a given time. Pettigrew (1979 [33]) views culture as the origin of a cluster of concepts (p. 574), with the system yielding symbols, beliefs, ideologies, myths, and rituals as its output. The author posits that the meaning of a system itself is subjective. The interpretation of the system's meaning is subject to the system analyst's attribution during evaluation or design.

Signs of system's behaviour in a human activity system depicts the unfolding events within a system (Calvo-Amodio, 2019 [14]). Checkland's (2018 [26]) depiction of the ebb and flow of everyday life elucidates the behaviours of a system over time, highlighting alterations in the system's regularity—manifested either in its response to the environment or situation, thereby altering its relationship with the surroundings. The condition of a human activity system, as evidenced by the concrete behavioural patterns, actions, and mannerisms, is the result of the system's meaning. What stakeholders or system analysts observe is the manifestation of the system's meaning in its behaviour. For instance, a team of workers installing a new process line, stemming from the conceptual design of an updated process line simulation, exemplifies how the system's behaviour is influenced by the conceptual system of meaning, as expressed in models and shaped by the worldview (weltanschauung) of the stakeholder(s).

Signs of system's structure within a human activity system are reflections of the relationships among its components. These signs of relationships between system parts manifest as observable connections or theoretical constructs that shape specific configurations of parts and their interactions (Zhang, et. al, 2011 [39]). Beer's (1959, 1979, 1981, 1985 [35-38]) viable system model serves as a high-level example illustrating structure in systems. For instance, the relationship between the Environment and the System 1 components, or more broadly, the horizontal operational system relations with the vertical control system, demonstrates relationships through functions. The function (or behaviour) of a system and its structure are inherently interconnected. Zhang et al. (2011 [39]) assert that as the system undergoes changes over time, there are implied dynamics within the underlying system. When determining whether the behaviour of the system should or needs to change, system stakeholders often examine the system's structure. Recognizing signs of the structure aids stakeholders in identifying relationships among parts within the human activity system, which contribute to the emergence of the system's behaviours. By identifying signs of causal structures arising from the relationships among parts and their feedback loops, stakeholders can influence these causal structures in their efforts to design and implement a more desired system behaviour.

Signs of system's process entail any sequence of behaviours or actions that occur with a specific purpose or reason. Processes represent the tasks that a system engages in while working towards its defined goal (Erez & Kanfer, 1983 [40]). In human activity systems, processes play a crucial role in achieving desired goals, constituting the steps, tasks, aims, etc., undertaken by the system or its components to fulfil the system's purpose. Indications of a system's processes assist in observing and assessing the system's state in relation to its purpose. For example, if a department exhibits signs of progress through processes that contradict the overall purpose of the system, adjustments may be needed to align the department's processes more closely with the higher purpose of the larger system to which it is subordinate (Rousseau, 2018). Erez and Kanfer (1983 [40]) emphasize that not all systems or stakeholders within a system necessarily share identical goals, as illustrated in the department example. However, the evaluation of outcomes can differ based on the perspective of the individual, whether they are setting the goal or working towards its achievement. This distinction is particularly significant in organizational systems where management goals and employee goals may diverge or even conflict (e.g., achieving higher product output vs. reducing workload). A crucial aspect is understanding the purpose of the human activity system, as it serves as the key to identifying signs of enduring processes within the system.

In summary, system's meaning answers the question 'why', which is directly related to the 'because'. Conceptual systems are systems made of concepts that together exhibit meaning; it is the result of two or more concepts and their interrelationship to each other. For context, the signs of meaning is highlighted in the case study below:

'*There were ideas* that exist within senior management to merge the R & D department with manufacturing. There would be a *clear understanding as to the owner* of each deliverable in the company.''

Systems behaviour can be thought of as a verb such as 'was', wanted, delivered, did, etc., or as a descriptor of what the system is eg, 'complicated', 'integrated' etc. For context, the signs of behaviour is highlighted in the case study below:

'The team *aims* to adjust their standard of work to meet with the new operating standards. There is *growing unease* among key workers that cannot have the technicians complete the R&D projects on time.'

System's structure indicates tangible connections such as physical objects or non-tangible/perception connections such as relationships between members of a team. For context, the signs of behaviour is highlighted in the case study below:

'There are six *technical managers working under the director of research* and they are responsible for the six production shifts.'

Conclusion

The key drivers of the human activity system are the timely identification of emerging properties within the system, signs from both within and external boundaries and the purpose for which the system was conceptualized.

The author's future research and its outcomes are anticipated to offer valuable insights for researchers and practitioners engaged in the design and management of human activity systems. The authors posit that the identification of signs representing meaning, behaviours, structure, and processes in human activity systems by system analysts can serve as a foundational element for an effective communication system. If appropriately assessed, the combination of these four types of signs is expected to signify the present state of human activity. Modifications can then be implemented to the current behaviour, structure, and/or processes of the system, which contribute to its current meaning, enabling the attainment of a future, desired state. In essence, recognizing these signs will support engineering activities in transitioning human activity systems from their current state to a more desirable future state.

With the advent of Natural programming Language (NLP) and artificial intelligence (AI), the author posits that it is now possible to bridge the gap between physical or discrete systems and human activity systems. System designers or analysts can train prompts to register and recognize human activity systems' signs to enable AI (Artificial intelligence) to learn from it without having to write mathematically inspired lines of code but using a natural human language.

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