The Possible Impact of the Behavioral Characteristics of an Agent in ASCW Performance

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ABSTRACT

Logic has been empirically shown to only be a part of what is normally considered intelligence. Other dimensions of behavior have been demonstrated to impact an entity's ability to "intelligently" deal with the world. Several management science and information science researchers have looked specifically at how the classic personality theory could be used to explain total system performance. Good managers recognize and assign intelligent people to tasks based in no small part on other behavioral characteristics. This paper considers how such characteristics could be applied to improve intelligent agents and how it would impact work performance.

Categories and Subject Descriptors

H.5.3 [INFORMATION INTERFACES AND PRESENTATION]: Group and Organization Interfaces - Computer-supported cooperative work, Organizational design, Theory and models

General Terms

Performance, Design, Human Factors, Theory

Keywords

artificial intelligence, intelligent agents, personality theory

1. INTRODUCTION

As the pace of business and industry quickens, the complexity of the business world and the environment in which enterprises operate increases daily. The drive for higher sales, greater productivity, reliable products, larger market shares, etc. pushes the manager, at all levels, to make more numerous decisions than ever before. The manager is confronted with increasingly complex problems and situations more often and decisions must be made in less time. The problems are even more confounded with today's "information explosion," the astronomical generation of volumes

of data in the modern business and industrial environments. At this time in our history, the wrong decisions are likely to be more costly to the organization, and indirectly to our society. With ever-increasing numbers of complex problems requiring complex solutions, the manager must turn to better problem-solving tools that integrate data from all sources and apply it to the decision problem [5].

Given progress in AI, it will not be too difficult to program an intelligent agent to perform specific tasks, face problems, or "think" certain "thoughts" when placed in various Agent Supported Co-operative Work (ASCW) situations. Ferber [10] defines an agent as a physical or virtual entity, which can act in an environment, communicate directly with other agents, is driven by a set of tendencies, and has resources of its own. An agent is also capable of perceiving its' own environment and behaves in a manner, which leads to satisfying objectives, while accounting for the resources and skills available to it and the way it perceives, represents, and communicates [10]. Some AI theorists believe that intelligent agents will evolve through three stages: 1) personal assistants (simple independent entities), 2) specialized agents (capable of communicating with each other), and eventually 3) autonomous agents that act on our behalf. If these "predictions apply to agent evolution in general, then you can expect to see a growing community of agents that become more and more interconnected while taking ever greater degrees of autonomy," suggests Barker [2]. In a few years, agents may be collaborating and cooperating across the web, delivering a wide variety of services and products just like human workers currently do [13].

When attempting to design an agent, who is as, or perhaps, more intelligent than humans, it is necessary to incorporate a vast array of human characteristics and psychological aspects into the agent, and consider them at all levels of human understanding and thought. It may be possible to assume that just as humans do, the "thinking" that agents do is resultant of interactions between a number of cognitive components or cognitions, which may generally be referred to as mental states. The term mental state may be questionably applied here because it leads to the assumption of a certain idea of sequential processing in cognitive functioning for an agent [10]. Attempts must also be made to thoroughly understand human thinking, including all of its structures and processes, and apply it to design, in order to make computers and agents more sensitive to human needs. Even thirty years ago, Churchman [8] made a compelling argument that one of the basic issues in the design of intelligent systems that perform historically human tasks is to determine what set of human attributes should be incorporated into the intelligent system.

Along with actual design considerations, questions may be further posed regarding the actual personality types of the agents. In other words, programming agents from a more psychological perspective will bring into being perhaps "smart, virtual people".

Just as a good manager would select certain employees over others to perform various cooperative tasks because of their personality and/or general business approach, it seems equally reasonable that one would want to use different intelligent agents to perform different tasks in ASCW. The American Management Association reports that personality testing remains the 2nd most widely used psychological measurement in the hiring process. Beyond the hiring process, many companies are using personality tests in improving internal communication, cooperation, and teamwork among staff, identifying leadership, and helping employees to "understand" themselves and their co-workers better by knowing their personality types [19].

In his book, *The Design of Inquiring Systems*, Churchman [8] examined how computer-based inquiring systems would behave if they were designed based on one of the epistemologies of five major western philosophers (i.e., Leibnitz, Locke, Kant, Hegel, or Singer). He demonstrated that different epistemologies generate different types of answers to the same inquiry [8].

Litzinger and Wise [13] took Churchman's concept and applied it to the design of intelligent agents. They examined how Machiavellian principals could influence the behavior of an intelligent agent and how the Machiavellian agent would perform compared to an agent developed using a stereotypical scientist/engineer model of behavior. For example, an agent that is configured to be Machiavellian would thus manifest related characteristics (e.g. "ends justifies the means", deception, cruelty, creative leadership, and strategic management) [13].

2. CLASSIC PERSONALITY THEORY

Personality theories can offer a detailed and operational description of personality development and how humans think and behave. The innovative ideas of Sigmund Freud and his closest protégé and colleague, Carl G. Jung, had a deep impact, not only on psychology, but also on twentieth century art, literature, philosophy, and potentially, the modern day e-world. Jung's theories were intended to provide insight into diverse personality types. He developed a unique paradigm for explaining the personality and performance differences between people. According to Jung, when we can systematically distinguish people by their dominant personality function we are simply referring to the way in which they most often behave. "The psychological type characterizes thus a *general habitus*, which naturally can appear within the limits of the typical in all individual variations, according to the social, mental, and ethical plane," explains Jacobi [11].

Jung divided personality along four salient functions, each one describing a way of processing and evaluating the "things one encounters" in the world [9]. Jung believed that the basic functions are constitutionally present in every individual and that they form the structure of consciousness. He believed that these functions are automatically and unconsciously called into action when aroused by a stimulus or problematic situation. Each function contributes a part of an individual's make-up and their

decision-making process [18]. However, given various everyday situations, one function tends to become more strongly developed and differentiated, and provides direction and quality to the consciousness [9].

The most widely used personality test, the Myers-Briggs Type Indicator® (MBTI®), is based on Jung's ideas about perception and judgement. "Almost every human experience involves either perception or judgement and is played out in the world of action or of ideas," suggests Briggs Myers and McCaulley [7]. If people differ systematically in what they perceive and in how they reach conclusions, then obviously, they will differ in their reactions, interests, values, motivation, and skills. "Jung's theory offers an explanation for these differences which makes it easier to recognize them and to use them in constructive ways" [7].

Mitroff [14];[18] has proposed that an information system consists of (at a minimum) one person. That person, like every person, has a certain psychological type. Mitroff has successfully applied the Jungian typology to demonstrate how differently these personality types approach decision making and problem solving. He has explored the impact of the differing personality functions and how their manipulation would impact total information system performance. His research has also investigated new possibilities for solutions to problems that contain basic differences in perception and judgement [14]; [18].

3. JUNGIAN THEORY AND INTELLIGENT AGENTS

Intelligent agents are performing a multitude of different tasks in the ASCW from bargaining and negotiation to communication to proposing solutions. Many of these tasks and interactions are seemingly human-like, therefore, researchers are presently attempting to assign intelligent agents with distinct personalities and social roles (e.g., socially situated agents). Intelligent agents are appearing in the form of engaging interactive characters adding interest and friendliness to the online experience [4];[6]. So it seems reasonable that one would use Jungian personality and cognitive theory to form the behavior of an intelligent agent. In very general terms Jungian theory can allow traditional information system (or intelligent agent) behaviors to be addressed in terms of data acquisition issues and data processing issues.

3. 1 Data Acquisition Issues

Aleksander [1] defines perception, one of several vital thinking characteristics, as encompassing all sensory inputs. Different effects of inputs may vary according to where they enter into specific regions of the mind's state structure or possibly the context in which an agent receives the information [1]. Specifically through perception, an agent is able to obtain information about the world, which allows it to prepare its action by pursuing its' goals [10]. "The perceptive system constitutes a door between the world and the agent, which gives it access to a certain 'conception of the world' in which its' reasoning and its actions are significant" [10]. An agent may also act as a result of motivations, which constitute the basic material for the foundation of tendencies.

Jung spoke of *perception* as a conscious form of "psychic energy" and subdivided this activity into two basic and opposing functions, "sensation" and "intuition." He stated they are "irrational" functions because they seem to work not with judgments, but with mere perceptions, without any real evaluation or interpretation [11]. Jung's concept of perception and its functions are what Mitroff has referred to as the data input dimension. Mitroff's data input dimension is a continuous function anchored by two antithetical ways of gathering data: "sensation" and "intuition." Data input describes not only the kinds of data initially taken in but more fundamentally, what is regarded as data in the first place [18].

Sensation: The pure sensation type pertains to individuals who are concerned with detailed facts. They may be data bound and can to go on collecting data forever [14]. The pure sensation type perceives objects in isolation and detail. Sensation types need to take a complex situation and break it down into very small parts [18]. Sensation focuses awareness of things as they appear and need to deal with things like shape, color, and arrangement of things. If an individual is a sensation type, information will be entirely empirical, devoid of almost any theoretical content [14]. Sensation types simply relate to the actual state of things [9].

Intuition: The pure intuition type is an individual who perceives objects as possibilities. They look through the facts and beyond them. They tend be too data free and form inexplicable hunches or conclusions where there may be no established facts. Strategy making and envisioning future possibilities and consequences are the strengths of the intuition type [14]. Intuition types integrate details into wholes or larger patterns. Therefore, only larger wholes and possibilities are considered real information [18].

3.2 Data Processing Issues

In order to distinguish between various perceived inputs, a person's awareness must be established involving the entry of specific external events and information into the state structure of the system. The same idea of awareness applies when input is received internally. Although in the case of internal inputs, the mind or system would interpret the input by exploring parts of its state structure, which are related to its' past experience. Once awareness is established of single or various inputs, attention then comes into play [1].

According to Aleksander [1], attention is the act of selecting between two different percepts or thoughts, which possibly involve either humans or systems switching thoughts from one idea to another. What determines how the selection is made involves will. Free will involves feeling free to think of continuing one way first and then another, or even of making a completely arbitrary choice [1]. Here, "thinking" and "feeling" are the opposing functions that embody this activity, which Jung calls *judgement*. Both functions are characterized as rational because they involve value and cognition [11]. Mitroff [18] refers to the judgement dimension as a continuous function anchored by two antithetical ways of reaching decisions: "thinking" and "feeling". He calls this the decision-making dimension, which refers to how data is processed [18].

Thinking: Pure thinking types rely primarily on cognitive processes for judgement, by first recognizing the meaning or purpose and then forming a concept of it [3]. If an individual is a pure thinking type, information will be entirely symbolic, an abstract system, model or string of symbols devoid of almost any empirical content. They are characterized by systematizing and evaluate by forming models and making rules. Thinking types can become so model bound, that they may be unable to understand a situation unless they are able to create one [14].

Feeling: Pure feeling types rely primarily on affective processes and value for judgement. Therefore, they take moral stands and make moral judgements [14]. Feeling types are concerned with the whole rather than the relationship between its parts and base their evaluations on concepts including nice and nasty, good and bad, agreeable and disagreeable, beautiful and ugly, and pleasant and unpleasant [9].

When viewing and experiencing the world, there is no right or wrong perspective, according to Jung [18]. Just as we do not always see accurately, does not mean that intuition is always correct, for example. Or that thinking is better because it happens to be named after one of our main mental functions [9].

3.3 An Example

As previously established, information systems consist of several different people with varying psychological types, such as thinking, sensing, feeling, or judging, who will encounter situations and resulting problems. Individual approaches to circumstances and information may vary greatly, depending on the method of generating evidence, how the evidence is presented, their own psychological type, and how familiar they are with the information. For the manager, information is the evidence upon which his decisions will be based. Therefore, every corporation needs all kinds of managers. For example, some managers will rely on basic observations of events like accounting data, others will rely on basic abstract reasoning like marketing models and others will rationalize through debate. While planning and strategizing is the strength of the intuitive type, day-to-day operations management is best suited for the sensation type. A management system comprised of only intuitive managers will always live in the future and won't pay proper attention to the present. A management system comprised solely of sensation type managers may be too limited and bound by the current set of available facts. They will be unable to envision future possibilities, have a short planning horizon, and lack innovation. Systematizing and rule making is the forte of the thinking type, while assessing value and taking a moral stand tends to be the feeling type's strength. A management level consisting entirely of thinking type managers will be so model bound since their first and instinctive response to any situation is to formulate models and to make rules. Unless they do this they will not be able to understand a situation or deal with it effectively. Eventually, they will "become victims of and slaves to their own categories and systems" [14]. A management system made up of managers of the feeling type will lack attention to detail, habitually generalize, and see "black and white" exclusively as they can only appreciate a complete relationship rather than separate parts.

Similarly, let us now consider the behavior of an intelligent agent that is assigned a psychological type. For instance, observe several agents crawling through websites looking for URLs. One agent might be impressed by the appearance of a site; it's awareness focused on the shapes, color and layout of the site. Another may perceive the site in terms of potential profitable markets. A third agent may be prompted to recall the history of the Internet and the evolution of global business and technology, upon arrival at the site. A fourth may consider how much it would enjoy investing the product this particular site is marketing. Obviously, as demonstrated by the four possible approaches taken by each agent in this example, individual agents possess specific qualities, which may characterize them as sensation, intuition, thinking, and feeling types, respectively. These four different characteristics become apparent in situations such as these where an agent assesses and perceives the same website in it's own individual manner. Each of the four agents in this example in particular detect elements of the site in a different way, and the same site means something different to each one of them. The agents are designed to acquire and focus on certain specific elements, while other elements may be ignored simply because they have not been designed or programmed in an agent's specific way of "thinking."

Employing varying types of people (or agents) who possess diverse psychological types will ensure that important information is attended to and miscellaneous information, which may not be considered useful now, is disregarded for the time being. This may be useful in situations where timely resolutions to problems are needed. Depending on the situation one agent's approach to information may be significantly more fundamental to the current situation and will ensure successful treatment. Each individual may be able to combine their own approach to information management and solutions in order to provide a thorough and successful resolution. By combining the various types in ASCW, situations should not arise where a group is bound by information and it may be easier to create effective strategies where the future will be considered, but focus will remain on the present task at hand.

3.4 Flexibility and Equilibrium
Just as the different functions are all at the disposal of every individual, however underdeveloped they may be, then might not the same be desirable for an intelligent agent? For example, when one solution to a problem is seemingly unsolvable or something else goes wrong, a "personality challenged" agent might get stuck [16].

Jung [12] has also argued that a personality that is in equilibrium (a self-actualized personality in Maslow's terms) is one where the individual has the ability to move around the personality space as a function of free will and the type of problem the individual is facing in ASCW. The individual can operate with equal skill and speed in any of the regions focusing on the problem they are trying to solve. An intelligent agent with equilibrium would be able to easily move to a new path of data acquisition or processing.

Early AI researchers designed systems and programs, which automatically applied specific rules. However, new systems have the capability to program increasing, basic, commonsense knowledge, thus avoiding getting stuck. Commonsense knowledge must be programmed with several representations of the information, which is adequate and provides the ability to switch to a new representation or understanding, if one of them fails. Besides applying basic human "thinking" concepts into the design of an intelligent agent, Minsky [17] emphasizes that the basic processes of perception, awareness, and attention are not the only thing that must be considered. Because there is so much information available to agents, in regards to the activities of humans, the agent must not only simply understand the inputs in one particular way. Eliminating the programming limitations of the past can lead to solving the types of problems that agents are designed for and allow them to "think" just as humans do [17].

AI models currently exist which attempt to map cognitive and emotional characteristics of humans [15]. Since personality is also an essential human quality, then perhaps the Jungian typology system should be incorporated into AI models, as well, and especially for ASCW. For instance, each function could be mapped based on the different dimensions. Differing amounts of senses, intuitive possibilities, logic and rules, and value could be translated into AI code depending on the situation. For example, Boole investigated the fundamental laws of the mind's operation and gave expression to them in symbolic, mathematical language. One can attempt to use that language and those laws in such a way as to facilitate the solutions of certain problems facing managers and intelligent agents in management situations [5]. Apply pertinent elements of the decision situation and its assigned psychological function and thus, virtual personalities would emerge! True type development would result by possessing a great command over these functions or powers [7]. Accordingly, a full program of agent typology research would seek to test the interaction effect of all possible combinations of these variables in ASCW. Suppose we change one or all of these conditions. How does changing these assumptions affect the overall design? Would the same intelligent system designs be effective? Could we predict and ultimately improve performance?

4. CONCLUSION
Of course the Jungian personality typology is not the only model to base agents' patterns of working in ASCW, but it is used for our purposes to illustrate how basic differences in behavior can create different possibilities for ASCW solutions. Four major modes or psychological functions characterize the Jungian typology. Jung differentiates these four functions from one another "…because they are neither mutually relatable nor mutually reducible," and because they exhaust all the given possibilities. In most individuals, a preference for one mode of perceiving and one mode of judging is characteristically developed [11].

With the inclusion of human "thinking" characteristics and applying Jungian typology in future designs, we begin to see steps toward the development of very realistic, "thinking" agents. Advances in design may provide agents with more human characteristics and knowledge, allowing them to ultimately "be" human. But first, attempts must be made to thoroughly understand human thinking and personality, including all of its structures and processes. Once Jung's four functions are understood and embraced, it is inevitable that personalities will be easier to detect and develop in agents.

5. ADDENDUM

As designers of computer-based expert systems and ASCW, it is useful to have some knowledge of Jung's four-fold classification of personality. But this is not always easy, since few people rely exclusively upon one function. Some possess these extreme characteristics, while others use two or three functions. It may be easier to determine which function is used the least, rather than most often [9].

In science, there is a tendency toward predominantly sensation/thinking activity. Therefore, the design of computers and programming (e.g., software, tools, displays, and agents) tends to reflect the designers' dominant psychological type, sensation/thinking. Unfortunately, intuition and feeling types are overlooked. As a result, users may be unable to receive all available information, much less process it. "In practice we tend to assume unconsciously that other people's *mind* work on the same principles as our own. This assumption is not much practical help. All too often the people we interact with do not reason as we reason, do not value the things we value, or are not interested in what interests us," explains Briggs Myers and McCaulley [7].

No matter how much data exists in the world, it will have no meaning or relevance if it is not able to be acquired and processed in some manner. Mason and Mitroff [14] recognized this conflict in management information systems (MIS) suggesting, "Thus, as designers of MIS, our job is not to get (or force) all types to conform to one, but to give each type the kind of information he is psychologically attuned to and will use most effectively" [14]. A designer should attempt to attain the goal of becoming "complete," recognizing the full value of the functions, and allowing all four to be raised into consciousness [11].

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