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Banking and Technology: Information Flow Between the Human and the Machine Through Automated Teller Machines

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Abstract: During their encounter with the Automated Teller Machines (ATMs), humans face up various choices and options, which leads them to make a number of decisions. During this process, accuracy, integrity and speed are the critical elements. The objective of this study was to design a simple human machine system, which would both incorporate these elements and enable humans to use their full capacities while not overdemanding or overloading. The design eliminates the information loss (equivocation) and gain (noise) and augments the process in terms of accuracy, integrity and speed.

Key words: Banking, human machine systems, information transmission, ATMs

INTRODUCTION

Automated Teller Machines (ATMs) are among the most important retail payment product innovations. ATMs are machines that serve as computer terminals and allow customers to access account balances and information at banks. During their encounter with the ATMs, humans face up various choices and options, which leads them to make a lot of decisions. While doing so, the information transferred and processed and the outcomes achieved should be supported by the perceived system objectives. Therefore, the accuracy, integrity and the speed of information transfer are important. The goal of the design should be eliminate the information loss (equivocation) and gain (noise) throughout the transmission process as well as increasing the speed, accuracy and integrity of the data processed. The objective of this article is to design a simple human machine system, which would enable humans to use full capabilities but not demand or overload too much. This could be achieved by minimizing the number of components in the system, reducing the dynamic responses within the system, decreasing the types of interaction among components and variety of people and maintaining the desired level of integration of successful systems which requires subsystems, assemblies and components to highly compatible, in terms of both technically and technologically.

Fitts and Posner^[1] classified information processing tasks as reduction, transmission, or elaboration depending on the task objective. Sheridan and Ferrell^[2] hypothesized that the information which is the output of

the channel consists of that part of the input that was not lost in transmission plus any spurious information that enters to the information channel. On the other hand Kantowitz^[3], proposed the human as an information channel, where the eyes and the ears sense and transmit to the brain an enormous amount of information per second. Reichtin^[4] introduces the process of architecting, the normative (pronouncement) methodology, the rational (procedural) method, the argumentative approach and the heuristic approach. Rouse^[5] introduced three important attributes in human-centered design as focus on the roles of humans in complex systems, design objectives in terms of roles of humans and design issues that follow from these objectives.

MATERIALS AND METHODS

Information processing: Information processing tasks are those in which a set of inputs is mapped into a set of outputs according to criteria, which are independent of the energy transaction involved. These are classified as: (1) Reduction: when the input has more variety or complexity than the outputs (Inputs>Outputs); (2) Transmission: the objective is to map the input into output on a one-to-one basis (Inputs=Outputs) and (3) Elaboration: producing an output with more variety than the inputs (Inputs<Outputs).

In our design model for information transmission, the operator is represented as behaving as an information processor limited in its capacity both to attend inputs and to match stimuli with appropriate responses. In analyzing the communication channels between the ATM and the

main processing unit based on information theory, it is found that, what is sent at one end is sometimes but not always what is received at the other^[6]. For any given channel information theory defines a limiting capacity or rate at which it can carry information, expressed in bits per second. Once the information content and channel capacity are calculated, coding techniques can be defined to control errors in the channel^[5]. At this point, we define the inputs, the information transmitted and the output. The inputs entered through an ATM by a human are: PIN number (alphanumeric data), transaction processes, such as withdrawal, money transfer between accounts and inquiries, such as account balance. The information transferred between an ATM and the main processing unit (both ways) are transaction processes and inquiries. On the other hand, the outputs received from an ATM to the human operator are transaction results, inquiry responses and the receipt of transactions.

$P(x)$ = Probability of occurrence of event x
 $P(x/y)$ = Probability of occurrence of y if x has occurred
 $I(x;y)$ = Information given by an observed event y about a hypothesis x
 $T(x;y)$ = The average information transmitted per event
 $H(z)$ = Information content of set z .

and

$I(x;y) = F [p(x), p(x,y)] = \log_2 [p(x/y) / p(x)]$ bits
 $T(x;y) = \sum p(x_i, y_j) \log_2 [p(x_i, y_j) / [p(x_i)p(y_j)]]$ bits
 $H(z) = \sum p(z_i) \log_2 [1 / p(z_i)]$ bits

When the channel is perfect (as it is set as a goal in our objective):

$p(x_i) = p(y_j)$, when $I = j$ and
 $p(x_i, y_j) = 0$ when $I \neq j$
 $H(x;y) = H(x) = H(y)$, similarly;
 $H(x) = T(x;y) = H(y)$

So, whatever the probabilities of inputs, the information content of the inputs in the design should be equal to the information transmitted. As mentioned earlier, an ATM user has 3 choices to select and has 3 accounts: primary checking, primary saving and primary credit. This information is represented by a the Choices-Accounts Matrix (Table 1).

Table 1: Choices-accounts matrix

	Primary saving	Primary checking	Primary credit
Withdrawal	1/3	1/3	1/3
Account Balance	1/3	1/3	1/3
Transfers	1/3	1/3	1.00

$H(x) = 3 (1/3) \log_2 [1/(1/3)] = 1.58$ bits
 $H(y) = 3 (1/3) \log_2 [1/(1/3)] = 1.58$ bits
 $H(x,y) = 3 (1/3) \log_2 [1/(1/3)] = 1.58$ bits

Which is a case that we already stated above, when the channel is perfect:

$H(x,y) = H(x) = H(y)$
 $T(x,y) = H(x)+H(y)-(H(x,y))$
 $T(x,y) = 1.58+1.58-1.58$
 $T(x,y) = 1.58$ bits

and

$H(x/y) = H(x)-T(x,y)$
 $H(x/y) = 1.58-1.58 = 0$ bits
 $H(y/x) = H(y)-T(x,y)$
 $H(y/x) = 1.58-1.58 = 0$ bits

Thus, the equivocation and the noise have a value of 0 bits, which means that, there is no equivocation and no noise existing in the model. Besides, the information input is equal to the information transmitted.

Control theory: In our design model, the human serves as a controller, ATM as the junction of control, the CPU (Central Processing Unit) of the ATM as the source of energy, main processing unit that the ATM is connected through telephone lines as the control effector and the screen of the ATM as the detector of the sensed information. The first order of control, which is the first derivate of control action with respect to time, is called the displacement.

The human operator first overshoots towards to the output expected from the screen of the ATM and in time, it is exponentially decreases (Fig. 1). After a certain point, say after having some experience about the output obtained from the screen, the user's response starts to be stabilized, but it is still behind the normal output. So, a time delay of the information transmitted emerged due to late response of the user to the inputs^[4]. Indeed, the

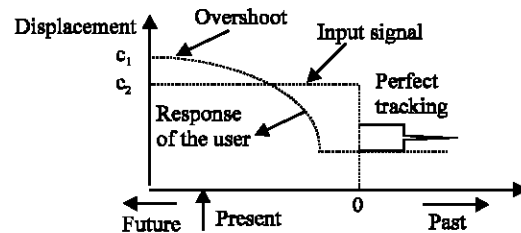


Fig. 1: Control in information processing

perfect response of a human operator needed to be analyzed from 3 different perspectives, reaction time, gain and neuro-muscular lag. The human operator does not overshoot, undershoot or give response to the stimulus on a wrong direction, however, he needs some time to be familiar with the system. After that time period, which is called the time delay, he would start giving correct, accurate, in other words perfect responses to the stimulus.

Decision making: In our system, the decision maker is the human operator and the function of the ATM machine is to present the choices to the decision maker and to describe how to make decisions by introducing the explanations of the transactions. Therefore, in our model the objective is descriptive than normative or prescriptive objective. The utility for the consequence is a numerical index if the strength of the human operator's preference for a consequence^[2]. Ranking the order of preference and choices among the alternatives could specify the utility. The way to determine the human operator's preferences is achieved by asking him to select the more preferred alternative under consideration. The procedure is to implement an algorithm by constructing a skeleton scale of worth.

Preferences	(Coordinates)
• Easy, understandable, functional	(x, 0, z)
• Easy, not understandable, functional	(x, 0, z)
• Easy, understandable, not functional	(x, y, 0)
• Not easy, understandable, functional	(0, y, z)
• Easy, not understandable, not functional	(x, 0, 0)
• Not easy, not understandable, functional	(0, 0, z)
• Not easy, understandable, not functional	(0, y, 0)
• Not easy, not understandable, not functional	(0, 0, 0)

There are three decision dimensions regarding ease, understandability and functionality. If we illustrate the graph of this scenario, we will encounter with eight "corners". The equation for worth of the alternative can be written as:

$$W(x, y, z) = A + Bx + Cy + Dz + Exy + Fyz + Gxz + Hxyz$$

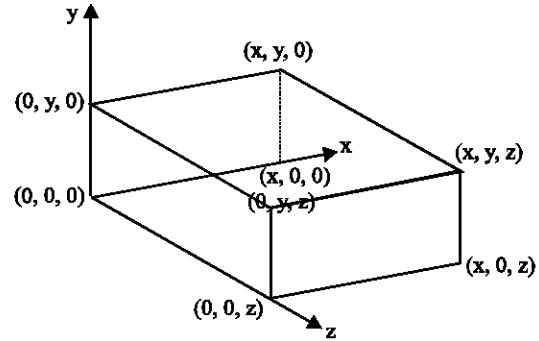


Fig. 2: Decision dimension

where, x-axis of the graph represents the ease of use, y-axis represents understandability and similarly the z-axis represents the functionality of the model (Fig. 2).

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