DOES AGENT STYLE MATTER IN ORGANIZATIONAL DECISION MAKING PERFORMANCE?

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INTRODUCTION

Organizations vary in the way they respond to organizational problems, even when they are in similar task environments or are facing similar stress conditions (Scott 1987). This way of response is due, in part, to agent style (Kets de Vries and Miller 1986; LaPorte and Consolini 1991), which is also related to the norms in, or culture of, the organization (Parsons 1956; Blumberg 1987)[2]. By agent style; we mean the general way in which the agent approaches the problem. However, the link between organizational culture (e.g., as seen in agent style) and performance has received insufficient attention (Saffold 1988). This is due, in part, to the complex and sometimes controversial natures of culture, agent style, and performance.

Agent style varies on many dimensions. We are here concerned with proactiveness/reactiveness, as there are strong links between this aspect of agent style and performance. We define an agent to be proactive if the agent engages in decision making and information gathering whenever possible. In contrast, a reactive agent is one that waits until being asked or until absolutely necessary to gather information or make a decision (Larson et al. 1986). The link between agent style and performance, however, has received insufficient attention.

The conventional evaluation of agent style typically regards proactive style as being better for the organization than reactive style. Organizations composed of proactive agents are supposed to respond to organizational problems faster than organizations composed of reactive agents. A consequence is that organizations of proactive agents should outperform organizations of reactive agents (Pauchant et al. 1990). The wisdom is that proactive organizations are more active (Smiar 1992), more cooperative (Rice 1977), more prepared (Das 1986; Newman 1989), and thus are supposed to be better performers (Jauch and Kraft 1986; Smiar 1992). This argument can be summarized by a famous Chinese proverb: One can always get credit for sweat if not for achievement.

Given that we are interested in proactive versus reactive behavior, another factor of paramount consideration is timing. This is, for many tasks, it is not important that the organization respond accurately, but also that it makes the decision in a timely fashion. One expects proactiveness to be particularly important when time matters. Moreover, numerous studies show that under time pressure, organizations tend to rearrange their decision making process (Rothstein 1986; Means et al. 1992). In many cases, time pressure causes errors due to loss of information because it stresses the limit of human cognition (Magazannik 1982). When time is short a proactive agent may have an advantage because he or she is prepared (Pauchant et al. 1990). In contrast, the reactive agent, though less prepared when time is short, may be a more economical solution when time is less critical, because they may need less training, and may have lower information processing costs (Sussman 1984; Pauchant et al. 1990).

The arguments that agent style matters are largely drawn from micro-level studies of organizational behavior and case studies of organizations facing crises. While proactive agents are often tauted as effecting high organizational performance, the relative benefit to the organization of having proactive versus reactive agents has not been systematically studied. Detailed case studies of organizations under stress point to agent style as well as many other factors (such as the structure of the organization and the nature of the task environment) when delineating the determinants of organizational performance. Theoretical and empirical studies have shown that organizational structure (Mackenzie 1978; Lin and Carley 1992), task decomposition scheme (Thompson 1967; Lin and Carley 1992), training (Hammond 1973; Carley 1992), task environment (Drazin and Van de Ven 1985), and stress (Staw et al. 1981; Lin and Carley 1992) all affect performance. A study of the impact of agent style on performance should control for the other factors.

Many studies of organizations, however, suggest that agent style is simply irrelevant. Network studies (e.g., Mayhew 1980; Wellman 1988) argue that performance is a function of the structure of relations connecting agents in the organization. Contingency theorists (e.g., Woodward 1965; Burton and Obel 1984) argue that performance is a function of the fit between organizational structure and task environment. Both the network perspective and the contingency perspective implicitly suggest that agent style will not determine organizational performance when these other factors are controlled.

In this paper, we will examine, from a mezo-perspective, how agent style (proactiveness or reactiveness) affects organizational performance. We are particularly concerned with the effect of time pressure on the performance of organizations composed of either proactive or reactive agents. Many studies of

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[2]Agent style may also be due to personality (Barron 1982; Kets de Vries and Miller 1986), although this point is controversial.

organizational design do not vary the agent style (Cohen, March, and Olsen 1972; Padget 1980; Carley 1992; Lin and Carley 1992). This study goes beyond those studies of organizational design as it not only considers both timing of the decision and the proactiveness/reactiveness style of the agents, but also controls for factors such as organizational structure, task decomposition scheme, training, nature of the task environment, and stress. This study is carried out using simulation.

We examine agent style using a dynamic and interactive computational model that integrates a set of factors that may influence organizational performance. There are several reasons to examine the effect of agent style using simulation. First, in the real world there is little consensus on what constitutes organizational performance and whether an organization is said to perform well depends on "the purposes and constraints" placed on the organizational performance measure (Cameron 1986). Second, it is virtually impossible to obtain sufficient data for comparing organizations with a range of designs under both normal and stressful situations due to either time constraints or confidentiality. In contrast, simulation has multiple advantages, in particular, (1) we can control for various factors and conduct systematic examination; (2) Simulated organizations have been shown to resemble the real world organizations in an idealized way (Lin and Carley 1993); (3) We can achieve our goal of research economically, and quickly.

To guide our analysis, we will consider how the results of our model fit with, contradict, or elaborate on propositions forwarded in the literature with respect to agent style. We will briefly describe the model, analyze the results from the model, and finally, we will discuss the results and conclude the paper.

MODEL DESCRIPTION

Task

The organizations we simulate are faced with a limited choice task in which organizations make decision choices regarding the state of moving aircraft under stress from limited alternatives according to information they have through organizational communication processes[3]. Choice tasks are very common in the real world. Such choice situations include law-making, price-setting, planning, and a host of other similar things.

We have operationalized this choice task as a stylized radar task. There is a single aircraft in the airspace. This aircraft is moving. The organization has three choices — deciding whether the aircraft in the airspace is friendly, neutral, or hostile. Each aircraft is characterized by 9 parameters (see Lin and Carley 1992 for details).

We measure the organization's performance as the percentage of these problems that the organization has made the correct decision[4] regarding whether the aircraft is friendly, neutral, or hostile. We treat type I error (making the decision that the aircraft is hostile, but in fact the aircraft is friendly) and type II error (making the decision that the aircraft is friendly, but in fact the aircraft is hostile) with equal weight. In organizational literature, organizational performance has also been measured by organizational effectiveness (Mackenzie 1978; Pfeffer and Salancik 1978), and organizational efficiency (Mackenzie 1978; Scott 1987). In many cases, accuracy, effectiveness, and efficiency are indistinguishable and can convert into each other.

Task Environment

Task environments vary on a large number of dimensions. Two such dimensions that have received some attention in the literature are decomposability and biasness. Task environment decomposability measures the interrelationships among task components. A task environment is decomposable if there are no complex interactions among components that need to be understood in order to solve a problem, and non-decomposable if otherwise. In a non-decomposable task environment there are interaction effects. As LaPorte and Consolini (1991) and Roberts (1990) note interdependence of task components (i.e., non-decomposability) is a factor that should be considered in designing the organization.

Task environment biasness measures the distribution of all possible outcomes. A task environment is unbiased if all the possible outcomes are equally likely to occur, and biased if not. As Aldrich (1979) notes, a biased environment is one in which the problems faced by the organization are concentrated and so highly similar. Based on these two manipulations, we examine four different "realities" or environmental situations. They are: (1) biased decomposable task environment; (2) unbiased decomposable task environment; (3) biased non-decomposable task environment, and (4) unbiased non-decomposable task environment.

Stress

Organizations are often affected by stress (Perrow 1984; Shrivastava 1987). In examining organizational performance it is important to consider multiple sources of stress: external hostile conditions or maydays (caused by hostile task environment), internal suboptimal operating conditions or murphies (caused by sub-optimal operating condition within organizational design), and time pressure.

We examine five types of internal stress or murphies (Lin and Carley 1992). They are: (1) missing information — a piece of the incoming information for a particular problem is not available, (2) incorrect information — a piece incoming information is erroneous, (3) agent unavailability — an analyst is not available to help the organization solve the problem and so does not report his or her decision to his or her manager, (4) communication channel breakdown — an analyst is unable to report to a superior because the communication channel is unavailable, and (5) agent turnover — an analyst leaves the organization and is replaced by a new analyst. For each type of murphy, the number of simultaneous murphies ranges from 0 to 3.

[3]The simulation test-bed used in this paper is an adaptation of that in Lin and Carley (1992) that takes into account time and agent style.

[4]The true states of all the aircraft are predefined by the task environment and are unknown to the organization.

In this paper, time pressure occurs when the aircraft is very fast, or when the time required to make the decision is very short. Time pressure is the number of time units before the organization must make a decision. Two factors affect when the organization must make a decision: (1) a decision is demanded by some outside or superior sources (e.g., congress) and (2) a decision is demanded because the aircraft reaches the danger point (the point at which if the organization does not respond and the aircraft is hostile, the aircraft can destroy the organization)[5]. In this model for each problem (i.e., an aircraft appearing in the airspace), we randomly assign the number of time units prior to a demand for a decision to be between 1 and 60. The characteristics of the aircraft are also randomly chosen for each problem[6]. Consequently, the time pressure varies randomly across all problems. We study three levels of time pressure: low (41-60 time units), medium (21-40 time units), and high (1-20 time units). Because this is a dynamic environment, agents' interaction with one another in terms of whether to communicate and how to communicate, and the utilization of decision making procedures in terms of which decision making procedure to choose, all depend on the constrained resource — time. How agents react to time pressure is discussed later.

Organizational Design

In this paper, organizational design is viewed as a combination of organizational structure, task decomposition scheme, training, and agent style. Through an examination of multiple designs, expected relations between design and performance can be computationally deduced.

Organizational structures are defined in terms of the network of relations among agents. We study four stylized organizational structures. They are: (1) team with voting — a totally decentralized structure in which organizational decision is through majority voting of each members of the organization, (2) team with a manager — basically a flat hierarchy such that while each analyst examines information and makes a recommendation, the ultimate organizational decision is made by the manager (or team leader), (3) hierarchy — a multi-leveled communication structure in which each baseline agent examines information and makes a recommendation to his or her immediate supervisor who in turn makes a recommendation to the top-level manager who makes the ultimate organizational decision, (4) matrix — like the hierarchy, is a multi-leveled communication structure, except that each baseline agent has two communication links with two middle managers across divisions.

The task decomposition scheme defines the relations between agents and resources and/or information. We study four stylized task decomposition schemes. They are: (1) segregated — each baseline agent has access to one task component, (3) overlapped — each baseline agent has access to two task components, with one task component being overlapped with another baseline agent, (3) blocked — each baseline agent has access three task components, but usually each three agents within the same division have the same three task components, and (4) distributed — each baseline agent has access to three task components usually across different divisions.

The third and final aspect of organizational design, with which we will be concerned, is training. We study three training scenarios. They are: (1) untrained — each agent in the organization makes decisions by basically guessing, (2) experientially trained — each agent in the organizational makes decisions by referring to historical experience, and (3) operationally trained — each agent in the organization makes decisions by using standard operating procedure [7].

Agent Style

Within a proactive organization, each agent asks for information, reads information if there is information, makes a decision based on the available information, then passes on the decision. This process repeats until time expires, i.e., the aircraft goes out of range, or the top manager decides to stop the process. Each agent (except the top manager) can be interrupted by a request from an upper manager for decision. The agent will respond to the request by communicating a decision, if there is one available. Clearly, the procedures followed by the top manager, middle managers, and baseline analysts differ somewhat on the basis of their organizational position. The top manager cannot be interrupted (since there is no superior), and a baseline analyst cannot ask for information (since there is no subordinate), while a middle manager can be interrupted as well as ask for information. Further, the top manager has the power to decide the final or organizational decision according to certain standards.

Within a reactive organization, each agent simply reads information again and again until time expires or until the agent is told by the manager to stop. Each agent (except the top manager) can be interrupted by a request from an upper manager for decision. The agent will then stop reading information (if not finished yet), make a decision, and pass on the decision. Unlike the proactive agent, a reactive agent will not make a decision and pass on the decision unless being requested by his or her manager. Again, there are processing differences among agents due to their organizational positions (top, middle, and baseline). The top manager cannot be interrupted, and initiates the decision making process by asking for information. A middle manager will ask for information only when a request from the top manager is received for decision and when there is no decision already being communicated by baseline analysts. A baseline analyst

[5]In this model, this danger point occurs when the aircraft has a range of 1 mile and/or a range of 5,000 feet. Both numbers were chosen based on characteristics of radar systems.

[6]Aircraft can vary with different characteristics such as speed, range, and altitude.

[7]Number of time units required for different types of decision procedure is different given the same amount of information. Due to the different complexity of decision making processes, experiential decision making procedure usually takes more time than operational decision making procedure, and they both take more time than untrained decision making procedure.

always reads information and never asks for information (please refer to Appendix for more detailed algorithms of proactive and reactive agent styles).

METHODOLOGY

The performance of the organizations is generated using a computer simulation test-bed built in C within a VAX/VMS system. Using this test-bed, we are able to systematically alter task environment (4), organizational structure (4), task decomposition scheme (4), training scenario (3), agent style (2) which are all built within the test-bed. Thus, 384 organizational types were examined. By varying type (5) and degree (4) of internal stress, we examine 20 internal conditions, with degree 0 as the optimal operating condition. In this experiment, we examine a total of 7,680 cases.

Each case represents an organization faced with a specific internal condition and task environment. The performance of each case/organization is evaluated by examining performance on 1,000 problems. Each problem represents a specific moving aircraft. This study is carried using Monte-Carlo analysis. All characteristics of each problem are randomly generated. These include: the starting position, speed, and nature of the aircraft, the location of the murphies affecting the organization internal, and the maximum time units allowed the organization to make a decision regarding the aircraft.

The 1,000 problems can be classified as being friendly, neutral, or hostile or as being under low, medium, or high time pressure. We can measure performance overall (percentage of problems for which the organization made the correct decisions) or we can measure performance for a subset of the 1,000 problems (e.g., percentage of problems given the true state is hostile for which the organization made the correct decisions). This simulation test-bed offers us the chance to systematically examine the interactions among, and effect of, the various organizational factors on organizational performance that have concerned researchers. Nevertheless, in this paper, our focus is on agent style.

Table 1: Performance by Agent Style across all Levels of Time Pressure

Across Experientially Trained Organizations			
External	Internal	Agent Style	
		Proactive	Reactive
Overall	Overall	46.11(3840,0.29)	46.08(3840,0.29)
	Optimal	47.28(960,0.57)	47.32(960,0.57)
	Murphy	45.72(2730,0.31)	45.66(2730,0.31)
Mayday	Overall	59.47(3840,0.32)	59.39(3840,0.32)
	Optimal	61.30(960,0.90)	61.35(960,0.89)
	Murphy	58.85(2730,0.49)	58.74(2730,0.49)
Across Operationally Trained Organizations			
External	Internal	Agent Style	
		Proactive	Reactive
Overall	Overall	47.86(3840,0.24)	47.81(3840,0.24)
	Optimal	49.99(960,0.53)	50.06(960,0.53)
	Murphy	47.16(2730,0.24)	47.06(2730,0.24)
Mayday	Overall	54.83(3840,0.33)	54.70(3840,0.33)
	Optimal	56.71(960,0.70)	56.68(960,0.69)
	Murphy	54.20(2730,0.36)	54.04(2730,0.36)

Note: Performance is in percentage. Number of cases and standard errors are in parentheses.

RESULT AND ANALYSIS

Across All Levels of Time Pressure

According to the general discussions of the nature of proactive and reactive agent styles in the literature, one might expect the following propositions to hold:

Proposition 1: Agent style does not matter (Mayhew 1980; Wellman 1988).

This says that when the structure of the organization and the fit between task environment and organizational structure are considered, organizations compose exclusively of proactive agents (proactive organizations) and organizations compose exclusively of reactive agents (reactive organizations) should exhibit equivalent performance.

Proposition 2: Proactive organizations perform better than reactive organizations (Kraft 1986; Smiar 1992).

Proactive agents are better prepared and can respond faster. Thus, organizations filled with proactive agents should perform better than organizations filled with reactive agents, controlling for all other factors.

Our analysis supports Proposition 1. Whether we consider just experientially trained organization, or operationally trained organizations, or both, there is no difference between the performance of organizations with proactive and reactive agent styles ($\alpha = 0.01$). This is true regardless of external or internal conditions (Table 1).

Similarly, for different organizational structures, for different task decomposition schemes, and different task environments, there is no difference in the performance of proactive and reactive organizations.

Under High Time Pressure

Under high time pressure, organizations are often overloaded with information. They give up normal "time spending procedures", or normal decision making procedures and mainly make decisions based on hunches (Rosenthal et al. 1989). Thus, agent style should not matter when time is at a premium, controlling for all other factors. This suggests the following proposition.

Proposition 3: Proactive and reactive organizations have the equivalent performance under high time pressure (Rosenthal et al. 1989).

In our analysis, when there is high time pressure on average there is no difference between the performance of proactive and reactive organizations ($\alpha = 0.01$), regardless of external conditions. However, if we consider only optimal internal conditions (no murphies), organizations filled with proactive agents perform worse than organizations filled with reactive agents. This is true across all external conditions ($p < 0.001$), and when just hostile (mayday) conditions are considered ($p < 0.005$) (Table 2).

It is important to note, however, that all organizations under high time pressure are making the right decision approximately 33.33% of the time. If the agents were simply guessing, then organizational performance would in fact be 33.33%. While the proactive organization is slightly worse than the reactive organization neither is noticeably different than an

organization that is simply guessing. The slight difference in performance may well be the artifact of randomness.

In summary, under extremely high time pressure, organizational performance is essentially reduced to be equivalent to the best that can be expected when agents guess. Consequently, there are no consistent effects that can be attributed to agent style. This generates mixed support for proposition 3.

Under Medium Time Pressure

Under moderate time pressure, the organizational decision making process should be tightly constrained by time, though not completely disrupted. Thus agent style should critically affect performance, controlling for all other factors.

Proposition 4: Proactive organizations perform better than reactive organizations under medium time pressure (Jauch and Kraft 1986; Pauchant et al. 1990; Smiar 1992);

Our analysis suggests that on average there is no difference between the performance of proactive and reactive organizations ($\alpha = 0.01$). This is true regardless of external or internal conditions (Table 2). However, when we consider the type of training that the agents have received, we see significant performance differences due to agent style under suboptimal operating conditions (murphies).

In experientially trained organizations, if we average across all operating conditions, or consider just optimal internal operating conditions, there is no difference between the performance of proactive and reactive organizations ($\alpha = 0.01$), regardless of external conditions. Under suboptimal internal operating conditions, organizations filled with experientially trained proactive agents outperform organizations filled with experientially trained reactive agents. This is true both across all external conditions ($p < 0.001$), and under maydays ($p < 0.001$). A similar pattern occurs for operationally trained organizations.

In summary, under medium time pressure, agent style affects organizational performance only under suboptimal internal operating conditions. In this case, proactive organizations outperform reactive organizations. Thus, Proposition 4 is supported only under suboptimal conditions. Proactive agents benefit the organization, but that benefit is most apparent when time is somewhat constrained and things are going wrong.

Under Low Time Pressure

Under low or no time pressure, organizations have enough time to make decisions regardless of external or internal conditions. It is usually efficient to use reactive style as it offers a comparable performance with proactive style, but with lower operating costs (Sussman 1984). Thus, we should expect no difference in the performance of organizations with either proactive or reactive style when time is not critical, controlling for all other factors.

Proposition 5: Proactive and reactive organizations have the equivalent performance under low time pressure (Sussman 1984).

In our analysis, when considering either experientially trained organizations, or operationally trained organizations, or both, there is no difference between the performance of organizations with proactive and reactive agent styles ($\alpha = 0.01$). This is true regardless of external or internal conditions (Table 2). Thus, under low or no time pressure, there is no effect of agent style on organizational performance. This result supports Proposition 5.

DISCUSSION AND CONCLUSION

In this paper, we have studied the effect of one aspect of agent style — proactiveness/reactiveness — on organizational performance.

Our results show that on average, there is virtually no effect of agent style on organizational performance (support for Proposition 1 but not for Proposition 2). However, if we consider the effect of time pressure we find

Table 2: Performance by Agent Style and Level of Time Pressure

Training Type	External Condition	Internal Condition	High Time Pressure		Medium Time Pressure		Low Time Pressure	
			Agent Style		Agent Style		Agent Style	
			Proactive	Reactive	Proactive	Reactive	Proactive	Reactive
Expe Training	Overall	Overall(1280)	33.27(0.07)	33.24(0.07)	43.69(0.29)	43.54(0.29)	61.38(0.51)	61.45(0.51)
		Optimal(320)	33.27(0.13)	33.31(0.14)	44.38(0.60)	44.39(0.59)	64.18(1.02)	64.27(1.02)
		Murphy(960)	33.27(0.08)	33.22(0.08)	43.45(0.33)	43.26(0.33)	60.44(0.59)	60.51(0.58)
	Mayday	Overall(1280)	33.18(0.10)	33.25(0.10)	55.38(0.45)	55.14(0.43)	89.84(0.42)	89.79(0.42)
		Optimal(320)	33.27(0.21)	33.41(0.20)	56.39(0.93)	56.42(0.90)	94.25(0.65)	94.21(0.67)
		Murphy(960)	33.15(0.12)	33.19(0.12)	55.05(0.51)	54.71(0.49)	88.37(0.51)	88.31(0.50)
Oper Training	Overall	Overall(1280)	33.67(0.08)	33.71(0.07)	53.71(0.29)	53.56(0.29)	56.21(0.35)	56.17(0.36)
		Optimal(320)	33.77(0.16)	34.01(0.15)	56.44(0.71)	56.40(0.70)	59.77(0.86)	59.77(0.86)
		Murphy(960)	33.64(0.08)	33.61(0.08)	52.80(0.31)	52.61(0.31)	55.02(0.37)	54.97(0.37)
	Mayday	Overall(1280)	33.69(0.11)	33.57(0.11)	64.09(0.42)	63.88(0.42)	66.71(0.46)	66.64(0.46)
		Optimal(320)	33.77(0.22)	33.85(0.21)	66.96(0.91)	66.79(0.89)	69.40(1.01)	69.40(1.01)
		Murphy(960)	33.66(0.12)	33.48(0.12)	63.13(0.47)	62.92(0.47)	65.81(0.51)	65.72(0.52)

Note: Performance is in percentage. Number of cases for each row are listed in the column Internal Condition. Standard errors are in parentheses. Expe — Experiential, Oper — Operational.

that in general, only under medium time pressure, does agent style play a large role. Under medium time pressure, organizations filled of proactive agents outperform organizations filled with reactive agents, but only if the organization is facing suboptimal operating conditions in which various obstacles limit its information processing capabilities (erroneous information, incomplete information, and so forth).

Further, there is basically no interaction effect between agent style (proactiveness/reactiveness) and structure, task decomposition scheme, training scenario, or task environment, on performance.

The result that agent style in most situations is irrelevant to organizational performance shows that the amount and frequency of information used in decision making may not characterize the quality of decisions. The myth around proactive agent style can probably be attributed to the fact that organizations often collect information for "signal and symbol" purpose rather than for decision making purpose (Feldman and March 1981).

In this research, our focus is on the effect of one aspect of agent style (proactiveness/reactiveness) on organizational performance, not on the origin of agent style. We believe further understanding of the sources of agent style is necessary for future research into the effect of agent style. More aspects of agent style such as emotion and creativity may also be included in future research on agent style. In addition, future research should examine more real world organizations, thus providing new insight into this theoretical study.

We categorized time pressure into three levels according to the time units assigned to the organization or the time units spent when the organization has to make a decision before the aircraft reaches a certain point. It is difficult to disentangle time pressure from organizational design and task environment, because a high time pressure to some organizations may not be as stressful as to other organizations.

This analysis is mainly based on simulation techniques. Those simulated organizations have enabled us to examine the effect of agent style across numerous factors that have interested researchers in organizations within a reasonably short period of time. In fact, to examine these same factors using human subjects would have taken at least ten years and cost at least two million dollars. Computer simulation is a powerful extension of human cognition. As pointed out by Ostrom (1988), computer simulation offers a third symbol system in studying social science, besides natural language and mathematics, because "computer simulation offers a substantial advantage to social psychologists attempting to develop formal theories of complex and interdependent social phenomena". Fararo (1989) also regards computational process as one of the three processes (the other two are theoretical and empirical processes) necessary to the development of any discipline. However, we should still view the results from this paper with caution.

To conclude, we find support for the implication of network theory and contingency theory that agent style often does not matter. Organizations should care more about the quality of information than about the amount and frequency of information in decision making.

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APPENDIX

Table A1: Preference Functions for Proactive Agent

Note:
TIME_REM — Time remaning for decision making
TIME_REQ — Time required for a round of decision
SIGN_PASS — Signal for passed up decision
SIGN_REQ — Signal for request of decision information
SIGN_EDEC — Signal for earlier made decision
ASK_INFO — Ask for decision information
READ_INFO — Read decision information
MAKE_DEC — Make a normal decision
MAKE_RAN — Make a random decision
UPD_DEC — Update decision
PASS_DEC — Pass up decision
WAIT — Wait
INT_ACT — Interrupt current action
CON_ACT — Continue current action
RETURN — Return final organizational decision

Top Manager

```
while (TIME_REM≥0){
    if (TIME_REM≥TIME_REQ)
        if (SIGN_PASS){
            READ_INFO;
            MAKE_DEC;
            UPD_DEC; }
        else {
            ASK_INFO;
            WAIT; }
    else
        if (SIGN_EDEC){
            UPD_DEC;
            RETURN; }
        else{
```

```
                MAKE_RAN;
                RETURN; }
}

Middle Manager
while (TIME_REM≥0){
    if not (SIGN_REQ)
        if (TIME_REM≥TIME_REQ)
            if (SIGN_PASS){
                READ_INFO;
                MAKE_DEC;
                PASS_DEC; }
            else{
                ASK_INFO;
                WAIT; }
        else
            if (SIGN_EDEC){
                INT_ACT;
                PASS_DEC;
                CON_ACT; }
            else
                CON_ACT;
    else
        if (SIGN_EDEC){
            INT_ACT;
            PASS_DEC;
            CON_ACT; }
        else
            CON_ACT;
}

Baseline Analyst
while (TIME_REM≥0){
    if (SIGN_REQ)
        if (TIME_REM≥TIME_REQ){
            READ_INFO;
            MAKE_DEC;
            PASS_DEC; }
        else
            if (SIGN_EDEC){
                INT_ACT;
                PASS_DEC;
                CON_ACT; }
            else
                CON_ACT;
    else
        if (SIGN_EDEC){
            INT_ACT;
            PASS_DEC;
            CON_ACT; }
        else
            CON_ACT;
}
```

Table A2: Preference Functions for Reactive Agents

```
Top Manager:
while (TIME_REM≥0){
    if (TIME_REM≥TIME_REQ)
        if (SIGN_PASS){
                READ_INFO;
                MAKE_DEC;
                PASS_DEC;
                RETURN; }
            else{
                ASK_INFO;
                WAIT; }
        else{
            MAKE_RAN;
            RETURN; }
}

Middle Manager
while (TIME_REM≥0){
    if not (SIGN_REQ)
        CON_ACT or WAIT;
    else
        if (SIGN_EDEC){
            PASS_DEC;
            WAIT; }
        else
            if (TIME_REM≥TIME_REQ)
                if (SIGN_PASS){
                    INT_ACT;
                    READ_INFO;
                    MAKE_DEC;
                    PASS_DEC;
                    CON_ACT; }
                else{
                    INT_ACT;
                    ASK_INFO;
                    CON_ACT; }
}

Baseline Analyst
while (TIME_REM≥0){
    if (SIGN_REQ)
        if (SIGN_EDEC)
            PASS_DEC;
            if (TIME_REM≥TIME_REQ){
                READ_INFO;
                MAKE_DEC;
                PASS_DEC; }
            else
                if (TIME_REM≥TIME_REQ){
                    INT_ACT;
                    READ_INFO;
                    MAKE_DEC;
                    PASS_DEC;
                    CON_ACT; }
                else
                    CON_ACT;
    else
        READ_INFO;
}
```