

16th ICCRTS

“Collective C2 in Multinational Civil-Military Operations”

“Ensuring Agile Power to the Edge Approach in Cyberspace”

Topics

(Primary)Topic 11: Cyberspace Management

Topic 1: Concepts, Theory, and Policy

Topic 5: Collaboration, Shared Awareness, and Decision Making

Name of Authors

Hiroshi Yamaguchi¹, Yuko Mori², and Chitoor V. Ramamoorthy³,

1. Research and Development Initiative, Chuo University,

2. Musical Director, The Nagaokakyo Chamber Ensemble, Kyoto, Japan

Former Professor, Roosevelt University Chicago College of Performing Arts

The Music Conservatory

3. Professor Emeritus, Department of Electrical Engineering & Computer Science

University of California, Berkeley

Point of Contact

Hiroshi Yamaguchi

Name of Organization

Research and Development Initiative, Chuo University

1-13-27, Kasuga Bunkyo-ku, Tokyo 112-8551, Japan

Tel: +81-3-3817

yamaguchivc@cap.ocn.ne.jp

Abstract

With the advent and growth of global network, the term 'cyberspace' has entered into everyday parlance and conventional means to define more by the social interactions involved rather than its technical implementation. The core characteristic of cyberspace is that it offers an environment that consists of many participants with the ability to affect and influence each other. In this paper, first we introduce a new methodology for the cyberspace management how to utilize human resource and bring out a human ability for satisfying the required properties in cyberspace society quoting the representative and disseminated example of musical ensemble without conductor. Second, we discuss to evaluate the feasibility on the Network Centric Warfare / Power to the Edge approach which preceded example in cyberspace society by applying our methodology.

Keywords: Power to the Edge, Musical Ensemble, Cyber Society, Methodologies.

1. Introduction

The term "cyberspace" has been standing for the global network of interdependent information technology infrastructures, telecommunications networks and computer processing systems. In current, the term has become a conventional means to describe anything associated with the Internet and the diverse Internet culture. Cyberspace can be defined more by the social interactions involved rather than its technical implementation. As a social experience, individuals can interact, exchange ideas, share information, provide social support, conduct business, direct actions, create artistic media, play games, engage in political discussion, and so on, using this global network. In their view, the computational medium in cyberspace is an augmentation of the communication channel between real people. The core characteristic of cyberspace is that it offers an environment that consists of many participants with the ability to affect and influence each other. The cyber society will inevitable become *far more competitive* than any society we have yet known---for the simple reason that with information being universally accessible, there are no excuses for nonperformance. (Ram2000) urged the coming of networked society, where the four distinct types of team organizations, namely centralized or hierarchialized and partially decentralized and fully decentralized team organizations are considered. When the communication and computer processing costs are negligible, fully decentralized disciplines appear to be most congenial to the rapidly evolving technologies and economics. (Dr2001) urged the emergence of knowledge society (i.e. in another word, cyberspace society) in which knowledge organization in global space is the central reality. He urged that the

changes and challenges of managing oneself may seem obvious in the cyber society. Managing oneself is a revolution in human affairs. It requires new and unprecedented things from the individual, and especially from the participants in the cyber society. For in effect, it demands that each participant think and behave as achieve executive officer. It also requires and almost 180-degree change in the participant's thought. Managing themselves profoundly challenges social structure from the traditional hierarchical organization to the flat organization due to the rapid change and flow of information needed directly to each participant without passing through managers.

We present the new management methodology how to utilize human resource and bring out a human ability for satisfying the required properties in cyber society by quoting the representative and disseminated example of musical ensemble without conductor. We argue to ensure the feasibility on the Network Centric Warfare / Power to the Edge approach as the preceded example in cyberspace society.

2. The preceded example in cyberspace society: NCW / PTE approach

The tenets of Network Centric Warfare (NCW) have increasing activity and undeniable progress toward network-centricity, in which leads to a transformation of command and control that is central to all military organizations and processes. On the other hand, "power to the edge (PTE)" presents the approach to command and control support systems in which command and control become unbundled. (AH2003) illustrates the responsibility for command in the following way:

Command in the information age is ultimately not the sole responsibility of any single individual. It is a shared and distributed responsibility. Commanders become responsible for creating initial conditions that make success more likely and exercise control.

The formulation of command in the cyber society is the instantiation of power to the edge in the domain of command and control. When fully achieved in each of the domains of warfare, provides the conditions that allow NCW to reach its fully mature form. Where a robustly networked, highly professional force exists, and the battle space is dynamic (changing rapidly), self-synchronization (read control-free) appears attractive. However, in order to work together effectively in this mode, the elements of this force will have to achieve a high level of trust. The most promising approach for the commander and subordinates are;

-The primary role of the commander is to support the force-creating initial conditions that minimize the likelihood of mission accomplishment and providing the information and resources necessary to the force elements to succeed including the new information.

-PTE is about changing the way individuals, organization, and systems relate to one another and work. Moving power to the edge implies greatly enhanced peer-to-peer interactions. Edge organization often reduces the need for middle managers whose role is to manage constraints and control measures.

3. Required properties for the NCW / PTE approach

Figure 1 focuses on the required property for the PTE to information age forces. It is important to note that this figure not only includes variables related to individual sense making and decision making, but mirrors this set of individuals with a set of variables that pertain to team, group, or organizational sensemaking and decisionmaking capabilities. These team, group, and organizational attributes include the degree to which (1) information is shared (2) awareness is shared (3) understanding is shared (4) self synchronization is achieved and (5) collaborative decision is done.

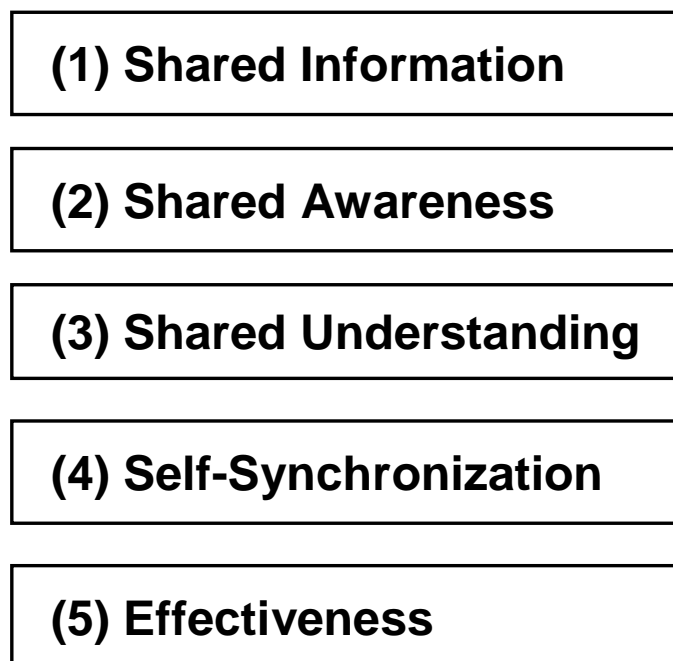


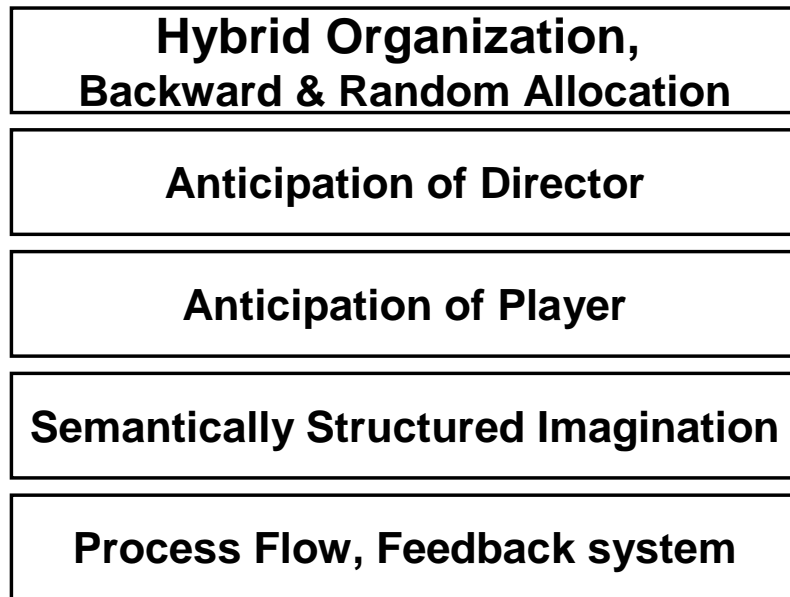
Figure 1. Required properties for NCW/PTE

4. Proposed methodologies: “Mori Method”

We propose the new methodology that satisfy and evaluate the required properties for the

cyber society introduced in Figure 1. This methodology is developed by the experience and trials through the musical ensemble in which new idea such as the ensemble without conductor, hybrid organization, anticipation of musical director, each player, process flow and semantically structured imagination model are devices.

The musical ensemble without conductor can be defined as a 'distributed conductor' theme where each musical player provides his/her own leadership. It is true that one of the first things on notices about this organization is that there is no conductor signaling with baton and eyes and body how the music should be played. It has, in fact, more leadership than virtually any other organization we have seen in over a decade of research on group behavior and performance. Because there is no conductor, each player must help decide about musical interpretations. Each one must take part of the responsibility for ensuring that musical entrances are together, that themes are passed smoothly from section to section, and that the composer's vision for a piece is realized musically. We propose a new methodology for the musical ensemble without conductor. In this scheme, the sound is only communication measure between each player that will be in quite same environment in the cyber society where the information through the network is communication measure between each participant. (Mori2010) presented the new methodology for satisfying the required properties of the cyber society organization shown in Figure 1 that will be effectively applied not only to the NWC / PTE approach but also to the cyber society organization depicted in Figure 2.



**Figure 2. Proposed Methodology;
“Mori Method”**

4.1 Hybrid organizations, Backward allocation

(1) Hybrid organization

Proposed musical ensemble without conductor takes two types of organization, i.e., (1) hierarchical organization and (2) flat organization shown in Figure 3. Each organization is chosen iteratively depending on the processing phase mentioned later.

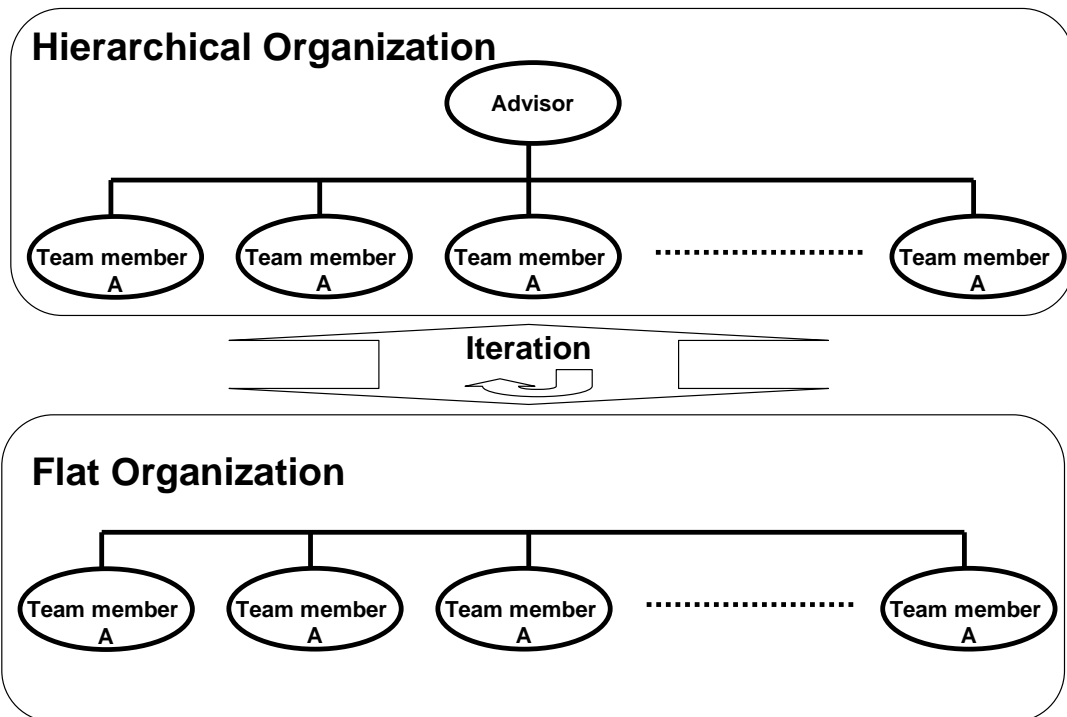


Figure 3. Hybrid Organization

(2) Backward/ random allocation

This allocation is taken for the sake of realizing an environment where no visual information except for aural information is given to the players. They can devote to listen the performance of musical ensemble and perceive a response of audience. Backward random allocation is necessary, as a means of producing for the ear what cannot be achieved by the eye. This allocation helps each player to depend on only the sound they produced without depending on the eyesight to the conductor or other players shown in Figure 4. Figure 5 shows the example of backward and random allocation in which each musical player cannot see the conductor due to the backward position and cannot rely on other players due to the random allocation.

4.2 Anticipation of musical director

Musical director is desired to guide but not dictate detail to each player. In the control-free approach, the primary role of the musical director is to support the music-creating initial conditions that minimize the likelihood of mission accomplishment and providing the information and resources necessary for the playing elements to succeed including the

information they require as the situation changes. That is the only direction issued and each musical player is left free to decide how he would accomplish the mission.

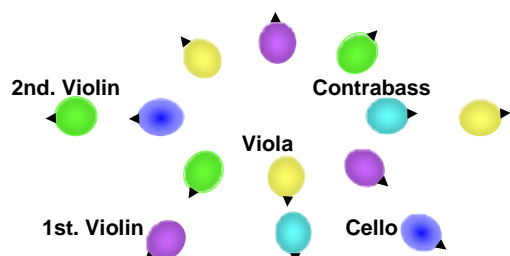


Figure 4. Backward and Random Allocation of String Orchestra (without a conductor)



Figure-5 . Example of Backward and random allocation

In the 'Drive' phase,

- The most promising approach involves establishing, to the extent possible, a set of initial conditions and clear and consistent conduct intention and timely advice and finally acceptant the simulation that will result in the desired behavior.

In the 'Carry' phase

- Creates the conditions that are likely to give rise to the behaviors that are desired.
- Allows for innovation and flexibility by subordinate commanders within a set of constraints imposed by senior commanders.
- Individual commanders with considerable confidence in their subordinates.

4.3 Anticipation of music players

- Each player owns the dedicated responsibility
- Each player has control over himself/herself
- No player has control over other participants, while he can output his intension of overall control through the output.
- Each player can access other participant's intention of overall control
- Each participant can access the external information, while each player has minimum essential capability in operation
- The ability to make sense of situation
- Possession of the appropriate means to respond
- The ability to orchestrate the means to respond in a timely manner

4.4 Semantically structured imagination (SSI) model

We define the following model (two observable variables, five latent variables, and loadings)

in Figure 6 as an unified direction for simplifying the comparison between the two cases in which one case takes the SSI model and another case does not do. We propose to enhance the power of information for exploring the information structure for shared patterns that is useful for the sharing information, understanding and self-synchronizing for anyone. For example, the initial condition given from the director implies many hidden information behind it. The SSI model enhances the quality of information much more. Formulating the information in a semantically structured form with correlated variables and loading factors is constructed with the hidden structure of unobservable variables. We define two types of variables, i.e., observable variables and unobservable variables (hidden, latent, underlying factor) which will influence these observable variables. These unobservable variables include hypotheses created by expertise and experiment. Hypothesized variables have certain implications, and these implications in turn can be tested against the observations and modified or changed as the need arises. Each variable in different subjects are all correlated with each other in a coalition environment.

For the example of musical ensemble without conductor, the important property for each player is to create a common imagination among the ensemble. We express this imagination in the linked relations between the observed information such as initial conditions given by the musical director and unobserved information such as the composer's intent the motif of a piece of music. Figure 6 show the observed information X_i , where $i = 1, \dots, n$ and the unobserved (latent) information Y_j , where $j = 1, \dots, n$ and loading factor λ .

Let us denote the observable variable (the information) i in the system, as X_i , ($i = 1, \dots, n$) and the unobservable variable (hidden information), as $F_{i,j}$ ($j = 1, \dots, m$).

The observable variables are modeled as a linear combination of the unobservable variables. The observable variables are independent of one another.

$$Cov(X_i, X_j | F) = 0$$

F is standardized (think "standard normal") and is, on average, 0.

$$\text{Var}(F) = 1 \quad E(F) = 0$$

The SSI model mainly improves the degree of information sharing and the quality of information improvement that consequently also enhances the degree of self-synchronization.

Loadings range from -1 to 1. The unobservable information may be used to provide meaningful predictions on new data. Under certain conditions the hypothesized factor model has certain implications, and these implications in turn can be tested against the observations. The loadings λ are parameters to be estimated that tap how the unobservable variables account for the observable variables. Note that the loadings λ vary across survey items, but not across individuals. The semantically structured information model mainly improves the degree of information sharing and the quality of information improvement that consequently also enhances the degree of self-synchronization

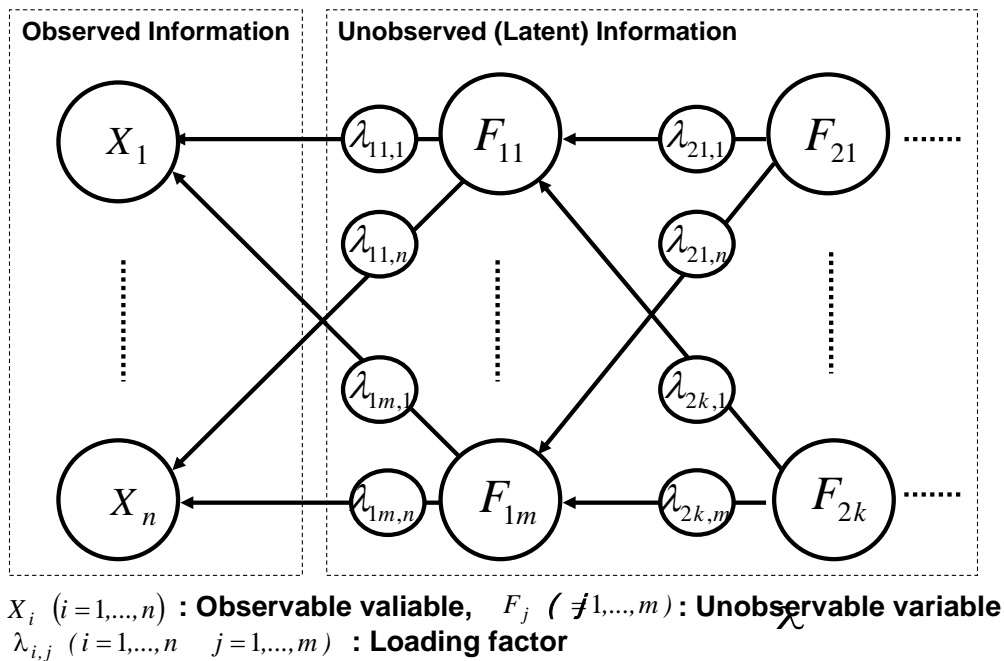


Figure 6. Semantically structured information model on observable and latent information

4.5 Process flow, Feedback system

(1) Processing flow of the orchestra without conductor

Figure 7 illustrates how the proposed approach proceeds.

-The musical director takes a hierarchical organization and practices the orientation and

discussion. In the orientation phase, the musical director transfers the initial conditions that will result in the desired behavior. In the discussion phase, the musical director gives a suggestion and advice but do not dictate details to the players.

-Each player defines the SSI model and tries for achieving the desired properties. The SSI model is modified along to each trial.

-Once the music director confirms that the desired level of performance is achieved, the concert is performed where the normal allocation without conductor is taken.

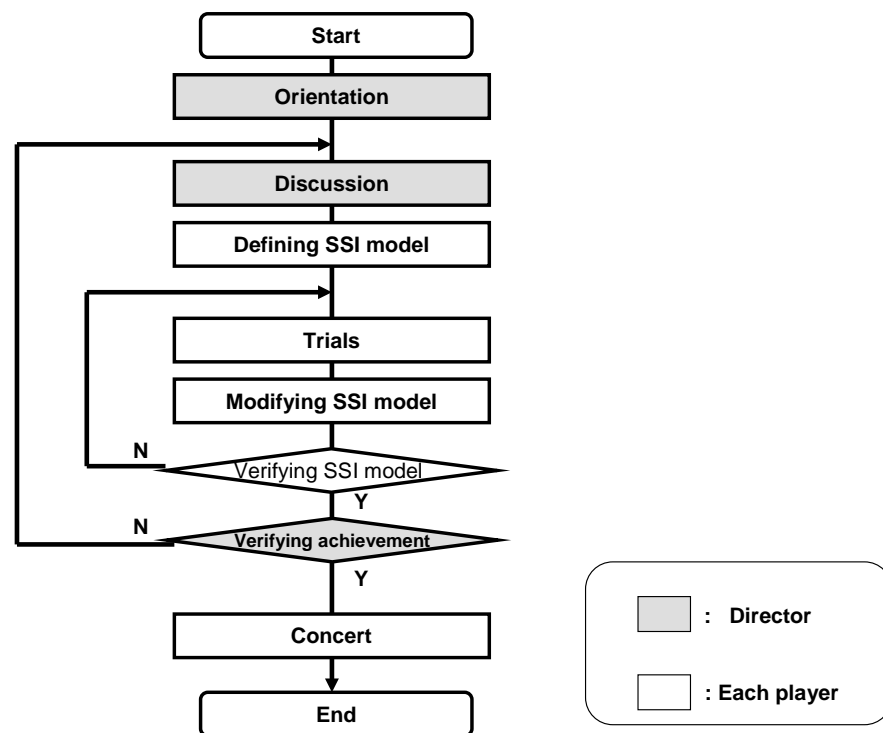


Figure. 7 Process flow of Mori Method

(2) Feedback system

A feedback system has to be built into the self-synchronization approach to provide a continual trying, against actual events, of the expectations. The criteria indicates the desired outcome in various operational situations including hypothesized information due to the decentralized organization which can be modified or changed according to the verified information through iteration. The agent receives the difference between the criteria and outcome of team (shared information) and executes shared situation awareness, understanding and self-synchronization as depicted in Figure 8. This basic idea is presented

in (YSR2003) The shared awareness puts the available information about the situation into context and identifying the relevant patterns for self-synchronization. Third party means the other participants who will offer some external information to the feedback system such as an adversary inform. The criteria is modified or changed each time the need arises.

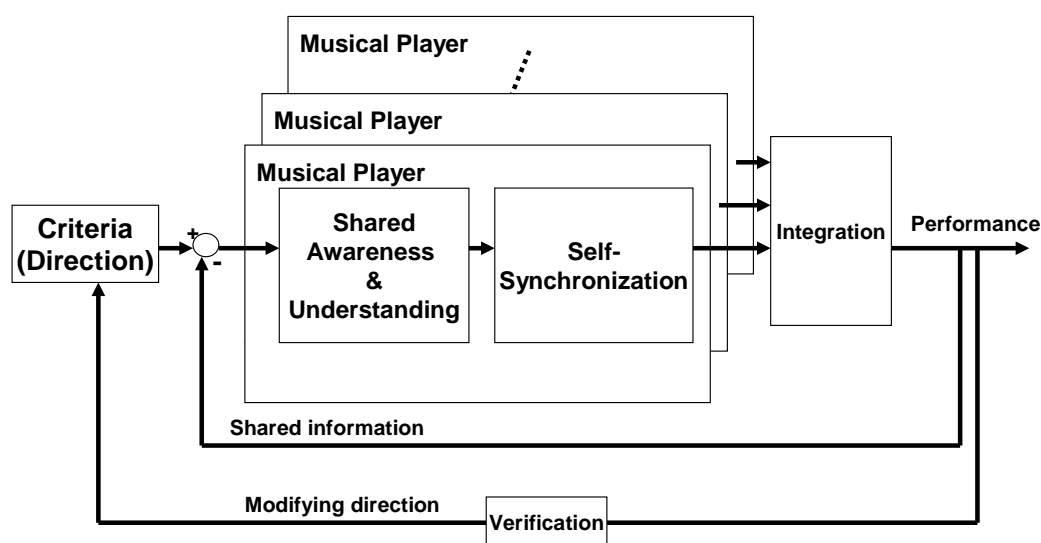


Figure 8. Feedback system for internal processing

5. Experimentation

We evaluate our proposed methodology by means of achieving items mentioned above.

5.1 Preparation

(1) Hybrid organization, backward/random allocation

Hybrid organization and backward/random allocation are taken in the trial phase. Each player takes his/her playing location backward and randomly allowing that only the sound is communication interface.

(2) The SSI model

First we define the musical note and musical director's intent as observable variables. Second, we hypothesize the composer's intent, composer's image, timing, articulation items and scenery required in ensemble as unobservable variables shown in Figure 9. The

loading factors are given from musical director in accordance with a piece they play.

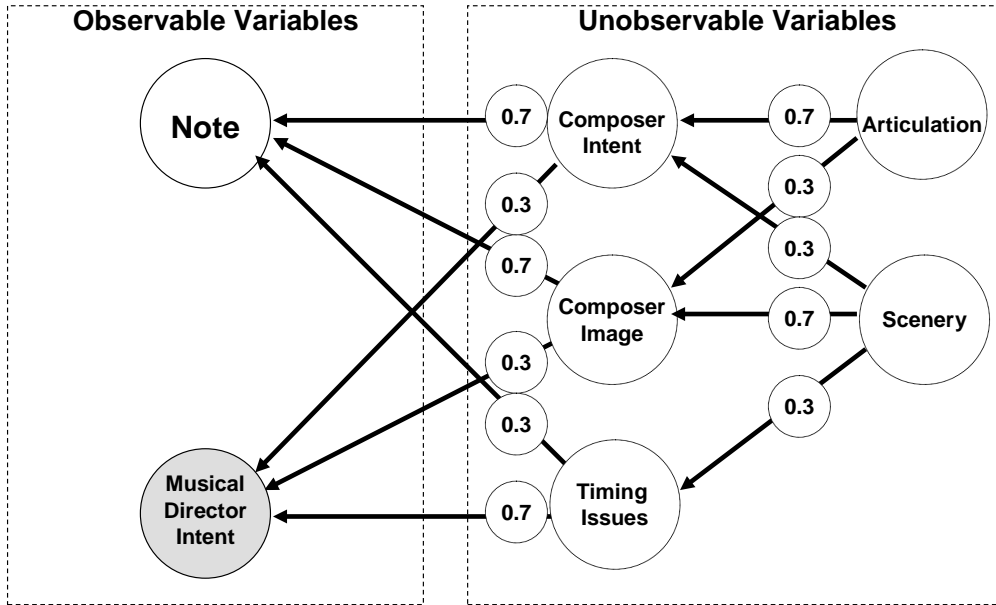


Figure 9. Hypothesized unobservable variables (SSI model)

(3) Questionnaire on impression

We executed the questionnaires to the musical players who participated in the experimentation. These questionnaires are a standard procedure to quantitatively evaluate subjective impressions on the query items. First, a selection of concept-pairs of adjectives related to the query items were chosen. Then the query items are scored using a 7 points scale for each concept-pair of the adjectives. The 6 query items are chosen based on the required properties in performing the musical orchestra without conductor as shown in Figure 10.

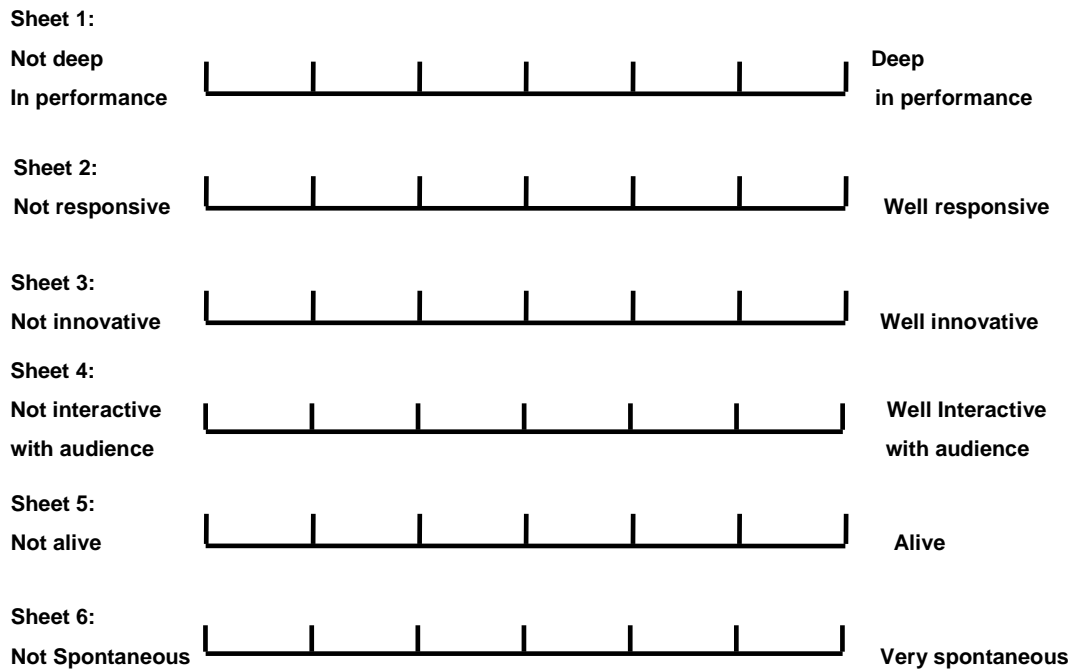


Figure 10. Questionnaire form

5.2 Results

(1) Responses of questionnaire

The responses of questionnaire compared with the case of musical ensemble without conductor and musical ensemble with conductor are shown in Figure 11 in which the distribution values on the answer of musical ensemble with conductor is normalized. In this figure, in particular, Degree of creativeness and degree of effectiveness in the case of musical ensemble without conductor are significantly increased compared to the case of musical ensemble with conductor.

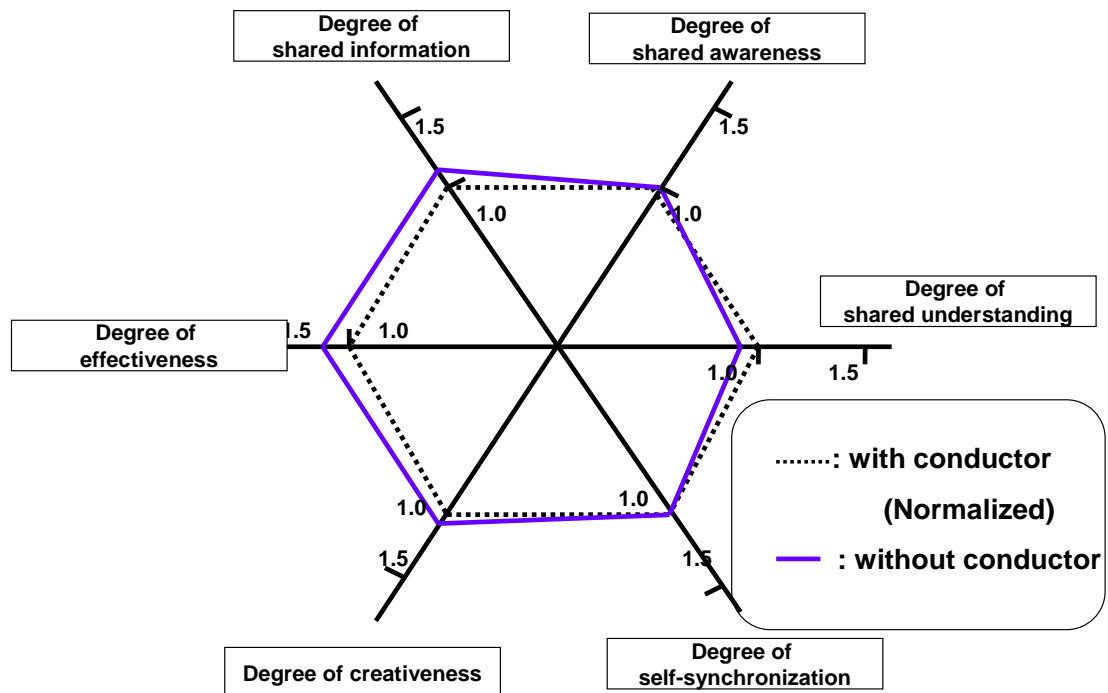


Figure 11. Response for the questionnaire

(2) Self-synchronization (time-based)

We evaluate the degree of self-synchronization in the case of musical ensemble without conductor compared to musical ensemble with conductor in time (i.e., interval) base. As a most remarkable interval variable example, we select the piece of ‘Serenade for string ensemble, P. I. Tschaikovsky’ in which ‘stringend part (4 bars), ritardando part (4 bars), and ‘fermata part’ are played in succession. ‘stringend’ means the acceleration of tempo and ‘ritardando’ meand the deacceleration of tempo and ‘fermata’ means the transitory pause of play. The existence or conductor is considered in general to be inevitable as a time beater due to the changes of tempo. Figure 12 depicts how self-shynchronized in the case of without conductor and in the existence of conductor. The results show the major difference between the case of without conductor and in the existence of conductor.

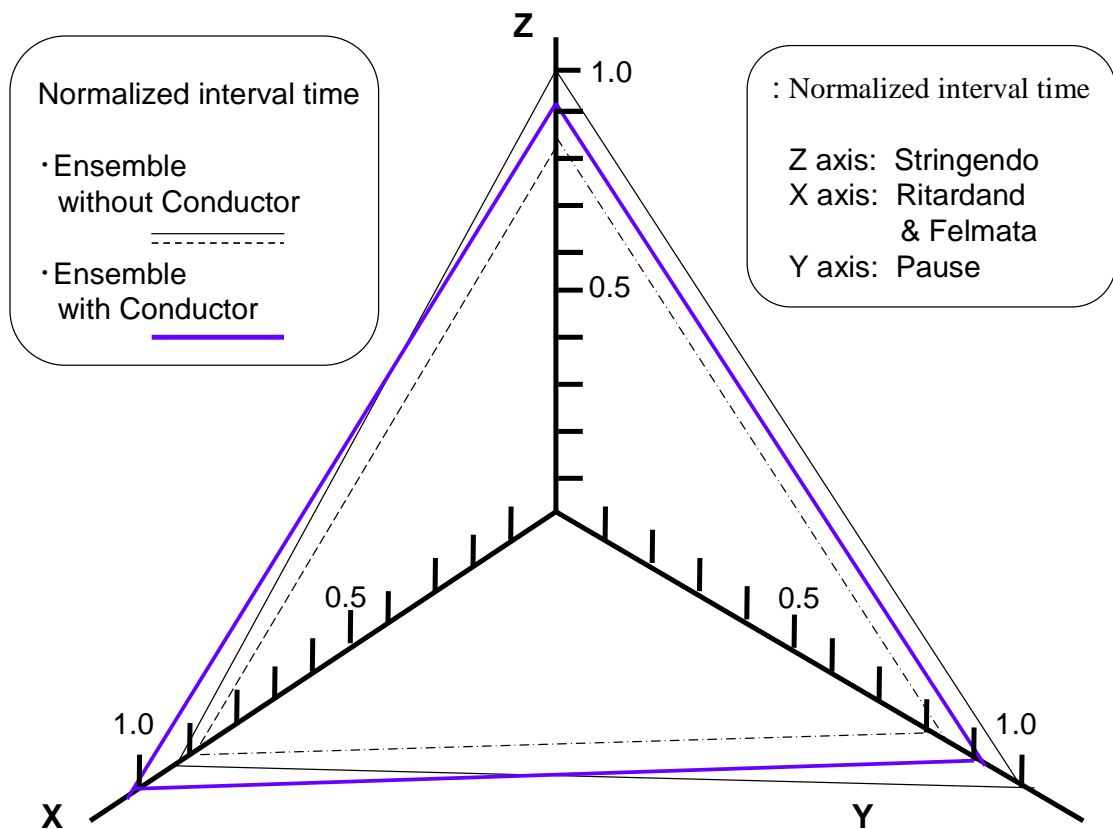


Figure 12. Self-synchronization (time-based)

6. Discussion

The required properties in the cyber society shown in Figure 1 are satisfied by practicing our proposed methodology 'Mori method' as evaluated our experimentation. We also evaluated the superiority of human ability for the self-synchronization not only the time-based but also the direction-based cases. The questionnaire revealed how each player has been stimulated to enhance the spontaneity. We assume that each player has been accustomed to follow and rely on many issues to the conductor, and consequently forgotten the effort to demonstrate his /her spontaneity. The most important point in Figure 7 is the 'verifying achievement' by the commander or the music director. This final verification and approval would become the key issues in which lead to success the following force execution or musical performance. Finally, the proposed approach based on NCW/PTE concept bears startling similarities with the orchestra in command and control, such as commander / music director, theater commander/players, the depth of command intent, shared information, situation awareness, understanding and self-synchronization as well as flat organization and expertness of the participants. Due to these similarities with the

orchestra and military force, the results of simulation and questionnaire analysis will be considered to adopt the military force.

Our result can be mentioned as follows in short:

(1) Hybrid organization

Hybrid organization constructed by hierarchical organization and flat organization is executed iteratively according to the maturity progression in process flow shown in Figure 5.

(2) Backward and random allocation

In the musical ensemble, backward and random allocation realize the situation without conductor and taking the responsibility for the player oneself and others. This allocation is similar to the Network Centric Warfare / Power to the Edge approach in which each participant have to take a leadership oneself and take a responsibility for perform the job.

(3) Anticipation of director

We proposed the new approach for director in stead of the conductor in musical ensemble and commander in Military. The most important issues mentioned in Section 4.2 is the 'Drive' phase and the 'Carry' Phase.

(4) Anticipation of players

The most important issues for the players are to take a responsibility to oneself and to others.

(5) Semantically structured imagination

The effect of this idea is shown in the degree of creativeness issue in Figure 11.

(6) Process flow and feedback system

This system can be applied to the Network Centric Warfare / Power to the Edge approach due to the similarity between the Network Centric Warfare / Power to the Edge approach and the musical ensemble without conductor.

7. Concluding Remarks and future work

We have shown a very effective methodology based on the hybrid organization, rolls of musical director and each player, process flow, semantically structured imagination model in this paper. As mentioned above, the relation between the NCW / PTE approach and our proposed methodology is very close in terms of the required properties, and consequently we convince that the agile power of ensured the agile power to the Power to the Edge approach in cyberspace is ensured. We would like to emphasize that our proposed methodology will satisfy the required properties in the cyber society in which information is the essence of communication and take a flat organization as well as the music ensemble. Finally, it is evident that uncertainty on the result of the experimentation should be expressed in a more elaborate manner than with the straightforward local analysis of the

importance of the individual arcs. These issues will be addressed when developing future versions of the data analysis.

Acknowledgement

The author owes a deep debt of gratitude to Professor Shigeo Tsujii and Professor Jinhul Chao of Chuo University have been tirelessly teaching me theoretical computer science. The late Professor Yukikazu Suzuki of Kurashiki Sakyō University has been enthusiastic about our ideas and provided many helpful advice and comments. Dr. Jyunko Hasegawa and Dr. Kazunori Sato of Nagaokakyo chamber Ensemble provided valuable insight. Director Hirshohisa Wakao of Masters Orchestra in Japan Amateur Corp. inspired me through his constant activities on orchestra work.

References

- (AH2003) Alberts, D.S., Hayes, R.E. (2003). Power to the edge: Washington. D.C.: CCRP
- (Dr2001) The essential Drucker, Harper Business.
- (Mori2010) Mori, Y. (2010), Violinist sounding to the sky, Shunjyū-sha, Japan. ISBN : 978-4-393-93550-7
- (Ram2000) Ramamoorthy, C.V. (2000), A study of the service industry-functions, features and control, IEICE Transaction and Communication, Vol. E83-B, No. 5, pp. 885-902.
- (YSR2003) Yamaguchi, H, Suzuki, K, and Ramamoorthy, C.V. (2003), The humanization, personalization and authentication issues in the design of interactive service system, Transaction of the SDPS, Vol. 7, No. 4, pp. 1-11.
- .