International Journal of Research Studies in Computer Science and Engineering (IJRSCSE)
Volume 1, Issue 1, May 2014, PP 1-12
www.arcjournals.org

Three Game Patterns

Takeo R. M. Nakagawa
Pan-Asian Institute for the Liberal Study of Science, Technology and the Humanities/ Jusup Balasaghyn Kyrgyz National University, Bishkek, Kyrgyz Republic
takeo-n@jaist.ac.jp

Hiroyuki Iida
School of Information Science
JAIST, Nomi, Japan
iida@jaist.ac.jp

Abstract: *This paper is concerned with three elemental game progress patterns. It is found that each of the three games in 2010 FIFA World Cup, Group E is a combination of the elemental progress patterns. It is inferred that this finding is universal and thus it is applicable to many other games. Time history of information of game outcome obtained by the data analyses and existing models shows that for players including winner-sided observers and loser-sided observers, "balanced game" is most exciting, "one-sided game" is least exciting and "seesaw game is intermediate exciting. It is suggested that for neutral observers "balanced game" is frustrating, "one-sided game" is boring, and "seesaw game" is exciting.*

Keywords: *Game Progress Patterns, Game Model, Soccer, Entertainment.*

1. INTRODUCTION

While knowledge about game design patterns and game play patterns has grown fairly well, little advancement has made to clarify game progress patterns, which show how information of game outcome depends on game length of time. Making use of game design patterns, Kelle et al [1] have implemented information channels to simulate ubiquitous learning support in an authentic situation. Lindley & Sennersten [2]'s schema theory provides a foundation for the analysis of game play patterns created by players during their interaction with a game. Lindley & Sennersten[3] has proposed a framework which is developed not only to explain the structures of game play, but also to provide schema models that may inform design processes and provide detailed criteria for the design patterns of game features for entertainment, pedagogical and therapeutic purposes.

Salen & Zimmerman [4] and Fullerton et al [5] argue in favor of iterative design method, which relies on inviting feedback from players early on. 'Iterative' refers to a process in which the game is designed, tested, evaluated and redesigned throughout the project. As part of this approach designers are encouraged to construct first playable version of the game immediately after brainstorming and this way get immediate feed- back on their ideas (Fullerton et al [5]). Play-testing, which lies in the heart of iterative approach, is probably most established method to involve players in design. Play-testing is not primarily about identifying the target audience or tweaking the interface, but it is performed to make sure that the game is balanced, fun to play, and functioning as intended(Fullerton et al [5]).

Game Ontology Project (Zagal et al [6]) offers a framework for describing, analyzing, and studying games by defining a hierarchy of concepts abstracted from an analysis of many specific games. The project borrows concepts and methods from prototype theory and grounded theory to achieve a framework that is continually evolving with each new game analysis or particular research question. The term ontology is borrowed from computer science rather than used in the philosophical sense. It refers to the identification and description of entities within a domain. This project is distinct from design rules and design patterns approaches that offer imperative advice to designers. It is intends not to describe rules for creating good games but rather to identify the abstract commonalities and difference in design elements across a wide range of concrete examples. The ontological approach is also distinct from genre analyses and related attempts to answer the question "What is a game?", which are indeed the same as the present study. Rather than develop definitions to distinguish between games and non-games or among their different types, it focuses on analyzing design elements that cut across a wide range of games. Its goal is not to classify games according o their characteristics and/or mechanics(Lundgren & Björk [7]) but to describe the design space of games. Another project seeking the same goals using a different methodological approach can be seen in Björk & Holopanionen[8].

Game information dynamic models (Iida et al[9.10]) make it possible to treat and identify game progress patterns and thus enhance their detailed discussion . In these models, information of game outcome is expressed as the analytical function of the game length or time, where information of game outcome is the data that are the certainty of game outcome. The two models are expressed, respectively, by

Model 1: $\xi=\eta^n$,

And

Model 2: $\xi= [\sin(\pi/2\cdot\eta)]^n$,

Where ξ is the non-dimensional information, η the non-dimensional game length or time, and n the positive real number parameter. The value of the parameter n depends on fairness of the game, strength of the two teams, and strength difference between the two teams.

It is realized that there are various game progress patterns in Base Ball(Iida et al [9]) ,Soccer(Iida et al [10]), Chess, Shogi and many others. In general, each the game proceeds with time in its characteristic manner. None the less, we sometimes encounter similar game progress patterns in each the game, so that it is quite useful to understand the nature of game if we can identify elemental game progress patterns, which are common in many games.

Main purpose of the present study is to confirm that game consists of the three elemental game patterns based on the actual Soccer games and existing game models, and clarify how emotion of players and observers varies with the elemental game progress patterns.

2. Elemental Game Progress Patterns

Three elemental game progress patterns, viz. “balanced game”, “seesaw game” and “one-sided game” have been heuristically found by the present authors during the investigation of information dynamics on Base Ball(Iida et al 2011a) and Soccer(Iida et al 2011b). It is realized that each of real games is a combination of the three elemental game progress patterns, though there are several supplementary game progress patterns such as “catchup game” and/or “against all odds game”: In “catchup game”, one team always breaks a tie in their favor, but it goes back to tied again, while in “against all odds game”, one team has a significant lead, but towards the end of the game, the other team recovers and wins. And also that their detailed discussions are essential for understanding emotion of players and observers during game. The elemental game progress patterns have been introduced by using three artificial Soccer games as listed in Table 1: Examples of the three artificial Soccer games, viz. “balanced game”, “seesaw game” and “one-sided game”, have been proposed so as to satisfy conditions, to be defined for each the game ideally.

Table 1. *Time history of goals for three artificial Soccer games between team A and team B.*

Game	Result	Goal time
balanced game	0 −0	
seesaw game	5 −4	10(A), 20(B), 30(B), 40(A), 50(A), 60(B), 70(B), 80(A), 90(A)
one-sided game	9 −0	10(A), 20(A), 30(A), 40(A), 50(A), 60(A), 70(A), 80(A), 90(A)

- In the column "Result", the left value is the goal sum for team A after the game, while the right value is the goal sum for team B.
- In the column "Goal time", characters A and B in the brackets denote team A and team B, respectively.

The non-dimensional information ξ_S in Soccer is here defined as follows: When the total goal(s) of the two teams at the end of game $G_T \neq 0$,

$\xi_S = | G_A(\eta) - G_B(\eta) | / G_T$ for $0 \leq \eta < 1$,

$= 1$ for $\eta=1$,

Where G_A (η) is the current goal sum for the team A(winner), and $G_B(\eta)$ is the current goal sum for the team B(loser). At $\eta=1$, ξ_S is assigned the value of 1, for at the end of game the information must reach the total information of game outcome. On the other hand, when $G_T=0$,

$\xi_S=0$ for $0 \leq \eta < 1$,

$=1$ for $\eta=1$.

Note that in a draw case ξ_S may also take the value of 0 other than 1 at$\eta=1$, depending on the game rules: In case of tournament match, $\xi_S=1$ at $\eta=1$, while in case of league match, $\xi_S=0$ at $\eta=1$.

The game length is defined as the current time (minutes), and it is normalized by the total time or the total game length to obtain the non-dimensional value η. The total game length of Soccer is normally 90 minutes, but in case of extended games it becomes 120 minutes.

Balanced game: Both of the teams have no goal through the game. Figure 1 shows the relation between the non-dimensional informationξ_S and non-dimensional game length η for the artificial balanced game. In this figure, the curve of Model 1 at n=50 is plotted for reference. In this case, we consider a "balanced game", in which winner and loser are determined by the penalty kick match after the game. Note that there exist anther "balanced game", in which$\xi_S=0$ at $\eta=1$ as being stated already. It may be worth noting that the artificial balanced game, as shown in Figure 1 is exactly the same as Japan vs. Paraguay, which is one of Round 16 in 2010 FIFA World Cup South Africa. This is because ξ_S jumps to 1 at the end, so it is accounted for by the curve of Model 1, having the large value of n=50.

Seesaw game: One team leads goal(s), then the other team leads goal(s), and this may be repeated alternately. It is, however, necessary that the current goal difference between the two teams must be smaller than the current safety lead, which is that once the goal difference exceeds to its value, the leading team will win the game with 100 % certainty. Note that the safety lead decreases with increasing the game length and depends on fairness of the game, strength of the two teams and strength difference between the two teams. This suggests immediately existence of the safety lead curve that once the game advantage goes above it, the advantageous team will win the game with 100 % certainty. Figure 2 shows the relation between the non-dimensional informationξ_S and non-dimensional game length η for the artificial seesaw game. In this figure, the curve of Model 1 at n=4 is plotted for reference and roughly accounts for the seesaw game.

One-sided game: The current goal sum of one team (winner) is always greater than that of the other team (loser), so that the goal difference between the two teams is kept to be positive. However, "one-sided game" is further divided into "complete one-sided game or state" and "incomplete one-sided game or state".: When the goal difference is smaller than the current safety lead, it is called "incomplete one-sided game or state". On the other hand, when the goal difference is greater than the current safety lead, it is called "complete one-sided game or state". However, when a game changes from incomplete one-sided state to complete one-sided state and finishes, it is simply called "one-sided game". Figure 3 shows the relation between the non-dimensional informationξ_S and non-dimensional game length η for the artificial one-sided game. In this figure, the curve of Model 1 at n=1 is plotted for reference and accounts for the one-sided game.

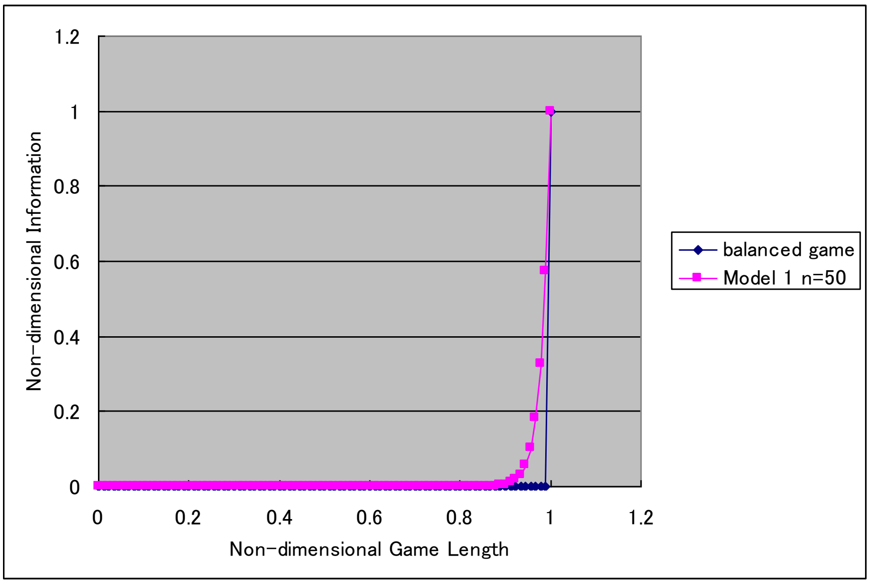

Figure 1. *Non-dimensional information ξ_S against non-dimensional game length η for the artificial balanced game.*

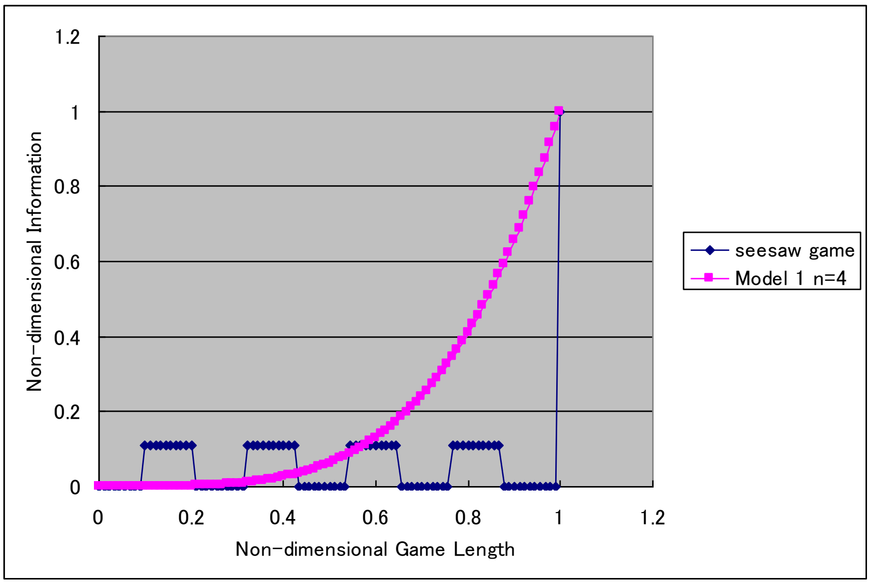

Figure 2. *Non-dimensional information ξ_S against non-dimensional game length η for the artificial seesaw game.*

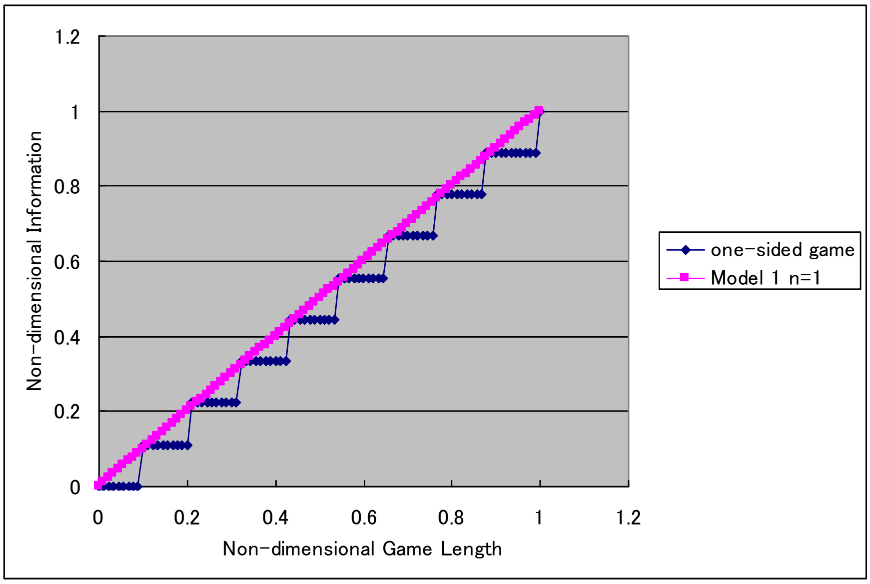

Figure 3. *Non-dimensional information ξ_S against non-dimensional game length η for the artificial one-sided game.*

The non-dimensional advantage α is here defined as follows: When the total goal(s) of the two teams at the end of game $G_T \neq 0$,

$\alpha = [G_A(\eta) - G_B(\eta)] / G_T$ for $0 \le \eta \le 1$.

On the other hand, when $G_T=0$,

$\alpha=0$ for $0 \le \eta \le 1$.

This means that when $\alpha > 0$, team A (winner) gets the advantage against team B(loser) in the game, while when $\alpha < 0$, team B (loser) gets the advantage against team A(winner). It is certain that when $\alpha=0$ the game is balanced.

Figure 4 shows the relation between non-dimensional advantages α between non-dimensional game length η for the artificial seesaw game. It is evident that in case of the seesaw game α changes from positive value to negative value alternately with increasing η. In case of the balanced game as shown in Figure 1, α takes the value of zero through the game, while in case of the one-sided game, as shown in Figure 3, non-dimensional advantage α coincides with non-dimensional information ξ_S , and takes the value , which is greater than or equal to zero through all of η.

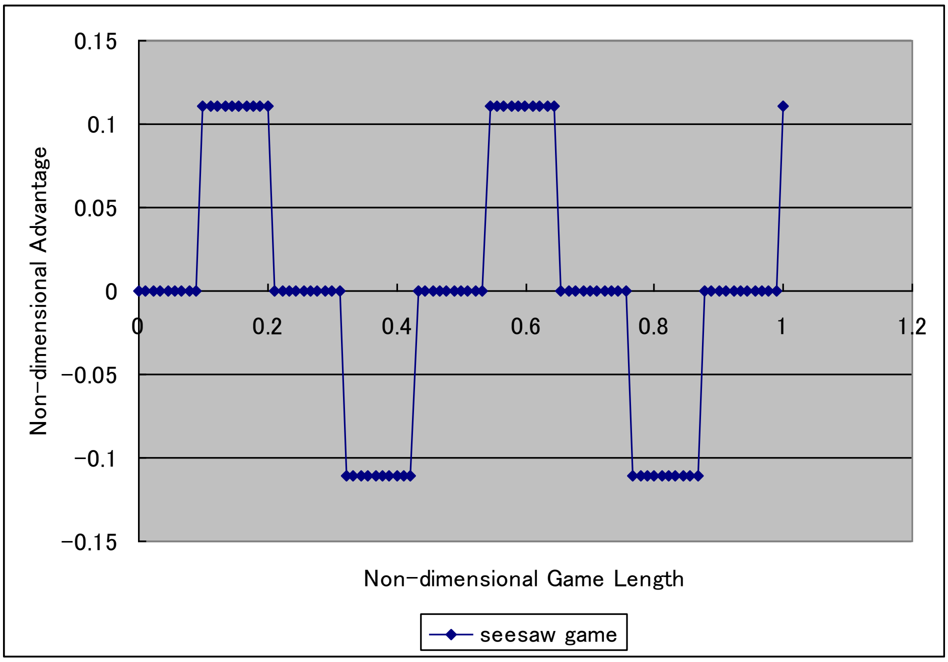

Figure 4. *Non-dimensional advantages α against non-dimensional game length η for the artificial seesaw game.*

3. Information and Advantage in three Soccer Games in 2010 FIFA World

In this section, some results of the data analyses on the three Soccer games in 2010 FIFA World Cup, Group E will be presented at first and then the game progress patterns will be discussed with reference to information dynamic models, Model 1 and Model 2. Some of the relevant information on the three Soccer games in 2010 FIFA World Cup are summarized in Table 2.

Table 2. *Three Soccer games in 2010 FIFA World Cup, Group E*

Game	Result	Goal time (min)	Total game length (min)	Date	Place
E1	Holland 2-0 Denmark	45(Holland) 85(Holland)	90	June 14	Yohannesburg

E2	Denmark 2-1 Cameroon	10(Cameroon) 33(Denmark) 61(Denmark)	90	June 19	Pretoria
E3	Holland 2-1 Cameroon	36(Holland) 65(Cameroon) 85(Holland)	90	June 24	Cape Town

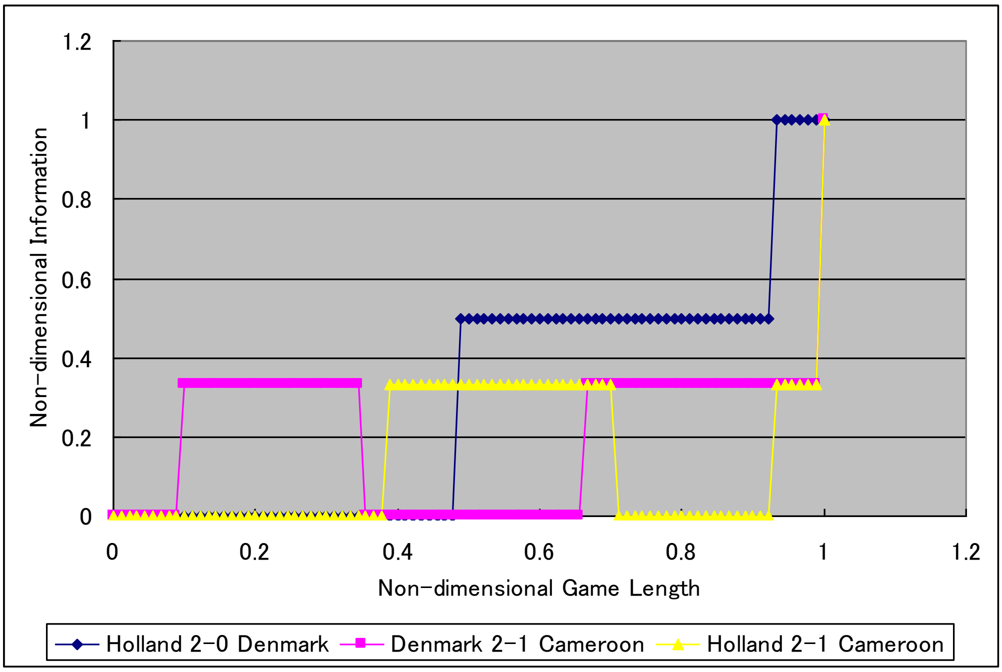

Figure 5. *Non-dimensional information ξ_S against non-dimensional game length η for three Soccer games.*

Figure 5 shows the relation between the non-dimensional information ξ_S and non-dimensional game length η for three Soccer games in 2010 FIFA World Cup, Group E. This figure clearly indicates that non-dimensional information ξ_S for these three games varies with the non-dimensional game length η in different manner each other. However, Denmark vs. Cameroon and Holland vs. Cameroon have a common character that the information increases rapidly near the end. It is realized that these games are accounted for by Model 1. This has been also suggested by Iida et al [11]. On the other hand, Holland vs. Denmark has a distinctive feature that the information gradually approaches to the total value of game outcome. It is realized that this game can be accounted for by Model 2.

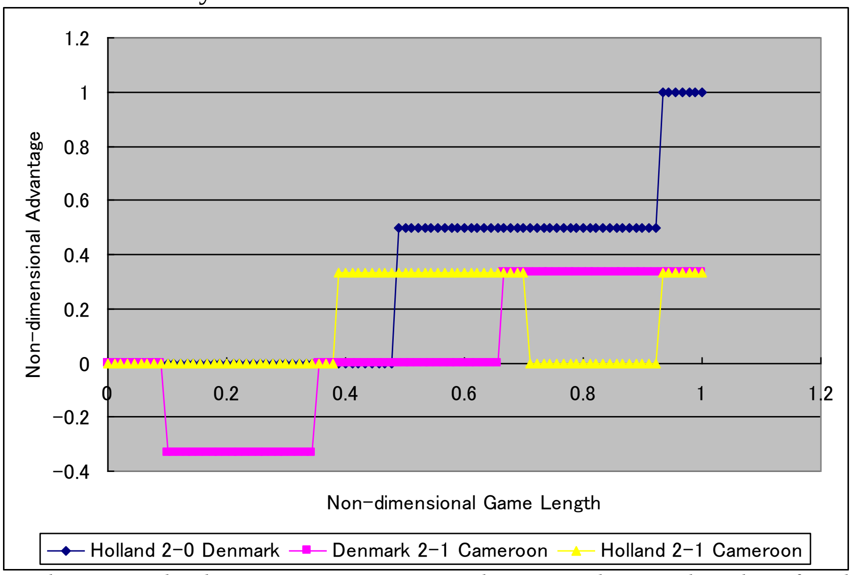

Figure 6. *Non-dimensional advantage α against non-dimensional game length η for the three Soccer games.*

Figure 6 depicts the relation between non-dimensional advantage α and non-dimensional game length η for the three Soccer games in 2010 FIFA World Cup, Group E. This figure, therefore, illustrates how the non-dimensional advantage α of each the game changes with the non-dimensional game length η: In case of Holland vs. Denmark, it is balanced until $\eta \simeq 0.49$, but then the advantage αincreases and takes the value of 0.5 at $\eta \simeq 0.49$ and then becomes the value of 1 at $\eta \simeq 0.93$, keeping this value until $\eta=1$. In case of Denmark vs. Cameroon, it is balanced until $\eta \simeq 0.10$, but Cameroon gets the first goal and thus keeps the advantage from$\eta \simeq 0.10$ to 0.36. However, the game becomes the second balanced state from $\eta \simeq 0.36$ due to Denmark's goal and this is kept until $\eta \simeq 0.67$, but Denmark gets her second goal at $\eta \simeq 0.67$ and keeps her advantage and the game finishes at $\eta=1$. In case of Holland vs. Cameroon, it is balanced until $\eta \simeq 0.39$, but the balance breaks at $\eta \simeq 0.39$ due to Holland's first goal and then Holland keeps the advantage until $\eta \simeq 0.71$. However, due to Cameroon's goal $\eta \simeq 0.71$ the game becomes the second balanced state and this continues until $\eta \simeq 0.93$ at which Holland gets her second goal, and maintains the advantage until the end.

Figures 5 and 6 show that in Holland vs. Denmark, the game changes smoothly from "incomplete one-sided state" to "complete one-sided state" with increasing η and finishes, though it is balanced from $\eta=0$ to 0.49. Thus, we may state that this game is a combination of "one-sided game" and "balanced game". Denmark vs. Cameroon is a "seesaw game", though it is balanced during two intervals, viz. one is from $\eta=0$ to $\simeq 0.10$ and the other is from $\eta \simeq 0.36$ to $\simeq 0.67$. Thus, we may state that this game is a combination of "seesaw game" and "balanced game". Holland vs. Cameroon is balanced during two intervals, viz. one is from $\eta \simeq 0$ to $\simeq 0.39$ and the other is from $\eta \simeq 0.71$ to $\simeq 0.93$. However, the goal difference between Holland(winner) and Cameroon(loser) during two intervals, viz. from $\eta \simeq 0.39$ to $\simeq 0.71$ and from $\eta \simeq 0.93$ to 1, is kept to be positive, but is only one. Thus, this game is considered as a combination of "incomplete one-sided game"and "balanced game".

4. CHESS DATA ANALYSES

In this section, it is inquired whether Chess can be expressed by a combination of the three elemental game progress patterns or not.

A Chess match was played between, GreKo6.5 (White) and Boook4.15.1 (Black), both of which are computer Chess Engines. In this game, Black mates White at the 25th move. Chess evaluators count and sum up the relevant materials in principle (o David-Tabibi et al [12]). A total of 25 evaluation function scores are collected from the computer Chess engine, GreKo6.5. one for each of White's moves in that game. When the computer Chess engines make a decision that the game is over, they may provide an extremely high value of evaluation function score. In such a case, as the evaluation function score at the move, the maximum value within all of the previous moves is substituted for it. This modified evaluation function score is used as current advantage in our analysis. When the first engine (White) takes an advantage over the second engine (Black), the sign of the current advantage is positive, while in the reverse case it is negative. When both engines are even the current advantage becomes zero.

The non-dimensional information ξ_c in Chess is defined as follows:

$$\xi_c = \begin{cases} |Ad(\eta)|/ACT(1) & \text{for } 0 \le \eta < 1, \\ 1 & \text{for } \eta = 1, \end{cases}$$

where $Ad(\eta)$ is the current advantage as described above. ACT (1) is the total advantage change at the end of the match, such that

$$ACT(\eta) = ACT(m/N) = \sum_{1 \le i \le m} |Ad(i) - Ad(i-1)|,$$

where m is the current move count, N the total move count, and i a positive integer. η is the non-dimensional game length, in which the current move count m is normalized by the total move count N.

The non-dimensional advantage α_c in Chess is defined as follows

$\alpha_c = Ad(\eta)/ACT(1)$ for $0 \le \eta \le 1$,

Figure 7 shows the relation between the non-dimensional information ξ_c and the non-dimensional game length η for the described Chess match. Figure 8 shows the relation between the non-dimensional advantageα_c and the non-dimensional game length η for the same match. Figures 7 and 8 indicate that from η=0 to $\simeq$0.547, the match is "balanced", from $\eta\simeq$0.547 to $\simeq$0.767, it is "seesaw", and from $\eta\simeq$0.779 to =1, it is "one-sided". Hence, it is considered that the present Chess match is a combination of "balanced", "seesaw" and "one-sided".

Regarding entertainment, in this Chess match the neutral observer(s) feel three different emotions, "frustrated", "excited" and "bored" during the balanced state, seesaw state and onbe-sided state, respectively, as to be discussed in the next section.

It is considered that the present results of the Chess match are supporting evidence to the statement that each game is a combination of the three elemental game progress patterns. It may be evident that this statement is applicable to many other games, such as Base Ball, Go, Shogi, or Basket Ball.

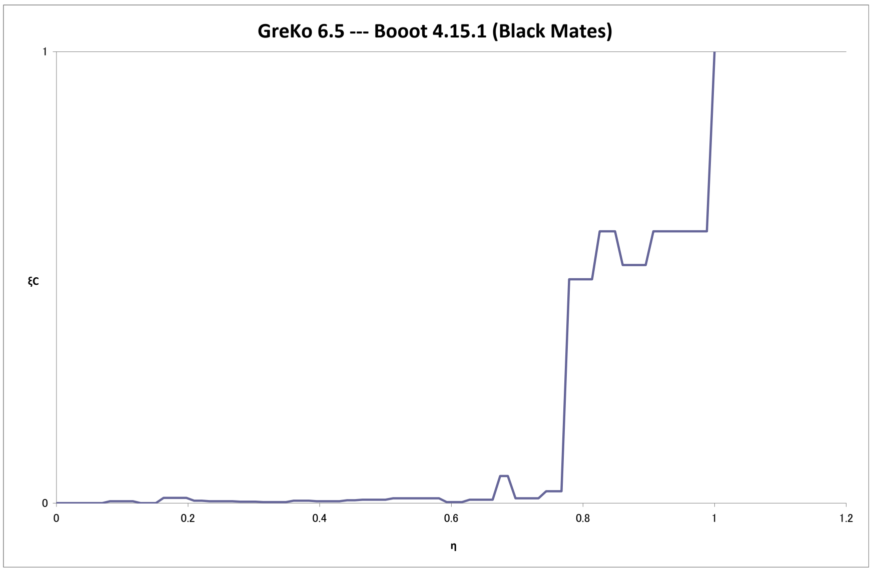

Figure 7. *Non-dimensional information ξ_c against non-dimensional game length η for Chess.*

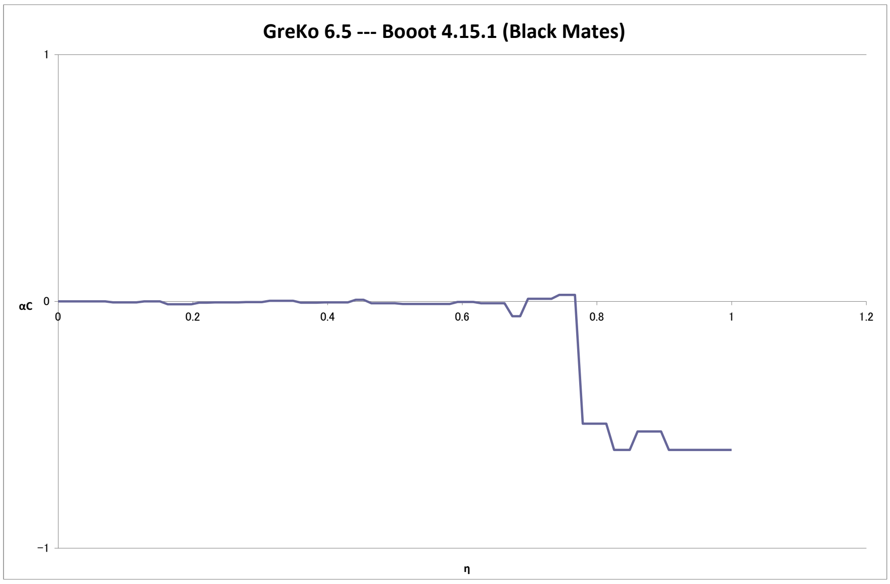

Figure 8. *Non-dimensional information α_c against non-dimensional game length η for Chess.*

5. DISCUSSION

This section discusses the entertainment in game through a comparison between Model 1(or Model 2) and data on three Soccer games in 2010 FIFA World Cup, Group E. Before the discussion, it must be noted that winner(s), loser(s) and neutral observer(s) have different emotion during the game from each other, where winner(s) is winning player(s) and winner-sided observer(s) and loser (s) is losing player(s) and loser-sided observer(s). The present discussion on entertainment in game only inquires how neutral observer(s) feels emotion during the game as the first step to understand it. For neutral observer(s), "balanced game" is frustrating, for both of the teams have no goal through the game even though the game may proceed experiencing alternate changes from offense to defense by the two teams many times. "One-sided game" is boring, for only one team scores goal(s) and the winning goal appears too early., and "seesaw game" is exciting, for both of the teams score goal(s) and advantage changes its sign during the game. However, it is important to note how one feels emotion during game essentially belongs to a private affair. The present discussion is therefore based on the authors' subjective views of this problem, and a more general discussion is beyond the scope of the present study.

Figure 9 shows the relation between the non-dimensional information ξ and the non-dimensional game length η. In this figure, the non-dimensional information for Holland vs. Denmark has been plotted and is compared with three curves for Model 2. It may be clear that although the non-dimensional information for this game proceeds in zigzag line, the non-dimensional information for Holland vs. Denmark roughly follows the model curve at n=4. As being already stated, Holland vs. Denmark is a combination of "one-sided game" and "balanced game", in which Holland gets two consecutive goals, but Denmark gets no goal. While Holland leads only one goal, the game is still a pending state or "incomplete one-sided game or state", for if Denmark gets one goal, the game reverts to a balanced state. One the other hand, once Holland leads two goals near the end, the game becomes "complete one-sided state", for the goal difference is considered to be the current safety lead. This means that this game becomes less exciting or more boring with increasing the game length for neutral observer(s).

Figure 10 shows the relation between the non-dimensional information ξ and the non-dimensional game length η. In this figure, non-dimensional information for Denmark vs. Cameroon and Holland vs. Cameroon, respectively, has been plotted and is compared with three curves for Model 1. It is evident that none of the information for these games fits to any model curve through the total non-dimensional

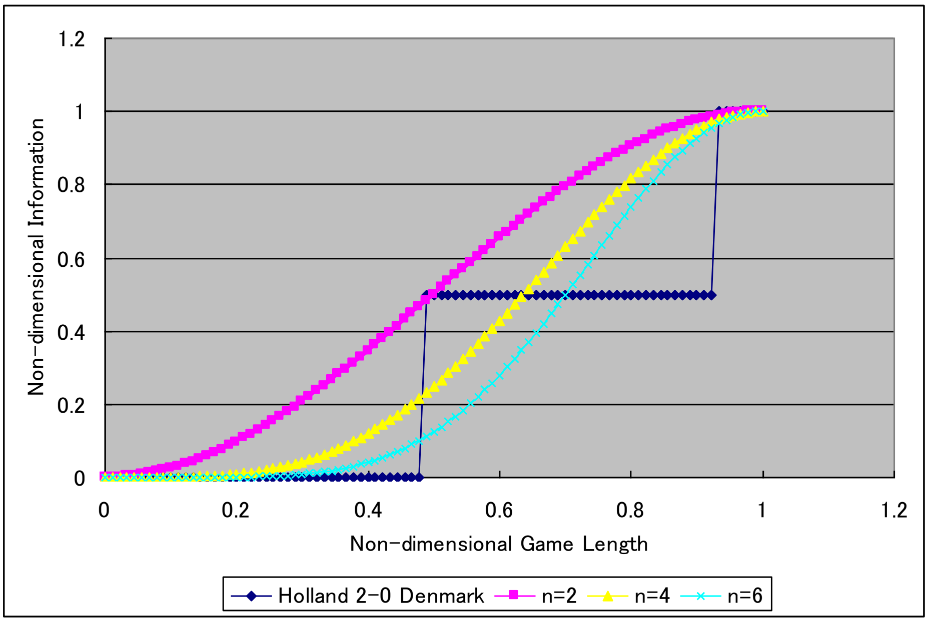

Figure 9. *Non-dimensional information ξ against non-dimensional game length η: A comparison between Holland vs. Denmark and Model 2.*

game length, but near the end the information for these games increases very rapidly with increasing η. This figure shows that Holland vs. Cameroon roughly follows the curve of Model 1 at n=50 near the end, while Denmark vs. Cameroon roughly follows the curve of Model 1 at n=10 near the end. As being already stated, Denmark vs. Cameroon is a combination of "seesaw game" and "balanced game", in which Cameroon gets the first goal, but Cameroon is reversed by Denmark, and then Denmark gets her winning goal. This game is tough for the both players, for the goal difference between the two teams is within 1 through the game. One the other hand, Holland vs. Cameroon is a combination of "incomplete one-sided game" and balanced game", in which Holland gets the first goal, but Holland is reversed by Cameroon, and then Holland gets her winning goal. The goal difference between the two teams is within 1 through the game, so that this game is also tough for the both players as Denmark vs. Cameroon.

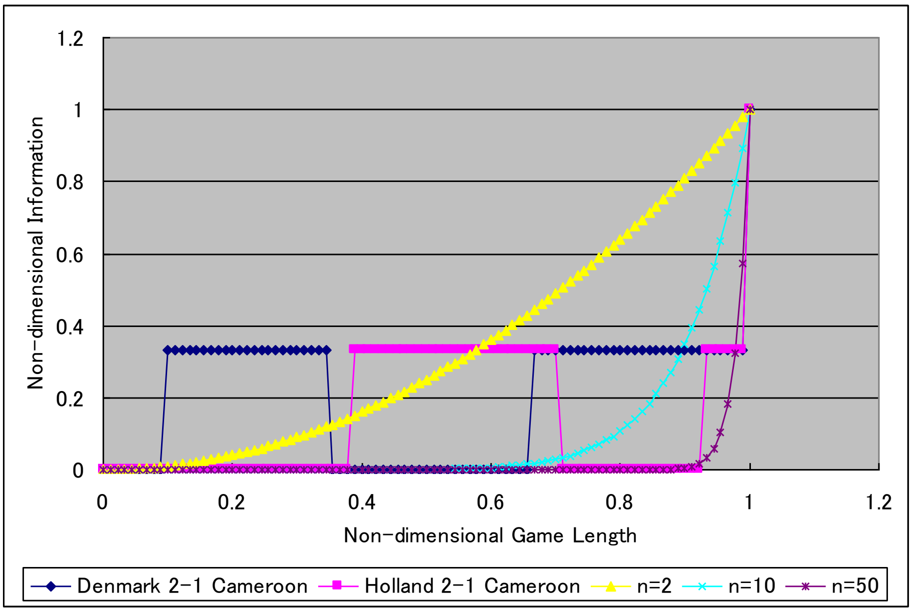

Figure 10. *Non-dimensional information ξ against non-dimensional game length η: A comparison between Denmark vs. Cameroon or Holland vs. Cameroon and Model 1.*

The main differences between Denmark vs. Cameroon and Holland vs. Cameroon are twofold: Firstly, in Denmark vs. Cameroon, Cameroon (loser) gets the first goal, and then Denmark (winner) gets the second and winning goals. Whereas in Holland vs. Cameroon, Holland (winner) gets the first goal, then Cameroon(loser) gets the second goal. Finally, Holland (winner) gets the winning goal. The advantage changes its sign in Denmark vs. Cameroon, but it does not change in Holland vs. Cameroon. This means that in Denmark vs. Cameroon, Cameroon (loser) takes an advantage during one interval of the game, but in Holland vs. Cameroon, Cameroon (loser) has no advantage through the game. Secondly, the winning goal time in Holland vs. Cameroon is later than that in Denmark vs. Cameroon.

Thus, it may be evident that difference in excitement between Denmark vs. Cameroon and Holland vs. Cameroon is quite small for neutral observers. However, Holland vs. Cameroon is more exciting than Denmark vs. Cameroon for neutral observers at least near the end of game. It must be noted that in case of "balanced game" the winning goal time corresponds to the end of game (see Figure 1), so that "balanced game" may be more exciting than Holland vs. Cameroon and Denmark vs. Cameroon for neutral observers, but they must be rather frustrating, for both of the teams have no goal through the game.

The above results indicate that the greater the value of n in either Model 1 or Model 2 is, the more the game is exciting for neutral observer(s), and vice versa (see Figures 7 and 8). However, when the value of n in either Model 1 or Model 2 is too large, the game becomes frustrating for neutral observer(s). This is because the balanced state is prolonged for almost entire game length.

6. Conclusion

The new knowledge and insights obtained through the present investigation are summarized as follows.

Three elemental game progress patterns have been heuristically identified by observing the real games, e.g. Base Ball, Soccer, Chess, Go and Shogi, and have been defined. It is found that each of the real games is essentially a combination of the three elemental game progress patterns, viz. “balanced game”, “seesaw game” or “one-sided game”, though there are several supplementary game progress patterns such as “catchup game” and/or “against all adds game”.. This has been confirmed by the three Soccer games in 2010 FIFA World Cup, Group E : Holland vs. Denmark is a combination of “one-sided game” and “balanced game”, Denmark vs. Cameroon is a combination of “seesaw game” and “balanced game” and Holland vs. Cameroon is a combination of “ incomplete one-sided game” and “balanced game”. It is suggested that this finding is universal, and thus it is applicable to Base Ball, Chess, Go, Shogi, Boxing, Rugby, Hand Ball, Basket Ball and many others.

Time history of information of game outcome, which is obtained by the data analyses for the three artificial Soccer games, as well as the three Soccer games in 2010 FIFA World Cup, Group E, shows that for players including winner-sided observers and loser-sided observers, “balanced game” is most exciting, “one-sided game” is least exciting, and “seesaw game” is intermediate exciting. It is suggested that for neutral observers “balanced game” is frustrating, “one-sided game” is boring, and “seesaw game” is exciting. This insight is quite useful for game design, for one can design games in such a way that they are apt to become “seesaw game”, for example.

The information dynamic model $\xi=\eta^n$, where ξ is the non-dimensional information, η the non-dimensional game length, and n the real number positive parameter, has been used to assess the degree of excitement of games: It is realized that in this model the “balanced game” takes the maximum value of n, the “one-sided game” takes the minimum value of n. The “seesaw game” takes the intermediate value of n. A comparison between the information obtained by the information dynamic model and that of the real game provides us the degree of excitement in the game: The greater the value of n is, the more the game is exciting for players, and vice versa In another words, the later the winning goal is, the more the game is exciting for players, and vice versa.

This work has clearly illustrated how to analize games interms of scoring outcomes (section 2) together with in terms of evaluation function scores(section 4) or winning rate. The formaer examples are Soccer, Base Ball, Rugby, Hockey, Basketball, Volleyball, Boxing, Judo, Kendo, Karate and so forth, while the latter examples are Chess, Go, Shogi, Othello, Tic-Tac-Toe, Hex and many others.

REFERENCES

[1] S. Kelle, D. Börner, M. Kalz, and M. Specht. Ambient displays and game design patterns. In WC-TEL710 Proc. of the 5th European Conference on Technology Enhanced Learning Conference on Sustaining TEL from innovation to learning and practice, 512-517, Springer-Verlag, Berlin, Heidelberg 2010.

[2] C.A. Lindley, and C.C. Sennersten. Game play schemes: from player analysis to adaptive game mechanics. International Journal of Computer Games Technology, 7 pages, Article ID216784, 2008

[3] C.A. Lindley, and C.C. Sennersten. A cognitive framework for the analysis of game play: tasks, schemas and attention theory. In Proc. of the 28th Annual Conference of the Cognitive Science Society, 13 pages, 26-29 July, Vancouver, Canada 2006.

[4] K. Salen, E. Zimmerman. Rules of Play: Game Design Fundamentals. MIT Press, Cambridge, MA, 2003.

[5] T. Fullerton, C. Swain, S. Hoffman. Game Design Workshop: Designing, Prototyping, and Play-testing Games. CMP Books, San Francisco, New York & Lawrence, 2004.

[6] Zagal, M.Mateas, C. Fernandez-Vara, B. Hochhalter, N. Lichi. Towards an ontological language for game analysis. In: S. de Castell & J.Jenson(eds.), Changing views: Worlds in play: Selected papers of DIGRA 2005(pp.3-14), Vancouver, British Columbia, Canada: Digital Games Research Association. 2005

[7] S. Lundgren, S. Björk. Describing computer-augmented games in terms of interaction. Paper presented at Technologies for Interactive Digital Storytelling and Entertainment, Darmstadt, Germany, 2003.

[8] S. Björk, J. Holopanien. Patterns in game design. Hingham, MA, Charles River Media, 2005.
[9] H. Iida, T. Nakagawa, and K. Spoerer. A novel game information dynamic model based on fluid mechanics: case study using base ball data in World Series 2010. In Proc. of the 2nd International Multi-Conference on Complexity Informatics and Cybernetics, pages 134-139, 2011a.
[10] H. Iida, T. Nakagawa, and K. Spoerer. On game information dynamics with reference to soccer. In 10th International Conference on Entertainment Computing ICEC 2011, 2011b(submitted for publication).
[11] H. Iida, K.Takehara, J.Nagashima, Y.Kajihara, and T. Hashimoto. An application of game refinement theory to moh-jong. In International Conference on Entertainment Computing, pages 333-338, 2004.
[12] Davod-Tabibi, O., Koppe, M., Netanyahu, N.: Genetic algorithms for mentor-assisted evaluation function optimization. In:GECCO2008(2008)

AUTHORS' BIOGRAPHY

Takeo R.M.Nakagawa

Born 1945 in Mikawa, Japan as a descendant of the Tokugawa family. 1965~1969.National Defense Academy. 1969 B. Sc. (Aeronautical Engineering). 1977~1979, Monash University, Post-Graduate School. 1981 Ph. D(Fluid Mechanics). Fellow, Academy of Mechanics Japan. President of Royal Society of Hakusan. Currently Director, Pan-Asian Center for the Independent Liberal Study of Science Technology and the Humanities, Jusup Balasagyn Kyrgyz National University. Major research fields: Applied Mathematics, Mechanics, Natural Philosophy, History.

Dr. Hiroyuki Iida is Full Professor of the School of Information Science and Director of Research Unit for Entertainment and Intelligence, JAIST. He has served as the Secretary/Treasurer of International Computer Games Association, while acting as important roles of international activities such as conference chair and journal editor.