仮想空間のプロジェクトマネジメントへの応用
Using Virtual World for Project Management

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Abstract: Managing large scale IT projects is getting harder because there are so many components, people involved, and technologies despite increasing demands for shorter delivery date. This paper describes how to simulate project management using virtual world and proposes a system which helps project managers understand project risks. Traditional ways for managing project are to use Gantt Chart and project tools like MS-Project and many managers depend only on their experiences for decision making. Managing projects using these tools has limitations as systems become more complex. We propose a new approach to solve problems when handling complex system management.

Keywords: System Dynamics, Virtual World, Project Management

1. Introduction

It is said that the average success rate of constructing enterprise information systems is 31 percent [1]. In other words, almost 70 percent of IT projects fail in terms of quality levels, cost overruns, and delays. Since large scale information systems consist of many subsystems and their inner states change dynamically, it is hard for a manager to comprehend whole of the system with traditional tools such as Gantt chart, MS-Project and Trac.

This paper describes how to assist project managers by using project simulator which detects risks of delays in development schedule. In this method, system dynamics models are used for simulating project and the cyberspace is used for sharing the computational result.

2. System Dynamics for Project Management

2.1 System Dynamics Overview

System dynamics originated by Jay Forrester[2] in 1956 and it has been applied to variety of fields like business modeling, economic activities and social systems.
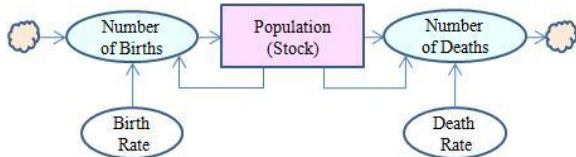

Figure 1 system dynamics model

Figure1 shows a simple example of the system dynamics modelling. Using this model, you can simulate how the population changes when shifting variables such as birth rate and death rate. System dynamics can be used in project management. Sterman [3] created a model for project management and shows how each management element impacts on production efficiencies and product qualities. Jeng and An [4] applied system dynamics to managing large scale SOA (Service-Oriented Architecture) IT projects. SOA, which is buzz term in the IT industry, means creating new services from existing IT assets using common protocol. They uncovered relationship among schedule pressure, time

to implement, and project member's fatigue. Shimoda, Mizuno, and Kikuno [5] used system dynamics for managing software development processes and they simulated how the number of bugs increases when other parameters like the number of communication paths, project scales, and review processes are changing.

These researches focus only on modeling techniques and simulations. This paper proposes a management system which assembles project data and finds potential risks for project managers using system dynamics and virtual world.

2.2 Running System Dynamics

We developed a Java library for system dynamics simulation. The model shown in Figure1 can be implemented in java(Figure2).

```java
Stock population = new StockImpl("Population", 10000);
Flow numberOfBirths = new FlowImpl("Number of Births");
Expression numberOfBirthExp = new ExpressionImpl("Birth Rate*Population",
new ConverterImpl("Birth Rate", 0.1), population,Operator.MULTIPLY);
numberOfBirths.setExpression(numberOfBirthExp);
numberOfBirths.flowTo(population);

Flow numberOfDeaths = new FlowImpl("Number of Deaths");
Expression numberOfDeathsExp = new ExpressionImpl("Death ate*Population",
new ConverterImpl("Death Rate", 0.2), population,Operator.MULTIPLY);
numberOfDeaths.setExpression(numberOfDeathsExp);
numberOfDeaths.flowFrom(population);
```

Figure2 Java codes for system dynamics simulation

3. Virtual World for Project Management

Figure3 Wonderland

In this study, virtual world is used to visualize simulation results. Although Second Life (and its clone product OpenSim) is the de-facto standard, we chose Sun Microsystems Wonderland(Figure3) because it is designed to create virtual office for real business use. For example, business applications such as OpenOffice, Firefox, NetBeans can run on Wonderland and several functions for business communications like conference call are equipped. These functions are beneficial as a project management platform.

3.1 System Overview

To realize project management simulation, we took the following approaches.

Visualizing Project

Project management tools have always been visualizing data by charts and tables and the information is usually entered by project members manually.

Our system displays project data as text information in the virtual world (Figure4). An avatar, which corresponds to a project member, has an information window and the member's information about the projects is displayed on it.

Figure4 showing data in virtual world

Simulating Project

Progress reports and concerns reports are usually made by project members by hand. Those kinds of reports tend to be subjective and members may fail to make these reports through inattention. To be objective, automatic risk detection systems are needed.

Traditional ways of using system dynamics for project management are to create human mental models and development process models in order to find root cause of problems. In other words, traditional ways are to find universal laws of project management.

Our system aims at detecting risks and sending warning information to project managers by obtaining project data in diverse ways.

3.2 System Architecture

The system consists of the following components (Figure5)

Project Activity Data

The simulator obtains project documents from Google Docs. Project documents include:
・ Work progress reports
    Each member writes down daily work concerning task names and the time required.
・ Software specification
    Each member creates software specifications using UML. In this paper, Usecase diagram and Activity diagram are used as a specification format.

Location Data

PlaceEngine[6] is used to obtain where the project members are. PlaceEngine determines locations by using wireless LAN access points and it is more accurate indoors compared to GPS. The positioning data (latitude, longitude, floor number) is sent to the server and it is converted to avatar position in the virtual world.

Information Server

All the data concerning projects is sent to information server. Information server has functions below:
・ Analyze Google Docs data
・ Convert real location data to virtual world position and send it to Wonderland server
・ Simulate projects using system dynamics model to find risks and send it to Wonderland server

Virtual World (Wonderland server)

Wonderland server receives data from information server and displays them.

3.3 Transmitting Data

The system is client-server system. The data flow is as follows:
- Client application obtains location data and Google Docs data.
- Client sends the data to the server using HTTP call.
- Servlet receives data and starts simulation.
- Servlet send the result to Wonderland server using Wonderland protocol. We expanded the original protocol to send our additional data.
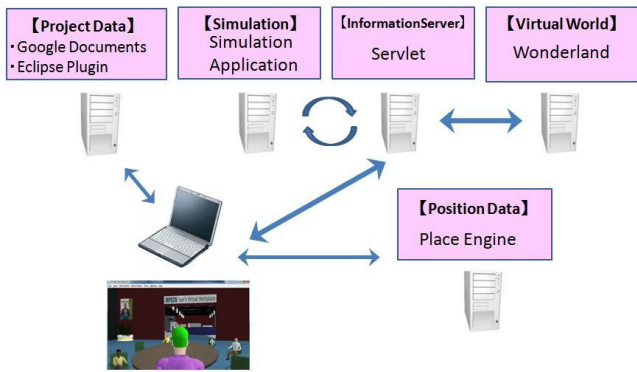- Wonderland server broadcasts information to client PCs.

Figure5 system architecture

3.4 Project Activities

The system needs to identify what the each project member is doing now. The activities are categorised into six groups.

(1) Create documents
Project documents include presentation materials, conference materials and specifications such as UML (Unified Model Language). All the documents are created by Google Docs.

(2) Code program source
To obtain coding activity, we use Eclipse which is widely used among programmers.

(3) Conference
If a project member is in conference room, the system assumes that he or she is participating in a conference.

(4) Customer service
If a project member is in customer's building, the system assumes that he or she is engaging in customer service.

(5) Other activity
If a member is at his or her desk and doing something, the system assumes he or she is doing project related activities.

(6) Outside of work
If the activity cannot be categorized, the system assumes the member is outside of work.

4. Elements of IT Projects

In order to create a simulation model using system dynamics, we defined project management elements. Large scale IT projects consist of so many subsystems and elements and all of them should be integrated into system dynamics model. We divided them to physical elements and non-physical elements.

4.1 Physical elements
Physical elements includes at least:
(1) Project members
Project member is one of the most important element. In our system, each member corresponds

to each avatar in the virtual world (which will be discussed later).

(2) Computers
Project managers have to obtain proper computers for software development and for production environment. System architects have to design the machine layout.

(3) Middleware
Operating system and middleware like application server are indispensable. If there are no developers who know them well, the project may fail.

(4) Business Applications
Software architects have to decide what kind of data must be processed on the client side. If client computers frequently access server data, the whole performance would get worse. When developing server-side software, each programmer must confirm whether the code is thread-safe.

(5) Database management system
Architects must decide database architecture. To configure replication is effective for reducing risks.

(6) Networks
If the bandwidth of the network were narrow, the software's performance would get worse.

(7) Data center
Project manager have to consider what is best for running server machines.

(8) Specification
Vague specifications cause a lot of problems. When creating specs, managers have to take attention to do's and don'ts.

4.2 Non-Physical elements
Non-Physical elements includes at least:
(1) Schedule
Schedule is usually defined in the early stage of projects and other element like project members and project scope are consequently defined.

(2) Task
A project is broken down to many tasks. A risk is defined as a factor of not being able to complete tasks in time.

(3) Time
Time includes due dates, development time and operation time.

(4) Money
Money includes investment money, development cost, profits and deficits.

(5) Geographical location
Location means where project members are.

(6) Complexity

Complexity is the system's complexity.

(7) Quality

Quality means the number of bugs and its seriousness.

(8) Efficiency

It is defined as numbers of tasks per unit of time.

(9) Fatigue

Fatigue is each member's fatigue. It is accumulated due to long working hours and leads to productivity reduction.

(10) Pressure

If the necessary skill level, the amount of task, due date are higher than the member's ability, pressures put on them increase.

5. Simulation Model

We use number of small simulation models instead of one large model. For example, we created a model which simulates IT project in M&A activities(Figure6).
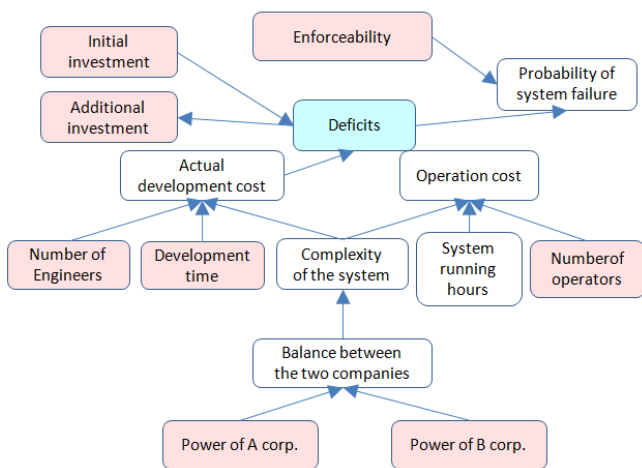

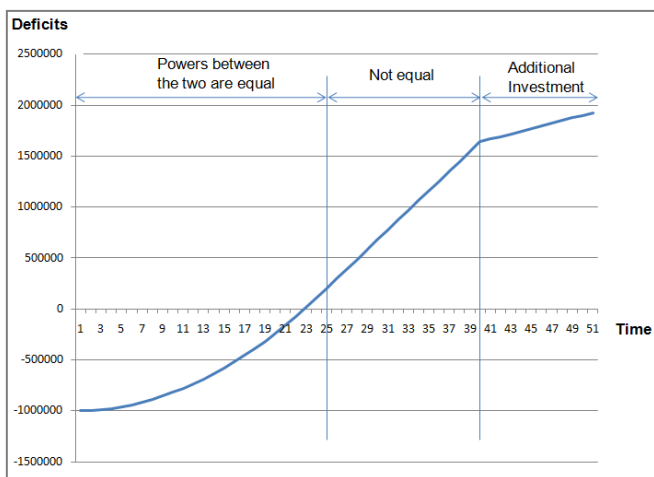Figure6 simulation model for project management

Figure7 simulation result

The simulation result(Figure7) shows that the amount of deficits rapidly increases if the powers between the two companies are equal. There are two ways to get deficits down. One is to increase the power of 'A corp.'(or B corp.). Another way is to make additional investments.
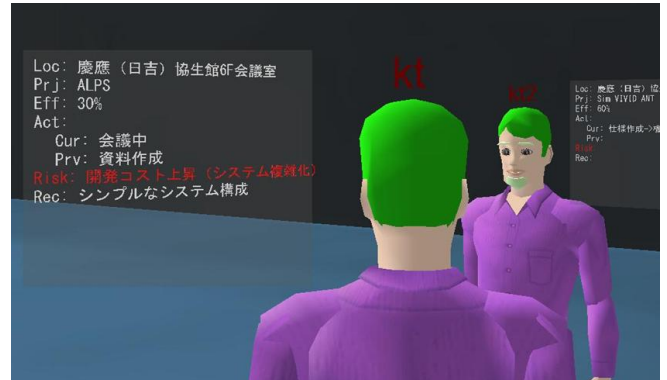

Figure8 visualizing in virtual world

After the system simulates the project, it informs the risk through virtual world(Figure8). In this case, the system warns about the danger of cost overrun due to the complexity of the architecture.

6. Conclusion

Large scale IT projects consists of many components and it is hard for project managers to know all the details. Tools currently used are not enough to control large scale projects and automatic risk detection system can be used to help project managers. As a real-time detection environment, virtual world can be effectual compared to traditional ways of visualization such as charts and tables because people will work and communicate in cyberspace in the near future.

We developed a platform of the system which obtains and simulates project data and visualizes the result in the virtual world. We will evaluate the system's practicability in the future work.

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