

# Visualization of Worker Activity in Construction Site

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## ABSTRACT

In this study, we examined methods to visualize the position data and action data of workers in a construction site into XYZ values and color value in CAD software. We proposed methods to make site manager understand work flow in site and to consider next plan. From comparison of multiple visualization method, we concluded a method, perspective views from directly above of the result of inputting XYZ position coordinates data into XYZ coordinate values and inputting time data into color value as each worker comparison, can be effectively grasped work flow in construction site.

**Keywords:** Time series, Position, Work analysis.

**Index Terms:** •Human-centered computing ~Visualization ~Visualization application domains ~Information visualization •Human-centered computing ~Visualization ~Visualization application domains ~Visual analytics

## 1 INTRODUCTION

Construction site is a work space in which workers who identified under contract sequentially update from vacant spaces to building rooms. In construction management in Japan, site manager who belong to general contractor company is assigned to the construction site to manage the progress of construction. Site manager needs to grasp whether the daily progress is as planned and updates the schedule appropriately. In the case of typical Japanese construction sites, site manager save the construction time by subdividing the work space so that multiple contractors can perform theirs work on the same day. In order to appropriately update the schedule, it is necessary to understand the daily work flow (e.g. the team-A of workers finished first the north side walls and then the east side one). In this study, we proposed visualization methods to make the manager in construction site understand work flow using the data of the workers' position and the data of the workers' action category.

## 2 METHOD

In this study, firstly we selected on-site data capturing method, and then examined data visualization methods using the captured data in a construction site our company managed.

### 2.1 Data Capturing

In data capturing, site manager wants to reduce the number of devices to reduce management effort. Therefore, in this study, we adopted a method of measuring a wide area using a camera. The construction site for data capturing was selected by size for the entire floor could be photographed with a single camera. The floor under construction on the measurement day was photographed by

a camera installed on a tower crane's rotating stage. The data of positions and action category were manually created from every minute's images. The action categories were given as nine basic actions (Fix, Remove, Shape, Move, Transport, Prepare, Talk, Wait, Rest) which were defined by us.

### 2.2 Data Visualization

CAD software that can handle 3D objects is one of the software that site manager are familiar with. In this study, we decided to visualize the data into CAD software since intended to ensure the convenience of site manager who make decisions based on the visualization results.

The acquired seven data (x, y, z, time, who, team, action) need to be reduced to four data (XYZ coordinate values and color value) that can be easily recognized on CAD software. In this study, we tried two types of input to the XYZ coordinate values: (X, Y, Z) and (X, Y, Time). In addition, we tried three types of input to color value: Time-color, Who-color, and Action-color.

## 3 RESULT

As a result of the data capturing, as shown in Figure.1, data was created as a list of text: time, who, team, action, position coordinates, and direction coordinates.

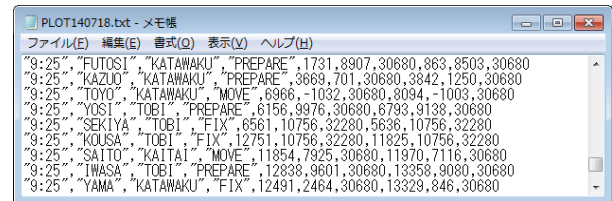


Figure 1:Result of data capturing.

A result of visualization in which one worker's timeseries position (X, Y, Z) are input to the XYZ coordinate values and the time is input to the color value is shown in Figure.2. The color indicates the passage of time with a gradient from red to green to blue. This worker was working to build a two-stage scaffold. As a work flow, we can be seen that the scaffold on the far side was constructed first, and then the scaffold on the near side was constructed after.

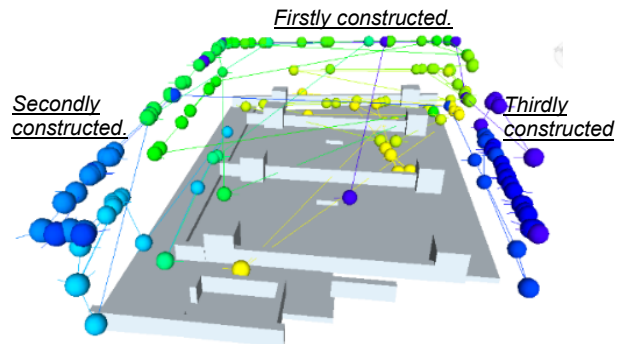


Figure 2:Visualization on XYZ with Time-color.

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A result of visualization in which all workers' (X, Y, Time) are input to the XYZ coordinate values and the data of Who is input to the color value is shown in Figure.3. It shows XT plane view. Time pass from left to right in the figure. We can be seen that the composition of the worker is changing. In addition, since the work which staying at a position looks like a chain, we can be seen that each person repeatedly moves and stays.

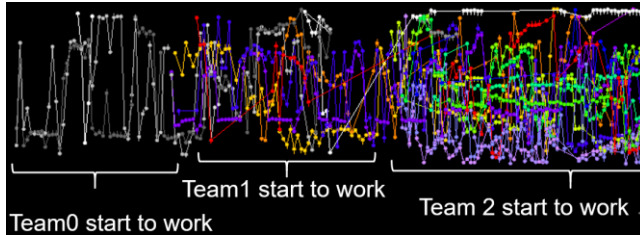


Figure 3: Visualization on XYT with Who-color.

#### 4 DISCUSSION

From comparison of multiple visualization method, we concluded the method shown in Figure.4 can be effectively grasped work flow in construction site.

Figure.4 shows perspective views from directly above of the result of inputting XYZ position coordinates data into XYZ coordinate values and inputting time data into color value, as each worker comparison.

The following points of work flow can be grasped from this method.

- Change in work position
- Change in number of worker
- Work sharing

The change in work position can be grasped from the color change in the figure. Since the time elapse is shown by the gradient from red to blue, we can understand the work starts in the center, then the work on the right area of the figure, then upper left area, and finally the lower center area. The site manager considers whether the change of the work position is the same as or different from the assumption at the time of planning, then the manager can make the next plan.

The change in number of workers can be grasped by observing the color change in the comparison of each figures. The workers has red plots are 2 out of 7 workers (worker2 and worker4). We can understand that after the 2 workers proceeded with the preparation work of the work area, the remaining 5 workers have started work. By understanding the breakdown of the entry and exit records of workers, the site manager can consider the number of people to arrange in the next plan.

The work sharing can be grasped by observing the shape of the work position shown in each workers' figure. We can understand that three workers (worker3,6,7) has a similar shape to the outer shape of the building, and the remaining four workers have work positions only in the center. We also understand that worker3 worked in other floor since he has few plots. The site manager can suggest a better assignment by looking at the situation of this assignment.

The weak point of this method is node's occlusion in dense area of nodes. Whole area work flow can be understood by this method, but interactive interface will be needed to check what was happen in the dense area of nodes.

Since many buildings are constructed in a layered structure with floors, this visualization method can be compared for each floor. By repeating the visualization and the improvement of the plan, it can be said that the construction can be progressed while updating

as an efficient plan every time the floor is piled up.

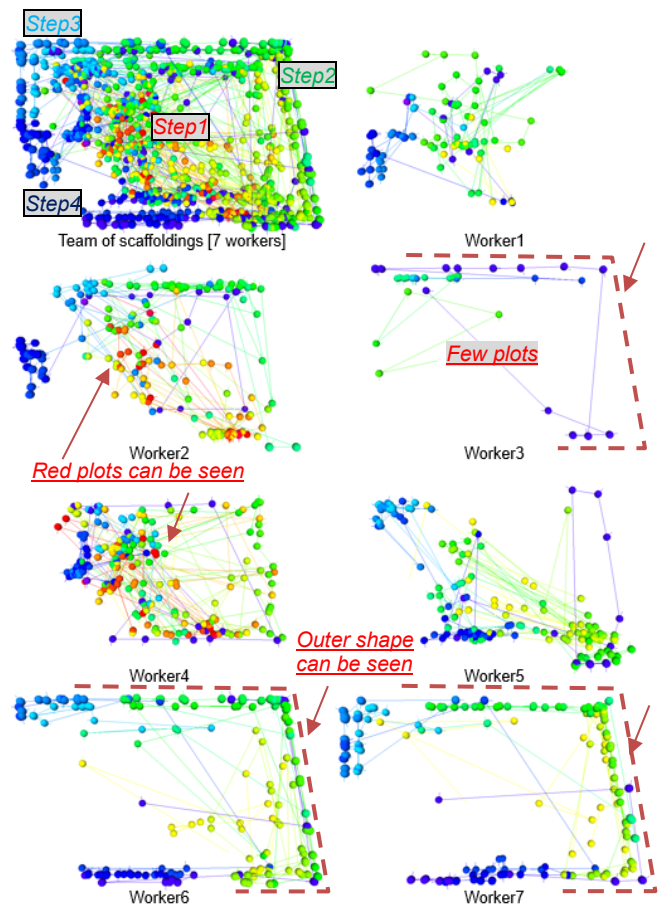


Figure 4: Perspective views of plot on XYZ with Time-color.

#### 5 CONCLUSION

We have shown that the visualization method that shows plots by XYZ and colored by time for each worker is effective for grasping the flow of construction work.

At present, this study is only a trial by the author who has just started learning the field of information visualization. We would like to apply a method that handles the process (e.g. storyline visualization [1]) or a method that handles the movement of the worker (e.g. pedestrian visualization [2]) that are developing in the field of information visualization.

We think the biggest challenge for data visualization in construction management domain is how to handle the change of meaning of position (e.g. vacant → prepared for work1 → work 1 → No-entry → prepared for work2 → work 2 → , , → completed).

#### REFERENCES

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