Management through Vision

—a case study towards requirements of BizViz—

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Abstract

BizViz (Business Visualization) is a rapidly growing phenomenon in the realm of visualization and information visualization. The main goal of BizViz is to support managers in their daily work of understanding forces within business processes and making decisions to control these forces. The case study presented in this paper illustrates the added value of visualization at a social security institution (Gak) in the Netherlands. The prototype built, integrates both databases and simulation as information sources. This way managers can study the past and present as well as experiment with possible future situations.

The intended contribution of this paper is twofold. First, it presents how visualization can (succesfully) be applied in practice. It illustrates the added value of BizViz in the social security domain. As a second contribution, the paper derives and discusses requirements that play an important role in visualization application development intended for decision-making support.

1 Introduction

Visualization is *the use of computer-supported, interactive, visual representations of data to amplify cognition* [1]. By visualizing the collected data stored in management information system databases, managers can get an overview of the past. They can employ this to search for possible trends in the production process. In addition, the current situation can easily be presented when the databases are up-to-date. To allow for experimentation with control measures in possible futures however, simulation is necessary. Simulation is a means to evaluate so called *what-if* situations. To increase the effectiveness of the visualization system, we decided to present both information sources, i.e. database and simulation, using the same visualizations. This allows managers to deploy the same views on past, present and future.

2 Managing Business Processes in the Social Security Domain

In The Netherlands, if people are unable to work, there are various benefits they can apply for. The government does not handle the applications for benefits themselves, but gave this job to the so called Social Security Institutions. If someone has a job but becomes unable to work he or she can apply for a wellfare benefit. The Gak is the largest social security institution in the Netherlands that processes these applications.

Problem The subject of this paper concerns the deployment of simulation and visualization to support business managers in planning and controlling the processing of benefit applications. To strengthen their position on the market, the Gak company wants to improve the efficiency of their production process without a losing quality. The delivered products (in this case products are benefit applications) are qualitatively good but the production process from the client arriving at the registration desk to deliverance (approval or disapproval of the application) takes too long. The norm production time for an application is in most of the cases 13 weeks, but due to unknown problems this norm is often

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exceeded. Obviously, the Gak company wants to find the production bottlenecks and their causes.

Goals The reason to build a visualization-based management information system is that we believe that this has some advantages not found in other techniques. Visualization provides users with a quick and effective overview of the material available. In short, the goals of this project comprise solving the current management problems and creating a more effective and efficient information system providing decision-makers with better information.

3 Visualizing Past and Present

To illustrate and validate our ideas about visualizing business information, we have built a prototype visualization system based on the DIVA software architecture [3]. The system was built in two phases. First, we concentrated on the current problems of the managers to indicate the bottlenecks in the business process. In this phase, we iteratively designed the visualizations which are shown in this section. In the second phase of the project, which is described in the next section, we created a simulation of the business process and used the previously designed visualizations to display the results.

The visualizations can be divided into quantity visualizations and capacity visualizations. Quality visualizations provide insight into the number and status of applications (usually called products) in the process. Capacity visualizations, on the other hand, represent to what extend the capacity, i.e. people, is employed.

3.1 Quantity Visualizations

The visualization of the throughput of a specific product type (in this case the application for a disability benefit) is given in Figure 1. The visualization consists of two integrated parts, the business process structure and the throughput histograms. The connected circles represent the structure of the process, i.e. the phases an application has to pass through. A new application enters the process on the left and moves through stages from left to right. Each application is being processed during the depicted phases, such as intake and medical examination. The percentages inside the circles reflect the amount of applications currently in that particular production phase that is ahead or on schedule. A higher percentage means a better timeliness of that stage in the process.

The histograms offer insight into the quantity and age of applications currently being processed. For example, the enlarged histogram belonging to the middle phase (stage 158) in the process represents all products in stage 158 at that moment. The x-axis of the histogram is a timeline where each bar represents a single week in the production process. This means that the first bar of each histogram reflects applications in their first week of production, the second bar represents products in their second week, etcetera. The last bar summarizes all products that are more than 16 weeks in production and therefore seriously exceed the norm of 13 weeks.

In addition to the overall norm of 13 weeks to deal with an application, internal norms exist that indicate when an application should be in a particular stage of the total process. The histograms belonging to the stages reveal the number and status of applications currently in progress. To emphasize whether products are late or on schedule, we deploy colors for both the bars and the background of the histograms. Blue represents applications that are ahead of schedule. Green means on schedule, whereas purple is behind schedule. Red applications are even worse, because they are not only behind schedule but they are even late for meeting the total production norms of 13 weeks.

It is interesting to notice what managers can derive from this visualization and how they might apply it to solve their problems. First of all, the percentages show that stages 158 and 159 are two possible bottlenecks with a timeliness of respectively 54% and 51% while the other percentages exceed 80%. (Because the first stage contains no applications in the example of Figure 1, the timeliness is 0%.) Other indications of possible problems are the red peaks at the end of the two rightmost histograms. These show that a relatively high percentage of applications is far too late at those stages of the process.

The choice for traditional histograms and bar charts instead of more complex visualization forms was made because we decided to create an easily accessible visualization system. Ease of use and simplicity were important design requirements because the managers are unfamiliar with visualization and explicitly requested us to keep things simple. In related work, we see a similar quest for straightforwardness: *traditional bar charts work well for comparisons and are well understood, including by business people* [5]. As an extension, however, we have investigated the effects of more complex 3D visualizations in [4].

3.2 Capacity Visualizations

Whereas quantity visualizations concern the production or processing of applications, capacity visualizations are intended to represent to what extent the current capacity is used (or has been used). The visualizations do not contain quantitative information but percentages. Capacity visualizations are about people, the resources of this business process.

An example of a capacity visualization is shown in the left part of Figure 2. It visualizes the load on the employees

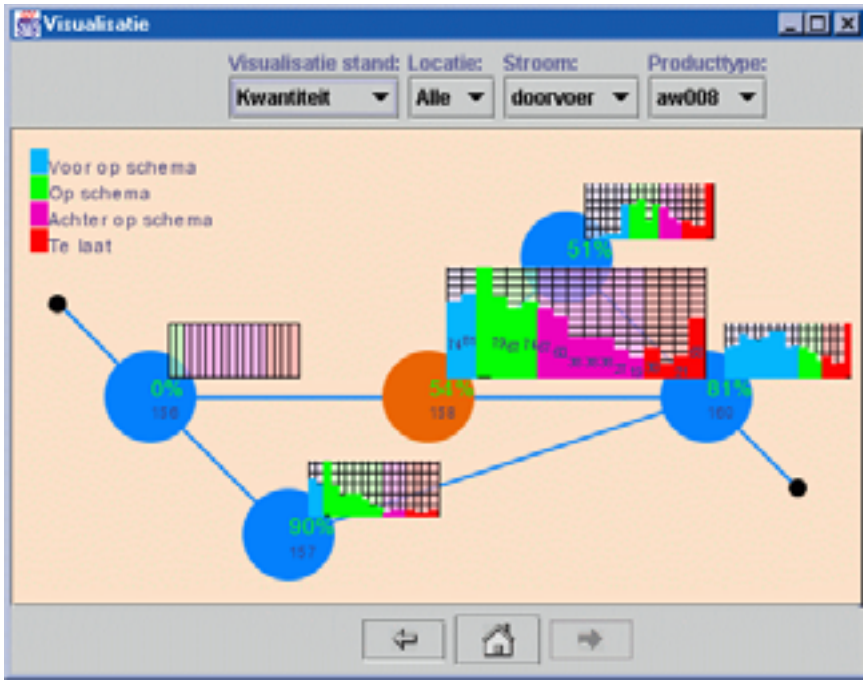

Figure 1. Throughput of a specific product type (AW008)

in the upcoming week. Each bar of the histogram represents a different type of employee. The red line represents the 100% capacity that is available for next week. If bars are higher than this 100%-line, the pile of work is larger than the available capacity.

The colors of the bar represent the status of the work that is waiting to be processed. Red (bottom of each bar) represents applications that are already late, green (middle) is exactly on time whereas blue (top of bar) represents products that are ahead of schedule. In an ideal situation the 100%-line runs through the blue area, just above the green part, implying that all late and on schedule applications are processed during next week. In the case of Figure 2 however, the labor experts, represented by the leftmost column (AD), can only get rid of a small fraction of the late applications. The same problem occurs at the third (CB) and rightmost (VA) column. Summarizing, the visualization clearly demonstrates bottlenecks at the AD, CB and VA employee types, whereas the other types have a large overcapacity.

4 Visualizing the Future

Now that we can identify bottlenecks, a means of evaluating the effects of interventions is needed. To achieve this, simulation is needed. In our approach, we tried to shorten the loop of making a model, run the simulation and analyze the results. We achieved this by integrating simulation, interaction and visualization. While the simulation is running, we already visualize the results until that point. Additionally, users can interactively manipulate the settings and parameters of the simulation which are immediately reflected in the results of the simulation and, consequently, in the presented visualizations.

Trend Visualization and Interaction Although the visualizations inherited from the representations of the databases are valuable to visualize the simulation, a new visualization has been added to better display the effect of interventions. Trend visualizations give a whole year overview of an application type or employee type.

For example, the right hand side of Figure 2 contains a capacity visualization of a specific employee type over the past simulated year. Each bar represents the work of a particular week compared to the available capacity (again the line indicates a 100% capacity). The colors of the different parts in the bars represent the capacity that is used to work on late (red) products or on applications that are behind schedule (orange), on schedule (green) and ahead of schedule (blue).

The simulation started with an empty process in week 0. While the weeks advance, we can see that the number of applications pile up because the capacity of the employees is far too small. In week 25, the controller of the simulation increases the number of employees working on this stage in the process. Immediately, the height of the bar has decreased, because the amount of work is not so large

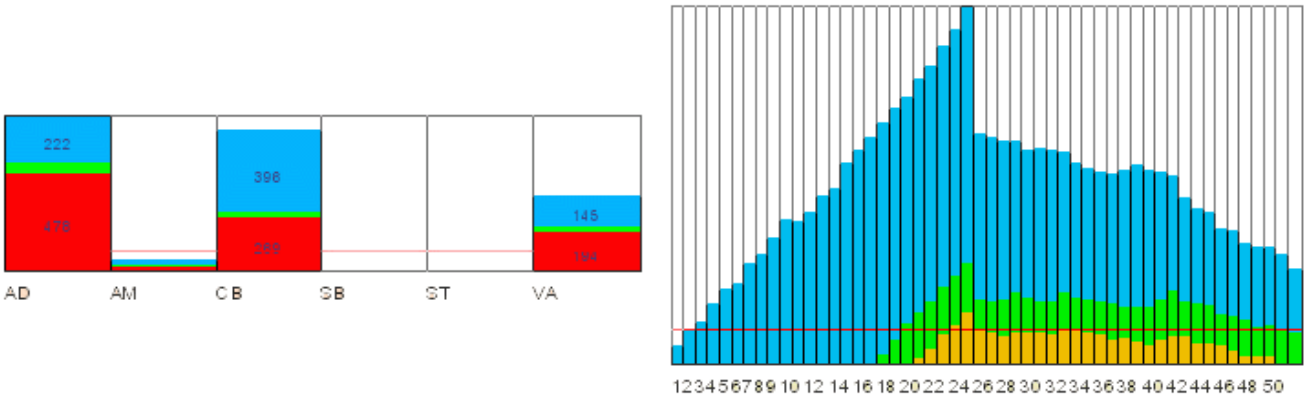

Figure 2. Left: capacity throughput visualizations show the AD, CB and VA bottleneck — right: trend visualization illustrates the effect of an intervention.

any more compared to the available capacity represented by the 100%-line. Additionally, we can notice a descending trend in the next weeks, indicating that the capacity is large enough to work away the backlog.

While the visualization only shows a single simulation run, it clearly illustrates the power of integrating simulation and visualization with user interaction. Based on experience gained by visualizing the static data in the database and their knowledge of the business process, managers can experiment with all kinds of interventions in the business process. In addition to single actions, the effects and efficiency of combined interventions can be evaluated and compared with complementary approaches. The set of available visualizations allows the experimenting manager to view the effects of interventions from different perspectives.

5 Evaluation of Concepts and Prototype

To evaluate the maturity of our visualizations and the usability of the developed prototype, we arranged two evaluation sessions at Gak offices in Rotterdam and Nijmegen. People who participated in the sessions are domain experts working at Gak Netherlands in the area of welfare benefits. The sessions started with a presentation about business visualization and an explanation of the prototype. After this, the participants had about 2 hours to work with the system. During this time, they were given some exercises to search for bottlenecks, compare the results of different products and investigate the capacity usage of the employees. Additionally, they were asked to fill in a questionnaire to provide us with feedback about the effectiveness of the visualizations and the usefulness and usability of the tool. At the end of the session, we presented the simulation extension.

Benefits The lack of information about the time that applications are already in a certain phase of the process appears to be an important omission in the current information supply. However, the missing information can be derived from the available data sources and is available in the visualizations of the current throughput of specific product-types. This extra piece of information was considered to be very useful in understanding delays in the process.

The participants of the evaluation were very positive about the usage of visualization to present the information. Without exception, they considered themselves visually oriented and had no problems with understanding the offered visualizations. Those present at the evaluation sessions agreed that the visualizations offered a better insight in current and past data. Additionally, they thought that it is easier to draw conclusions based on the visualizations than based on the currently used information system.

Shortcomings A problem with the concept of visualizing process data is the fact that the quality of the visualizations is highly dependent on the quality of the underlying data source. Visualization adheres to the slogan: *garbage-in, garbage-out*. This might cause a risk when managers solely rely on the visual representations to base decisions on.

Two often requested features were an annotation facility and further drill-down. Annotation would be useful to evaluate the effects of taken measures at a later time. Additionally, it would help when somebody could read other people's opinions about certain phenomena in the data. Especially operational managers often requested the ability to drill-down further on the data. The current implementation stops at the functionary-type level, but could be extended to represent data at the individual level since the necessary data is already available in the data sources. Whether this is

wise thing to do, however, remains to be seen.

Simulation In general, the participants of the evaluation reacted very positively towards the possibility to simulate decisions in the business process. However, the current intervention option (changing the number of available employees of a certain type) seems to be too limited. Other options such as setting priorities or skipping particular applications must be added to make the simulation extension useful in practice.

6 Discussion and Issues Raised

The motivation to perform a series of case studies at ASZ/Gak NL was to illustrate and prove the added value of business visualization to support decision making. In addition, performing a BizViz case-study in a real-world situation will lead to a better understanding of requirements and features that play a role in visualization application development.

Multiple information sources In this case study we have used a single database and a simulation as the data providers of the visualizations. This raises the issue that in general visualizations get their data from different information sources. These sources can be similar, such as in the case of two databases. They can, however, also exhibit a different type of behavior and contain different types of information.

Multiple visualizations The case study described here clearly demonstrates that a single visualization is not sufficient to meet all information needs required by its users. For example, we included visualizations of quantity and capacity, historic and current data.

Iterative approach to create effective visualization Although not covered in the discussion of the case study given here, we experienced that creating straight-forward, effective visualizations cannot be done out of nothing. We discovered a close resemblance to engineering software for a client who does not really know what he or she wants. An approach taken to tackle that problem in software engineering is an iterative approach with a lot of end user interaction, e.g. in *Rapid Application Development* [2]. In the case studies performed at ASZ/Gak this turned out to be a good choice for visualization development too.

Derivation of new information Information that appears to be crucial for good decision making is not always directly available from the data sources. For example, information about how long applications are already stuck at a particular stage is not directly saved in the source databases. The information can, however, easily be derived and presented to the user.

7 3D Visualization

To experiment with more esoteric visualizations, we have also built three-dimensional representations to visualize business processes. Although more information is contained in a single 3D visualization, such as a combination of 3D process graph and 3D histograms (Figure 3), we did not introduce them at Gak Netherlands at that time. The main reason is that the added value of presenting more information at a single glance does not make up for the increased complexity of 3D visualizations. We wanted to keep the visualizations as simple as possible during the managers' first encounter with interactive visualizations. More information about the 3D visualization and the discussion of 2D versus 3D can be found in [4].

8 Summary and Conclusion

This paper presented a case study done at Gak Netherlands to illustrate the usage of simulation and visualization to control business processes in the domain of social security. Evaluation showed that visualization could indeed aid in better understanding of the available information. Consequently, visualization leads to more informed decisions. The usefulness of the current prototype could be increased further by allowing quick access to up-to-date data, extending the intervention evaluation possibilities and by adding support for collaboration.

As a conclusion, we state that interactive simulations and visualizations are a powerful means to control business processes. Especially, an integrated solution combining the advantages of retrospection and experimentation, allows decision makers to discover trends in the past, monitor the current situation and predict possible futures.

9 Acknowledgements

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References

[1] Stuart K. Card, Jock D. Mackinlay, and Ben Shneiderman. *Readings in Information Visualization: using vision to think*. Morgan Kaufmann, 1999.

[2] James Martin. *Rapid Application Development*. MacMillan, 1991.

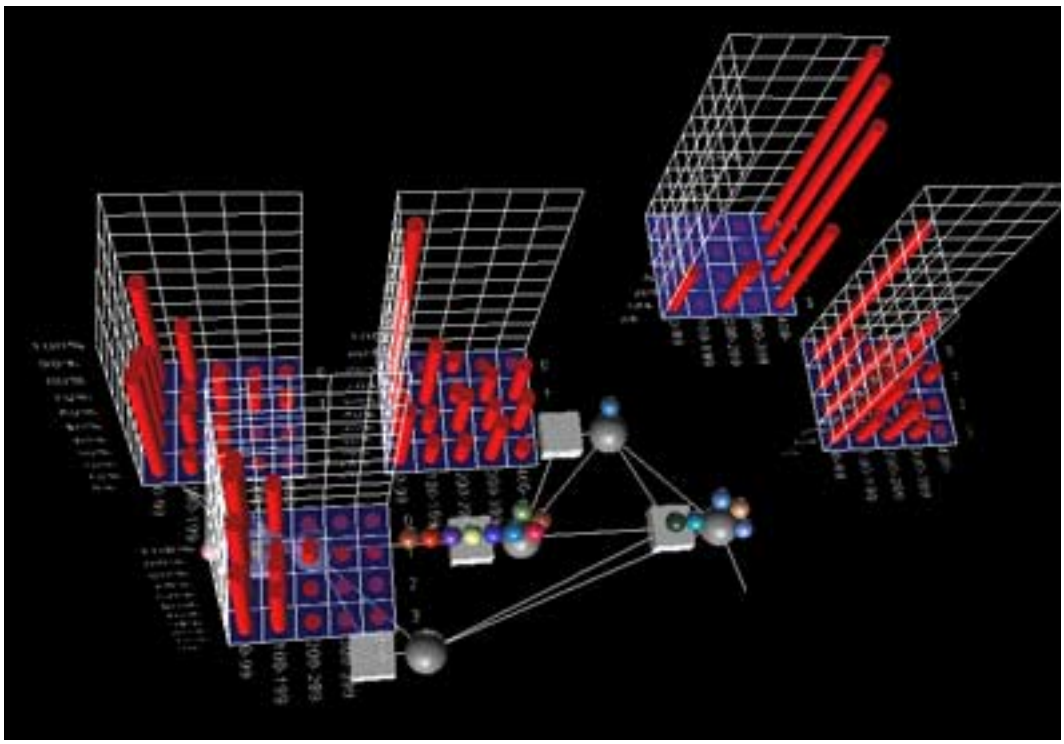

Figure 3. A three-dimensional variant presents more information at the price of increased complexity.

[3] S.P.C. Schönhage and A. Eliëns. A flexible architecture for user-adaptable visualization. In David S. Ebert and Charles K. Nicholas, editors, *Workshop on New Paradigms in Information Visualization and Manipulation '97, Conference on Information and Knowledge Management, 10 - 14 November 1997, Las Vegas, USA*. ACM Press, 1997.

[4] S.P.C. Schönhage, A. Eliëns, and Alex van Ballegooij. 3D Gadgets for Business Process Visualization: a case study. In *Proceedings of Web3D/VRML2000 - International Conference on the Virtual Reality Modeling Language and Web3D technologies*, pages 131—138, 174, 2000.

[5] Ping Zhang. Visualizing Production Planning Data. *IEEE Computer Graphics & Applications*, 16(5):7–10, 1996.