Mor(e)ph: embodying business key figures in a data sculpture

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ABSTRACT

Purpose – The benefits of visualizing complex datasets is recognized in the business community. However, the use of experiential representation of key operating figures is unexplored. This paper explores the potential of data sculptures as a means to represent key operating figures and make them comprehensible according to multi-sensory principles.

Design/Methodology/approach – The design of a data sculpture is studied on the basis of a case study of an agricultural enterprise.

Findings – The experiential representation of business data provides a means to support internal and external communication, and contributes to the development of a shared understanding.

Research limitations – The mapping of business data to physical parameters has been designed specific to the particular case under consideration. Further research is needed to examine whether it can be applied for other enterprises.

Practical implications – Presenting business data in a data sculpture can be used as an experience-oriented approach to engage stakeholders and for building customer relationships.

Originality/value – Presents a proof of concept for embodying key business figures in a data sculpture. The findings contribute to understanding basic aspects in designing the mapping to physical parameters.

Key words - Data sculptures; experiential representation; business key figures; communication tool, entrepreneurial decisions.

Paper type – Conceptual paper

Introduction

Key figures form a fundamental basis for decisions in business life. In family business economic factors are intertwined with interpersonal relationships. In this context personal relationships have to be considered in order to make fruitful and forward-looking entrepreneurial decisions and to implement these decisions. This paper investigates data sculptures as a tool to support family business leaders in entrepreneurial decision-making processes. Data sculptures are defined "as the physical "embodiment" of data in a tangible presence, shape or form". Data sculptures are realized by mapping abstract data values to physical parameters such as size, height and colour. While other types of information visualization focus on efficiency, the purpose of data sculptures is to convey meaning and engage onlookers in sense-making. This paper explores the potential of data sculptures to support members of family business to develop a shared understanding of their current situation. The objective is to design data sculptures that encourage members of family business in participatory sense-making, in identifying ingrained relationships and possible action for future growth. The paper discusses issues concerning generalizable factors of family business. Further, we present our mapping of business data to parameters of data sculptures and underlying design rationales.

Data sculptures

A division of different ways of visualizing data in a physical way is giving by Moere (2008), dividing them in the five different groups ambient displays, pixel statues, object augmentation, wearable visualization and data sculptures. Regarding sculptures, the central aspect is that the data is represented within the object and therefore be interpreted. Through its physicality the viewer interacts with the data in a different way. Furthermore, the mapping of the data influences the readability of the sculpture. Hereby, a person's interaction with the object can contribute to a new understanding of the data. A comprehensive overview of physical visualization is given by Dragicevic and Jansen (2019). But these sculptures are different in three relevant ways. First of all, most of them are presented in artistic way concentrating on entertaining the audience. Second, the data is mostly private or public related, not with the aimed business aspect. And finally, an analysis how people are perceiving and interpreting the data or even taking decision is missing. In order to reach more business-related literature, the database of the London School of Economics was scanned regarding the terms data, business, and sculpture respectively physical visualization brining no relevant results. Although the review did consist only of one database and the used variety of terms is small, it reveals that the visualization of business data in sculptures is a new development in the field of business and economics.

Design process and rationale

This section presents our approach of exploring the requirements and challenges that accompany the process of embodying business key figures in a data sculpture. Our approach includes two phases: a) conceptual considerations regarding the data set and the geometric features and b) the implementation into a concrete data sculpture named Mor(e)ph.

In the first step, the data sets to be visualized must be analyzed regarding their characteristics - i.e. their properties and relationships. Characteristics in this context are orders of magnitude, dimension dependencies on other key figures, but also hierarchical dependencies. For example, the division of business areas can be dependent on turnover or profit. Further important questions for analysis are:

- Which key figures are to be visualized?
- How many ratios are related to each other; should more than one morph be generated?
- What type of key figure: relative or absolute?
- What dependencies are "serial" or parallel data sets?

- Which dimensions/order of magnitude? How can the data sets be scaled meaningfully and correctly?
- Are the key figures directly related in terms of content (sales to personnel = productivity, sales to profit = return on sales, but are profit and personnel directly related?) maybe several morphs?

Classification of input data and geometric properties

A classification of the input variables is useful if several key figures are to be visualized simultaneously and several morphs are to be generated. For example, classes can be created such as primary and secondary key figures. The basic key figures can be assigned to the primary classes, which represent the uniform basis in the case of several morphs. Examples of this are sales and business areas. Classification can also be hierarchical, i.e. a further classification takes place within an initial classification. In the present example, the educational level within the class "secondary" factors was assigned to 3 categories with fixed numerical values. In the example these were a) unskilled and b) skilled workers, as well as c) master craftsmen and engineers.

Geometric properties in this context are all characteristics that can be mapped in a physical 3-dimensional model, make the model or parts of it distinguishable and can be unambiguously interpreted by third parties. Geometric properties can be, for example, dimensions, coordinates, angular relationships, but also colour and topology of surfaces. The geometric properties are very different in their expression and their applicability in Mor(e)ph, so that a classification appears meaningful. A subdivision into relative and absolute properties is the first important classification. For example, distances can be absolute (reference to a defined origin) or relative to each other. Surfaces can be subdivided absolute or relative. Furthermore, the properties can be combined or modified according to the requirements of the data sets to be visualized and the associated set of rules, so that new specific properties can be generated from defined combinations of properties. An example for this is the even division of partial areas, which have been created in advance by weighted or proportional division of a total area. Furthermore, areas can be formed by 2 key figures. Among other things, the following geometrical properties can be summarized:

- Distance relative to origin (absolute)
- Distance relative to another key figure
- Angle (polar)
- Areas from two key figures
- Uniform or weighted area division

Values must be assigned to all geometric properties so that the property itself takes on a specific form. These values are partly dependent on the classification. The following value ranges were used in the experiment:

- Categorized values (qualification)
- Analog Values (Working Time)
- Absolute values (number of employees)
- Attribute Values (Name)

To use this method, it is necessary to perform scaling during the transformation of input variables and output variables, because the orders of magnitude of the key figures are very different. For example, sales in thousands and number of employees under ten.

Translation of the data set using Mor(e)ph as an example

In the following, we will describe how the transformation of business ratios into geometric properties was carried out in the "Mor(e)ph" experiment. For this purpose, a scenario was developed in which different developments in the area of personnel development were considered in relation to the business segments and based on sales. The scenario can be presented as follows:

Scenario for the Mor(e)ph

For the evaluation of the Mor(e)ph model, the basic functionality will be examined with the help of the scenario method and the abstract persona method. Hence the following fictitious scenario is used:
Operation:
The company has three business divisions
I) eggs
II) farm shop
III) winter road clearance
T0 = present, T1 = short-term, T2 = medium-term

T0 = now, T1 = short-term, T2 = medium-term

Share in % of turnover	T0	T1 turnover +10%	T2 turnover +12%
I eggs	50	70	75
II farm shop	40	20	25
III winter road clearance	10	10	0

Staff
Heinz: 80% in I, 20% in III v. 40h, wants to work 30h part-time
Berta: 50% in I, 10% in II, 40% in III v. 20h wants to work full-time
Francis: 40% in I, 60% in III v. 30h stays at 30h

Personal total working time in hours	I eggs			II farm shop			III winter road clearence		
	T0	T1	T2	T0	T1	T2	T0	T1	T2
Heinz	32	25	20	0	5	10	8	10	0
Berta	10	20	25	2	15	15	8	5	0
Francis	12	20	21	0	8	9	18	2	0

In summary, seven key figures (dimensions) can be worked out. The following table names these and lists the transformation into geometric properties, as well as their value range and scaling:

Key figure	Geometric property	Calculation	Value range
Turnover	core diameter inner circle, absolute property, center=origin	1mm ≙ 1th €	absolute, 0 to +∞
Business division	Partial area of inner circle, relative property	total sales/sub-sales business segment(s)*360° total sales/sub-sales business segment(s)*360° = angle of the partial area for the business segment	angle weighting as a percentage of turnover
Number of employees in the respective division	uniform distribution of angular dividing lines (employee axes), starting from the origin	angle of partial area business division (n) / number of employees working in the GF + 1 = Angle of employee axes	absolute, 0° to 360°
Time	Distance of construction planes	number of times considered = number of construction planes, distance to each other 1mm ≙ 1 week	analog value; -∞ to +∞
Working hours of the employees in the respective division	expansion of employee axes beyond the inner circle	1mm ≙ 1h working time	analog value; 0 to +40
Qualification	distance of the two-sided offset from the employee axes	5mm ≙ helper 7,5mm ≙ skilled worker 10mm ≙ master craftsman/engineer	categorized values: 5, 7,5 and 10 mm

unique person assignment (possibly coded)	color	1 person = specific unique color	attribute value

Implementation and realization

In order to realize the mor(e)ph two steps were necessary. At first the data was transformed in a 3D CAD system (Dassault Solid Works 2018) with basic functions that are basically available in almost all 3D CAD systems. The system is parametric so that all mapped data can be entered exactly and, unlike surface modeling Software, can be adapted and modified at any time. As a result of the transformation of the key figures into geometric data by mapping, a sculptural morph appears in the first step as a virtualized model. Virtual tools make it possible to measure and query data. In addition, its topology can be explored from all perspectives. Sectional views complement the virtual analysis.

However, in order to do justice to the desired approach of the multi-sense principle to data communication, the mor(e)ph was implemented as a physical model according to the rapid prototyping principle. A 3D printer according to the FDM (Fused Deposition Modelling) method was used. Now it is possible to read the transformed data sets intuitively. Much more interesting is the possibility to perceive the results of the change in the data sets tactilely and visually. The authors start from the thesis that economic changes in complex contexts show strong geometric changes when using the method. Accordingly, considerable directional changes, enlargements or reductions are an indication that the data sets used lead to considerable changes and possibly also risks.

Findings

How do you arrange and put up key figures that are relevant to the operation of the enterprise but that are also allowing sections of the operation to be compared to each other? That has been one of the mayor challenges at first when starting the project. In order to be meaningful the sculpture needs to have a relevant base and classification. After extensive discussion the team succeeded in finding criteria that allows the sculptures to be compared to each other even for different sections of operation.

Lack of relevant data

One of the major problems when trying to generate the Mor(e)ph turned out to be that there was no actual data available that could be used to create a scenario mirroring reality. The original approach has been to set up a sculpture representing a timeframe of ten years, looking at five years into the past and five years into the future of an economic section of the operation. The idea was that this could be a possibility to show the development of the chosen portrayed economic section on a solid real database and could have the potential of giving a forecast regarding the development. The intention was to test if looking at the shape and the course of the sculpture recommended action to optimize the business could be generated. However, it was not been possible due to two reasons: First of all relevant data regarding the past could not be generated from the farmer. Secondly the forecast turned out to be quite difficult for more or less the same reasons. Personnel development in relation to the business segments and on the basis of sales were the criteria the sculpture was to show. As for the personnel development data from the development of the regional labour market would have been necessary for a forecast. However, these were not available. Even the German national agency for labour (Bundesagentur für Arbeit), could not provide them. The same is true for data concerning the development of the regional market in general. There are no forecasts on it that could have been used. In order to be able to pull up a sculpture at all the team therefore decided to use fictitious data to get a first impression on what a Mor(e)ph looks like and how it might be affecting people.

Mor(e)ph does have an effect

When the Mor(e)ph has finally been pulled up and created through 3-D-printing based on fictitious data the results that showed up were the following:

Frist of all: the Mor(e)ph does something to the one that looks at it and touches him! That has been a mayor insight to the team. Most of the people that were willing to take a look and interact with the Mor(e)ph where somehow drawn in. It might have been mere curiosity sometimes but the idea of putting economic data into a new approach seems to trigger something. On a deep level, humans tend to like exploring and the Mor(e)ph offers plenty of playground.

Some of the observers were asking if it was some kind of Art, others asked for the data that was implemented and how to read it or even interpret it. There has definitely been an interested in the sculpture and its potential usage. Many wanted to touch it and feel the structure that supports the original theory that there are other ways of perceiving information even on a subconscious level and that people are willing to use those alternative approaches as well.

Therefore: even though the data for the Mor(e)ph had to be made up, the insight out of the experiment was that the shaping and creation of it into a form does have an effect on people with all kind of educational background and that there is an interest to use it for economic purposes i.e..

Nevertheless the data is fictitious and more to it: even if the data would be real at the moment it is not known to the team how to interpret a potential real case let alone draw advice for action out of it. In addition, the original base of the data setting has to be verified and to be proven as reliable and relevant. This will have to be the subject of a further project that is already on its way.

Conclusion

The experiment to transform economic key figures and their correlations into geometric properties is successful. Making complex data correlations comprehensible according to the multi-sensory principle and making their effects visible and tangible is experimentally proven. The fact that for this kind of reading and analyzing of data sets and their connections no technical devices and corresponding know-how are necessary for their use is only one of the characteristics of this trend-setting method. It can therefore also be used independently of technology over generations, cultures or as long-term archiving.

Nevertheless, further research is needed to examine the method for consistency, validity, feasibility and, above all, limits. This can be done by further case studies and experiments, as well as user surveys.

In addition, it makes sense to identify further areas of application. Based on the collected experiences, a set of rules - similar to the languages - can then be developed, which make the application of the method process-safe and the results reproducible and resilient.

References

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