Data Visualization in Online Journalism and Its Implications for the Production Process

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Abstract

Data stories – this buzzword links together two different disciplines: computer science and journalism. The new relationship is called data-driven journalism. The emerging product of this relationship: data-based visualization that reveals the story behind the data. However, who produces those "data stories"? A journalist, an information designer, a computer scientist, or a team? New formats often implicate new workflows and a new way of thinking. This paper sets data visualization in the context of online journalism by focusing on the production process. We interviewed 19 experts of German, Swiss, and American media companies: designers, programmers, and journalists. For the analysis of the interviews we used the grounded theory approach. The findings show: The crucial success factor in the production process of data-based visualization in journalism is the attitude that everyone in the team acts as a journalist – no matter whether programmer, designer or statistician. A case study of the New York Times newsroom illustrates our findings.

Keywords: **data visualization, interactive information graphic, data driven journalism, online journalism, attitude, collaboration, sketching, storyboard**

1. Introduction

Data visualization has a long history stretching back hundreds of years [5, 9, 21, 22, 26]. According to Friendly, data visualization is "the science of visual representation of 'data', defined as information which has been abstracted in some schematic form, including attributes or variables for the units of information"[9][1]. Classical visual representations were statistical graphics (e.g. for financial data) and thematic cartography (e.g. weather map); both cartography and statistical graphics are visual means to discover and display data, information or even stories. *Story* leads us to another research field that – looking back on its history – normally is not known for exploring large amounts of data: journalism. Since a few years, as a consequence of media convergence, these two research fields (data visualization and journalism) have merged to a new form of news coverage: data-driven journalism, which can be seen as a part of computational journalism [1]. Data-driven journalism is based on large sets of data for the purpose of writing news stories. Data journalists describe the journalistic process as a workflow that consists of: digging deep into data, analyzing and filtering the found data, visualizing it, and forming a story [2, 14]. In the last years, collections of data have become available online (e.g. Open Government Data) and open source tools allow analyzing and visualizing the data even with little knowledge of information technology.

A visual format in the data-driven journalism is the interactive information graphic, also called interactive feature or interactive graphic. We define an interactive information graphic as a visual representation of information or knowledge with the following elements: Verbal elements (text, audio, typography) and visual elements (photo, illustration, diagram, map, symbol, icon, pictogram, video, moving image) are combined in such a way that they create a new hybrid form. Interactivity and multimedia are main characteristics of an interactive information graphic [4, p. 361]. The value of an information graphic is to display complex information, which is difficult to be told verbally, in a visual way. With their interactive graphics and features *The New York* Times (Fig. 1), *The Guardian,* and *Zeit*

[1] For the definition of data visualization in comparison to information and knowledge visualization, see [3, 9]. According to Post et al. [17] "the phrase 'Data Visualization' is gaining acceptance to include both the scientific and information visualization fields".

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online (Fig. 2) play a pioneering role in data visualization in online journalism [cf. 1, p. 2].

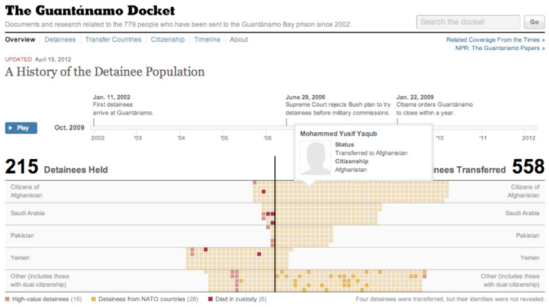

Figure 1: The interactive graphic "The Guantánamo Docket" is based on documents and research related to the 779 people who have been sent to the Guantánamo Bay prison since 2002[2]

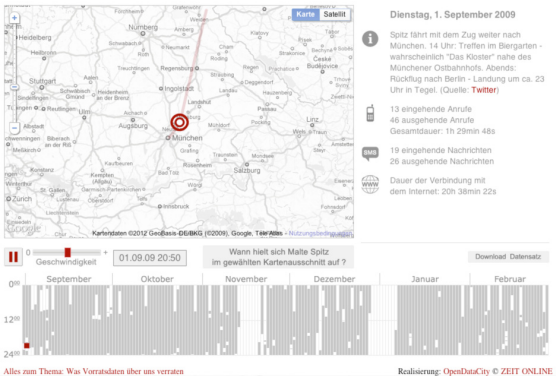

Figure 2: The interactive graphic "Tell-all Telephone" visualizes the phone data of six months collected by the Deutsche Telekom[3]

In this context, we often find the buzzword "data stories" or the phrase "telling stories with data". However, who tells the story[4], and who designs the graphic? Is it a journalist or a designer? Do they collaborate with a programmer? Who decides in which way the data is to be displayed? How is the development process of a data-based visualization structured? What about journalistic ethics and standards? In order to answer these questions, we focus on the production process of data visualizations in the context of online journalism with the aim to identify changes in workflows, challenges, best practices or factors of success. In a second step, we demonstrate with a case study the implications the use of data visualization has for the journalistic practice. The research framework for our study is a transdisciplinary one by bringing together the academic fields of data visualization, information design and practitioners in the field of journalism to identify and solve problems.

2. Applied Methods

We started our study with a literature research. A lot of blogs discuss the strengths and the weaknesses of data-driven journalism and try to describe and define the new journalistic practice [2, 7, 8, 14, 15]. The video report "Journalism in the Age of Data" provides a good overview of trends, tools, and formats [16]. However, since data-driven journalism has arisen only a few years ago, we found no scientific studies about the production process in data-driven journalism. In order to explore this new research field, we decided for the method of qualitative interviewing. We conducted 19 expert interviews in 8 media companies (5 in Germany, 2 in Switzerland, and 1 USA) in the period May 2010 to August 2011. The experts are information graphic designers, graphic editors, art and design directors, programmers, and journalists, who work in editorial departments for print and online journalism or TV and regularly plan, design and/ or program interactive graphics. The interviews were based on an interview guide specially developed for the research questions of our study. We focused on several main aspects: education, competences, tools, tasks, roles, workflow, and responsibility. Each interview took about one hour and was recorded as audio file. Afterwards, the interviews were transcribed and made anonymous. For the evaluation of the interviews, we used the qualitative method of grounded theory [19], which has proven as a good method to explore behaviors of groups. In contrast to traditional scientific research, the grounded theory method does not start with a hypothesis, but ends with a hypothesis or a theory developed from the collected data. The collected data comprises theoretical samplings, which means: not representative samplings, but samplings that have proven relevance to the evolving theory [19, p. 176]. Sampling stops, when theoretical saturation is achieved and no further sampling leads to a change of the theoretical concept, which was the case with 19 expert interviews.

We analyzed the data by constantly comparing one interview to another, identifying concepts on different levels of abstraction, integrating the concepts into categories and relating them to each other; this process contains open, axial and selecting coding according to Strauss and Corbin [19]. The theoretical categories that have emerged from the coding process are: *methods*,

[2] http://projects.nytimes.com/guantanamo/ (retrieved Feb 20, 2012)

3 http://www.zeit.de/datenschutz/malte-spitz-vorratsdaten (retrieved Feb 20, 2012)

[4] In contrast to narratology, which defines story as a sequence of non-fictional or fictional events that are **temporally structured and coherently related to each other**, we use the term "story" in the journalistic sense of conveying facts or events.

time, *competences*, *collaboration*, and *role,* with *attitude* as the core category; the core category connects the other categories and forms the core of the theory or hypothesis. For the coding process, we used the coding paradigm that consists of four items: conditions, interaction, strategies, and consequences [12, 19]. Our case study of the New York Times illustrates in detail the interplay of the categories in the production process.

3. Results

The grounded theory coding process yielded the following results: We identified *attitude* as a *core category*, which is related to all other categories as follows: In the era of convergent journalism, *collaboration* between the different professional groups (authors, designers, programmers) is a crucial *condition* to produce data-based visualizations like interactive graphics. This collaborative production process requires a change of attitude: each team member should understand him or herself as a journalist, because they are all involved in producing a journalistic product (*hypothesis*). The *compliance with journalistic principles* can be seen as a *consequence*. The collaboration also implicates a change in the communication modus: *sketching and storyboard* become a visual communication device (*interaction*/ *strategies*).

3.1 Attitude as a Success Factor

How do designers, programmers, journalists understand their role in the production process? One result of the expert interviews is: In German and Swiss editorial departments it is still the journalist or the editor who is responsible for the content or the story of the interactive graphic; the designer only delivers his visual part, the same goes for the programmer. An interviewed designer said: "Mostly the journalist does the research, and we care for the visual things like maps or charts." In contrast, the interviewees of the New York Times stated: "We are journalists" (see case study, section 4). In this statement, we recognize a paradigm shift that has occurred in the New York Times newsroom. What is new is that even programmers and designers see themselves as journalists; they belong to the journalistic team of the newsroom and define their task as a journalistic task. We could not make out such a strong comparable self-understanding in the other interviews. It seems that in German and Swiss media companies the traditional concept of roles still exits: here, the journalist – there, the designer or programmer, who is more or less regarded as a supplier. Admittedly, we detected a slight tendency to overcome the gap by building a team of three people (journalist, designer, programmer) for special projects, e.g. an interactive feature of the Olympic Games.

3.2 Collaboration as a Condition

Collaboration as a crucial condition to produce data-based visualizations is closely related to the key factor attitude. Important steps in the production process of a data-based visual are: data retrieval, analyzing and filtering data sets, extracting the message from the data, transforming the message into a story, visualizing the story, and programming the story. These steps require new competences and capabilities of those creating data stories: mathematical, visual and verbal competences, in addition technical and multimedia skills. Depending on the intended final outcome this might also include knowledge of modeling virtual characters, animating them, film editing and the addition of interactive elements, not to forget the obvious necessity to write text(s), incorporate sounds, and provide journalistic integrity and authenticity.

Not all of these skills will be equally in demand for each project and purpose and it is rather unlikely, that all of these areas of expertise can be covered equally well by just one person. This results in an intertwined collaboration of experts, who can combine and exchange their areas of expertise customized for the requirements of specific projects: e.g. a graphic editor with strong design skills in visualizing data would collaborate with a colleague, who is able to transform this into a highly cinematic approach through storyboarding and the subsequent use of 3D animation software. As our interview analysis has shown, a team of at least three experts has proven itself in practice: a programmer (e.g. flasher), a designer, and an author.

As a consequence, new curricula in education or even new job descriptions might emerge from the collaboration: e.g. the visual journalist or the graphic reporter with journalistic competence and in depth knowledge of digital animation tools, or the data journalist, who becomes an expert in data retrieval, data analysis, data visualization (e.g. geovisualization), with a background in statistics or systems programming and storytelling [cf. 13, p. 2].

3.3 Journalistic Principles as a Consequence

Beside the purely skill related challenges pertaining to the fields of journalistic writing and data visualization, another very specific challenge needs to be addressed: How to create visually appealing images without compromising journalistic integrity? Is there any such thing as "creative freedom", if it comes to transforming data into interesting visuals? What if facts are missing or data is wrongly displayed? And what about speed, which is a relevant criterion in news production? All interviewees agreed that in news coverage time is the limiting factor for data visualization, because visuals, e.g. interactive graphics, cannot be produced in a few hours like an article; data visualization requires time. Therefore, reporting new information first or getting the scoop cannot be the aim of data journalism; accuracy

always comes before speed. The attitude "we are journalists" – as mentioned above – implicates to work according to the journalistic standards and ethics like integrity, accuracy, credibility, clarity, which is the foremost priority over speed and aesthetic aspects[5].

3.4 Visual Methods as a Strategy

The collaboration also implicates a change in the communication modus: Sketching and storyboard act as a visual communication device between interacting parties as well as a tool to structure the main creator's visual thought process. According to the analyzed expert interviews, some interviewees use a storyboard to further translate and transfer the plot of the story into a visual narrative. The importance of the storyboard is to provide the bigger frame of storytelling, the context, which prevents the team from getting lost in the details and "not seeing the wood from the trees". Comparable with the breakdown of a film-script into single shots, the storyboard fulfills the function: to create a visual architecture for the piece defining its structure, narrative flow, including potentially non-linear deviations from the main storyline. In general, drawing remains an ideally simple and fast tool to share ideas and discuss ideas with others. These visualization methods, which normally do not belong to the toolbox of a journalist, become more and more important in the production of news.[6]

4. The New York Times – a Case Study

We illustrate the preceding theoretic considerations and the implications with a case study of the New York Times newsroom in New York. We interviewed two people who are actively involved in creating data visualizations and interactive features, which are considered to define the state of the art in the field.[7] This is demonstrated by winning the National Design Award 2009[8] and by dominating the Malofiej Award for years. After a short introductory session with Steven Duenes, graphic director of the New York Times, the interview focused on the graphic editors Xaquín González Veira and Graham Roberts, who have created a multitude of interactive information graphics based on data. The goal of the interview was to gain deeper insights into the details of the production process, the working methods and the application of multi-disciplinary skill-sets to achieve the final results. The interview was one of the guideline-based interviews as described above in section 2. The visual representation, we refer to as an example, is the data-based visualization "How Mariano Rivera Dominates Hitters"[9]. It can be classified as a hybrid format between video and animated graphic and explains the pitching mechanics and technique of the famous baseball pitcher Mariano Rivera.

4.1 Sketching as a Tool of Visual Thinking

We were particularly interested in exploring to what extent the age-old technique of drawing is still employed in the creation of cutting edge digital information graphics. It emerged rapidly from our conversation on the creation process that drawing as a tool of visual thinking remains still relevant. New York Times Graphic Editor Xaquín Gonzalez Veira answered the question whether he and his colleagues are also using the sketches, concepts and scribbles: "Yeah, I do – and Steve Duenes, who is actually the Graphic Director, is very obsessed with sketching." He further elaborates on this process and confirms the importance and relevance of this tool: "Because the moment you see, you can explain graphics with words but the moment you see them, or you see a sketch, you understand if it works or not. (….) My wife always tells me: Just don't explain to me the graphic – just show it to me."

To take the process of visual construction of an interactive visualization further, the initial sketches would be further developed into the most commonly used tool for planning audio-visual narratives: a storyboard (Fig. 3). Similar in appearance to a comic, it illustrated the graphic through a series of sequentially arranged images. Different from a comic though, the storyboard will of course use the correct screen aspect ratio(s) and further incorporate elements like split-and multiple screens through corresponding illustrations. Such a storyboard can certainly be very loose and rough in its drawing; the goal is not to achieve a polished look (that is left to later production stages) but a clear visual

[5] Giner and Cairo offer a checklist to ensure basic, ethical journalism standards in presentation of infographics [10]. The reason was a series of non-factual and inaccurate graphics in the media's coverage of the death of Osama bin Laden. In his books, Wainer illustrates how graphs can be used and misused and how to avoid pitfalls [24, 25].

[6] For sketching as a visual tool, see [23].

[7] Hannes Rall: Interview with Xaquín González Veira, Graham Roberts and Steven Duenes conducted at the New York Times Newsroom, New York, August 17, 2011.

[8] "The Communication Design Award, which honors work in graphic or multimedia design, is presented to The New York Times Graphics Department. The New York Times has a long history of groundbreaking information graphics. From Sept. 11, 2001, when the department produced scores of maps and diagrams explaining the attacks and their aftermath, to the 2008 presidential election when the desk built the interactive maps on nytimes.com, the Times Graphics Department provides readers with a visual way to understand the news. A staff of cartographers, illustrators, researchers and developers work as a team to shape and deliver information by reporting, writing, designing, drawing and programming information graphics for both the printed newspaper and nytimes.com. Over time, the graphics have evolved from simple maps and charts to more complex visualizations, but the goal of authoritative, accurate journalism has remained the same." [18]

[9] "How Mariano Rivera Dominates Hitters" (2010). http://www.nytimes.com/interactive/2010/06/29/magazine/rivera-pitches.html (retrieved Feb 29, 2012).

plan before moving into production. Its very own aesthetic quality lies within the clarity of the information it provides.

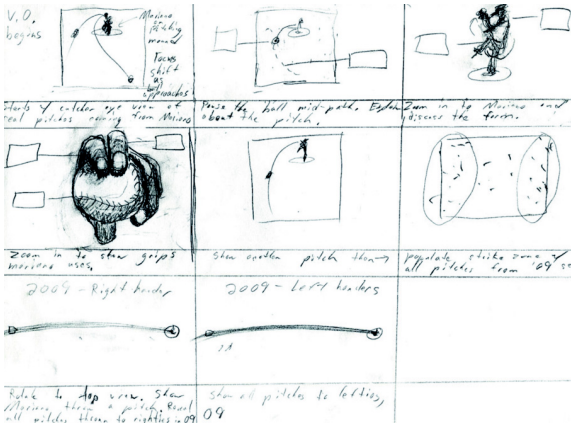

Figure 3: G. Roberts' storyboard for the graphic "How Mariano Rivera Dominates Hitters"[10]

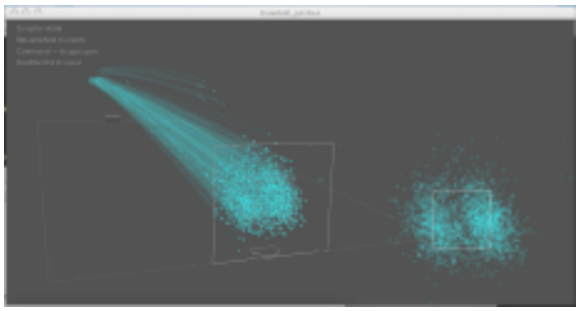

Figure 4: Data visualization for the nearly 1,300 pitches Rivera threw in 2009[11]

Graham Roberts, one of the graphics editors of the "How Mariano Rivera Dominates Hitters"-graphic, explained more on the topic: "So Shan wrote this little application using Processing that will take all the pitch data to be collected and it was almost like a pre-graphic graphic, where you could see all the pitches." His colleague Xaquín González Veira added: "It was a graphic to make a graphic."

Graham Roberts further elaborated – and this is not only interesting concerning the working method, but also in terms of the dramaturgic structure (let the user explore the data vs. narrating the story): "And we thought maybe originally it would be something where you'd just see all the pitches and you could punch in different numbers and just look at what the pitch's path of view's like, but I think we came to the conclusion that it's better to show what the field's in directly to the user rather than giving them a bunch of data and force them to figure it out on their own. You know that way they see everything, but maybe not really discover anything about it. So that's how the cinematic style came in, I storyboarded something that would kind of take everyone through bit by bit." (Fig. 3, 4, 5)

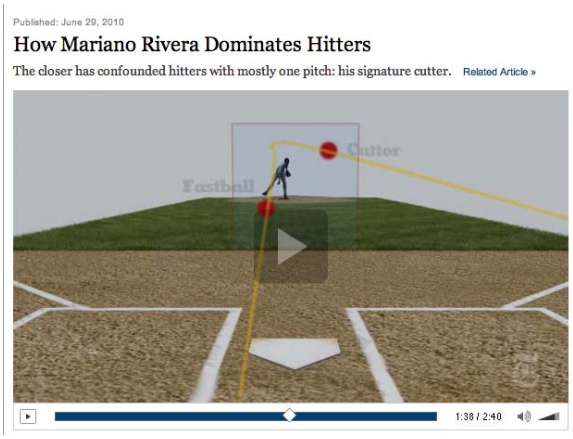

Figure 5: The information graphic as a mix of video and graphic.[12]

According to Roberts the initial storyboard versions of the graphic were already very similar to the finished graphic at least in the structure. He said: "That was really my storyboard of, you know, and it's very crude, obviously. But it did pretty much follow this idea. (…) It did actually end up pretty close to that. (…) I did make two more detailed storyboards."

4.2 Roles and Attitude

Besides the documented relevance of understanding the sophisticated use of visual storytelling and its application through sketching and storyboarding, there is further evidence for the increasing convergence of the field. In an environment like the newsroom of the New York Times experts with competences in several areas are working closely together, supporting each other when and where needed with their specific strength(s) in an area. In several cases a very high competence in research and journalism is combined with a mastery of sophisticated animation skills and software. The graphics people have degrees in cartography, statistics, graphic design and journalism, but others have different backgrounds, for example the graphics editor for Science has a degree in East Asian Studies, and the senior editor got his degree in Urban Studies, and the interactive designer majored in Economics.

[10] http://www.xocas.com/blog/en/?p=184, (retrieved Feb 20, 2012)

[11] http://www.xocas.com/blog/en/?p=184 (retrieved Feb 20, 2012)

[12] http://www.nytimes.com/interactive/2010/06/29/magazine/rivera-pitches.html (retrieved Feb 20, 2012)

In Duenes' opinion, information graphics are not just art. They are a combination of art and journalism and a little bit of science [cf. 6]. New York Times Graphic Editor Xaquín González Veira stated: "We are journalists". This is the reason, why the title is graphics editor and not graphic artist. They do not only decide if something is published as an information graphic: "We, I'd say, 90 percent of the time gather all the information that is in the graphic." These graphic editors are not only working out the story, visual concept and its visual storytelling flow in the storyboard – they even model the characters and environments and animate them for the final graphic. In the award-winning New York Times visualization about the famous hitter Mariano Rivera[13], the only portion not done in house (by NYT newsroom graphic editors) was the actual recording of motion capture data-provided by a closely situated lab of New York University (NYU). Anything else, including modeling, rigging, rendering and textures plus animation, was done by the authors of the graphic themselves. Anybody aware of the high quality of the final outcome and the complexity of high-end 3D animation software will immediately recognize this as an extraordinary accomplishment. Graphic editors Xaquín González Veira, Graham Roberts, Frank O' Donnell and Mika Gröndahl are journalists and skilled computer graphic artists.[14]

4.3 Journalistic Principles vs. Visual Appeal

For the final section of the interview, the question was addressed whether there can be a conflict between journalistic principle (e.g. integrity, accuracy), and artistic freedom. And, if so, how this can and must be addressed by information designers and data journalists in responsible ways. In other words, is there any conflict between integrity and visual appeal or how do the designers at it? Xaquín González Veira emphasized: "There's no conflict. We don't make up things – (…) some other people may have that conflict. We don't." Graham Roberts added: "Something we discussed, there's no conflict in knowing that we are not going to show stuff that we don't have. That's the bottom line." Veira confirmed by quoting the former graphics director Charles Blow: "Show only what you know", and he continued: "Which is like we're not going to – if there's a breaking news of the Osama bin Laden's capture. We're not going to reproduce what happened inside that complex; we don't know it. But we know where it was, we know the shape of the complex, we can point to general areas where we know that something happened there, but we don't show that thing happening. We just say that whatever source told us that here, this happened."

In this case a clear primacy of journalistic integrity over any speculative artistic interpretation for dramatic effect was formulated and it demonstrates the general work ethic at the New York Times newsroom. It is all the more remarkable that the graphic editors there still manage to come up with highly entertaining and visually appealing information graphics which preserve absolute factual accuracy. A statement of Graham Roberts from the interview sums up this philosophy and will provide a fitting closing quote here: "I mean, the choice for me is made on what's the cleanest, clearest way of showing this, what's the least noise between the information and the news and the person receiving it. You know I try and make that as aesthetically pleasing as I can along the way, but not hopefully without adding noise to it."

5. Conclusions and Discussion

In our study about data visualization in online journalism, we have identified one key element, which can be described as the success factor for the production process: attitude – the attitude that each team member acts as a journalist. Information designers, programmers, statisticians, animators, authors – anyone who is involved in news production is part of a journalistic project and fulfills journalistic tasks and therefore should understand him or herself as a journalist. Its holistic approach for producing information graphics makes the New York Times a leader and a role model in the field of interactive information graphics. This paradigm shift that the New York Times newsroom made is still to be accomplished in German and Swiss media companies where we can still find two different ways of thinking: verbal vs. visual.

When looking toward the needs and requirements of the professional field compared to the "traditional" journalist, we found new and diverse professional profiles: Artistically skilled journalists who can serve the multi-disciplinary requirements of interactive information graphics almost autonomously, even though those persons are hard to find. Conversely, it might be argued that this constitutes the need for new academic programs, which balance the education in the fields of design/ visualization, computer science, and journalism and bridge the gap between these disciplines. Such an interdisciplinary approach might lay the foundations for a holistic understanding of information and knowledge visualizations and therefore might foster better visualizations and information graphics. Some universities have already been starting to set up courses in data-driven journalism combining computer science,

[13] At the 19th Malofiej World Infographics Summit 2011 in Pamplona, the New York Times won the Peter Sullivan Award in the category "Best of Show" with the information graphic "How Mariano Rivera Dominates Hitters".

[14] Mika Gröndahl, a graphics editor and illustrator, talks about his diagram of a centrifuge for the print version of Science Times: "The centrifuge graphic is a classic example of how reporters and graphics editors work together. To gather the reference material, I spoke with sources the reporter had cultivated over the years. Then I made a sketch and refined it. I created a 3-D model and made revisions until we were satisfied with the level of detail and clarity." [11]

mathematics and journalism, e.g. the Columbia University's Graduate School of Journalism [1].

A limitation of our study might be the grounded theory approach. Some authors criticize the grounded theory approach for its claim to be a theory and call into question the emergence of empirical data [12, 20]. However, since the whole research field is at its very beginning, the grounded theory is a helpful method to generate first ideas and hypotheses. Another limitation of the grounded theory approach is the sampling process: When is the theoretical sampling finished? According to Strauss and Corbin "sampling continues until theoretical saturation of categories is achieved" [19, p. 193]; that is the point where new data from further interviews has no more implications for the theory. We had the impression that the theoretical saturation was achieved by 19 interviews. Furthermore, the grounded theory approach always generates only qualitative data, not quantitative, since statistical methods are not used. That might be seen as another weakness of our study.

We are aware that our findings reflect a current stage in convergent journalism, which is in a constant state of flux. Therefore, we do not want to use the strong term "theory" for our findings; instead, we prefer the term hypothesis. A quantitative analysis (e.g. a survey in media companies) to verify or falsify our hypothesis could be a next step.

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