Elsevier's Article of the Future: enhancing the user experience and integrating data through applications

In a world where our levels of knowledge advance rapidly, so should the communication of research. In partnership with the world's research community, Elsevier investigates the future of research communication with the 'Article of the Future'. An intuitive online article format, this proposes the next generation in research publishing, with a simple-to-read online layout and enriched content, allowing true immersion in the subject matter. In addition, through the use of SciVerse® Applications, the Article of the Future connects the formal scientific record with associated external data sets and other contextual information that is available elsewhere on the web.

In this article, we present the outcomes of the second phase of the Article of the Future project, with an emphasis on its final designs, user feedback collected, and how the Article of the Future handles the rising need of connecting the formal scientific record with associated discipline-specific data sets.

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Introduction

In the past, science was simply recorded through handwriting and until the arrival of the published medium remained isolated and largely unquestioned. With print technology, new methods of recording and communicating research originated, but these too were limited: articles were flat, references and supplementary information intangible, and there was no access to the authors' research tools and data to fully explore and benefit from their insights.

In today's world where information moves electronically, quickly, and where the scientific tools and levels of knowledge advance rapidly, so too should the communication of research. To this end, in 2009, Elsevier initiated the Article of the Future project to improve the formal and electronic communication of research. The key objectives of this (multi-year and still ongoing) project are:

- to improve scientific communication by publishing the full richness of scientific research

- to offer authors the right tools for communicating diverse and discipline-specific results
- to provide users an optimal reading experience to obtain effectively maximum insight.

Following the approach that significant publishing improvements can be made by going discipline-specific, the first milestone of the Article of the Future project was the release of a new article format for all Cell Press life sciences journals in 2010[1]. The positive reception of this format led to a continuation of the project for a variety of other scientific disciplines. Milestones in this second phase of the Article of the Future project were (and will be) the release of 13 complete prototypes in 2011[2] and two SciVerse ScienceDirect® releases implementing many of the project findings in 2012[3].

In this article, we present the outcomes of this second phase of the Article of the Future project, with an emphasis on its final designs, user feedback collected, and how the Article of the Future handles the rising need of connecting the formal scientific record with associated discipline-specific data sets.

The Article of the Future project

Due to the success of its focus on discipline-specific publishing, in 2010 the Article of the Future project extended to seven other disciplines: parasitology and tropical diseases, electrochemistry, materials science, psychology and cognitive science, mathematics and theoretical computer science, palaeontology, and business management. For each of these disciplines, a group of about 20 scientists collaborated with Elsevier staff to determine the optimal scientific article format for that discipline.

From this discipline-specific approach, two clear observations resulted:

1. Independent of the scientific discipline, scientists like their PDF format, for reasons ranging from optimal typography and predictability to easy storage and distribution. Furthermore, scientists continue to prefer scientific articles to be presented in this traditional and tranquil style, without too much additional clutter obscuring the actual content of the article.
2. However, despite the above, scientists do appreciate additional discipline-specific content, enrichment, value and context – as long as these elements are not distracting from the core of the science presented in the article. In other words, extensive use of pop-ups or flashy highlights should not obscure their core task of reading the article.

These two observations led us to focus the Article of the Future design on the elements of:

- improving the article presentation
- enriching the article content
- adding article context.

Improving the article presentation

Improving the article presentation has been done in multiple ways. First, we clearly separated the tasks of navigation and quick browsing through the images and tables, and introduced a left-pane to support these tasks. Second, we created a middle pane for optimal online article reading, and overhauled the current typography of the online research article. Here we combined lessons from print typography (like maximum number of words per line) and best practices from online page designs (like optimal left and right margin sizes). Third, in order to support the addition and presentation of discipline-specific contextual information without cluttering the core article, we added a right-hand pane to present this type of information. An example of the result can be seen in Figure 1.

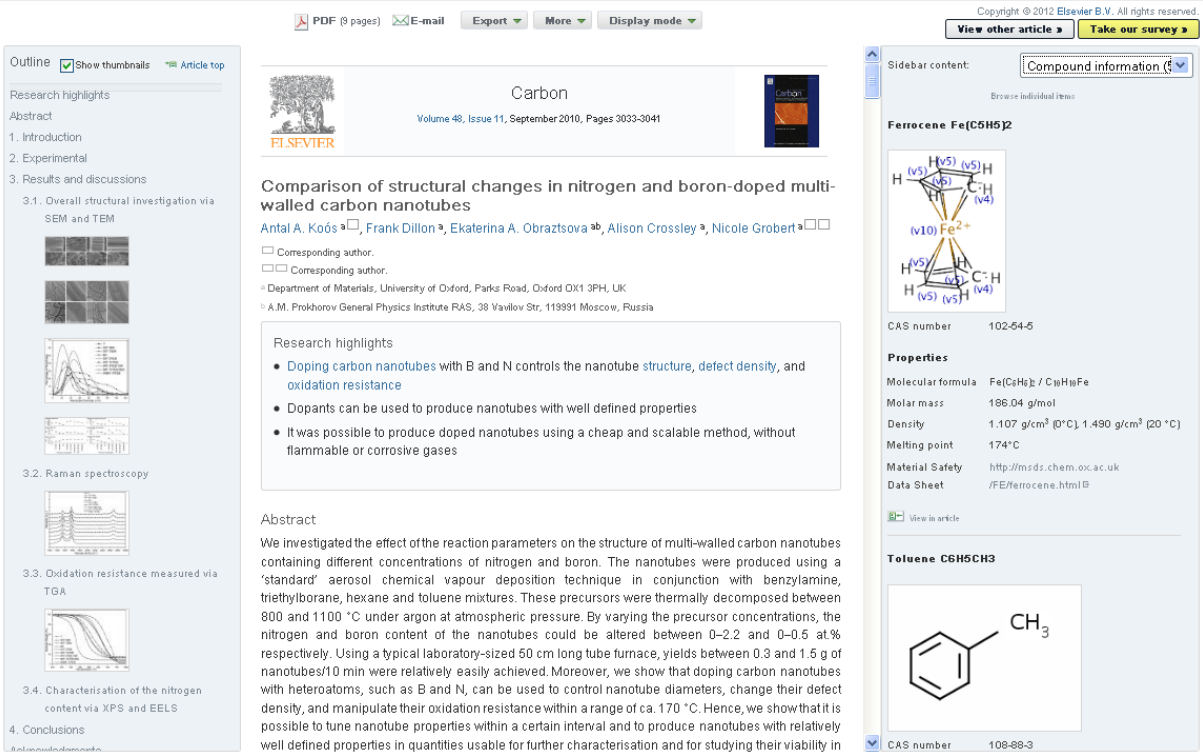

Figure 1. The three-pane Article of the Future format

Enriching the article content

Enriching the article content has been accomplished by bringing discipline-specific research tools inside the article. For instance, in earth sciences, digital and interactive map software (like ArcGIS or Google Maps) are frequently used in the research workflow, and thus the Article of the Future enriches the article content with such added-value maps as well. Similarly, in materials science and engineering, there is a need for more detail on graphs and plots, and current research tools (like MatLab or Mathematica) do already support this functionality. Hence, the Article of the Future enriches articles with features like cross-hair functionality or 3D-interaction. Examples of these content enrichments can be seen in Figure 2.

Adding article context

Adding article context satisfies a need that is frequently observed from the behaviour of researchers. After or even while reading an article, scientists search for related information or associated data sets. For instance, when reading an article on protein or gene sciences, the relevant protein or genomic information is fetched from the Protein Data Bank or GenBank for inspection. Similarly, in chemistry there is a need for basic information on the chemical compounds being mentioned in an article, plus references and links to the relevant databases in which these compounds are covered. The Article of the Future supports this behaviour by presenting the related key information next to the article, saving the researcher the additional effort of searching for this information. See Figure 3 for an example of how protein information from the Protein Data Bank is added to the article – in the right-hand pane, thus not to clutter and detract from the article content as presented in the middle pane.

Going mobile: tablets

As well as the focus on improved presentation, enriched content and adding context, the Article of the Future design also incorporates the need for an optimal mobile tablet experience. With the Apple iPad being the key device in this segment at the time of development, the design supports all key functionality on the iPad. With the iPad screen being smaller than a regular computer screen, this means that in landscape view the user can choose whether to view the left or right pane next to the middle content pane, while in

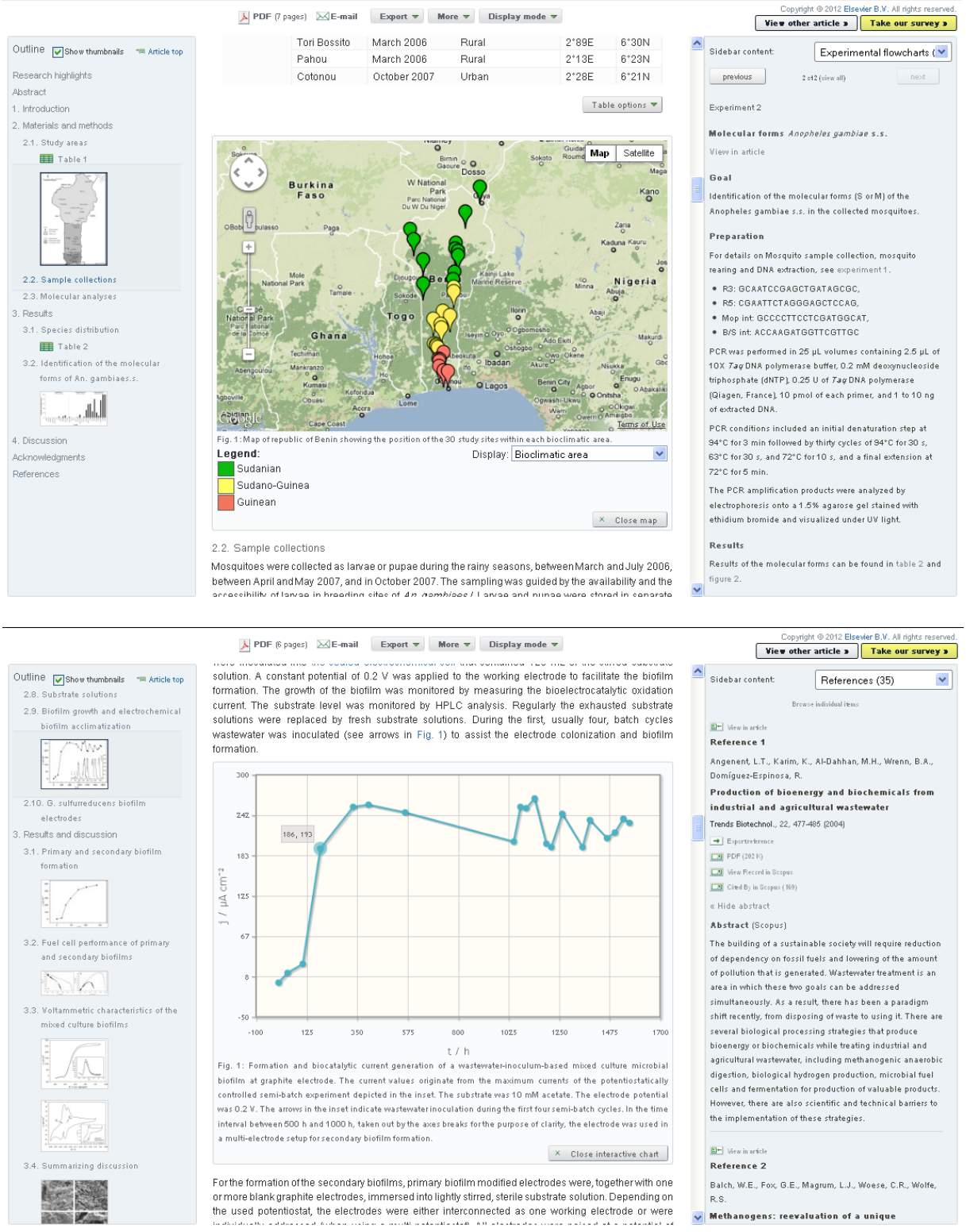

Figure 2. Content enhancements in the Article of the Future: an interactive map (top) and graph (bottom)

portrait mode only the content pane is visible. In both cases, the hidden panes can always be 'flown in' from the left or right, for temporary display and inspection.

Authors and readers

For authors, the Article of the Future delivers greater exposure and a better opportunity to showcase their work. By enabling a higher level of communication and engagement with the scientific community, it enriches and extends the reach of research, giving it more credibility and increasing the likelihood of use and citation.

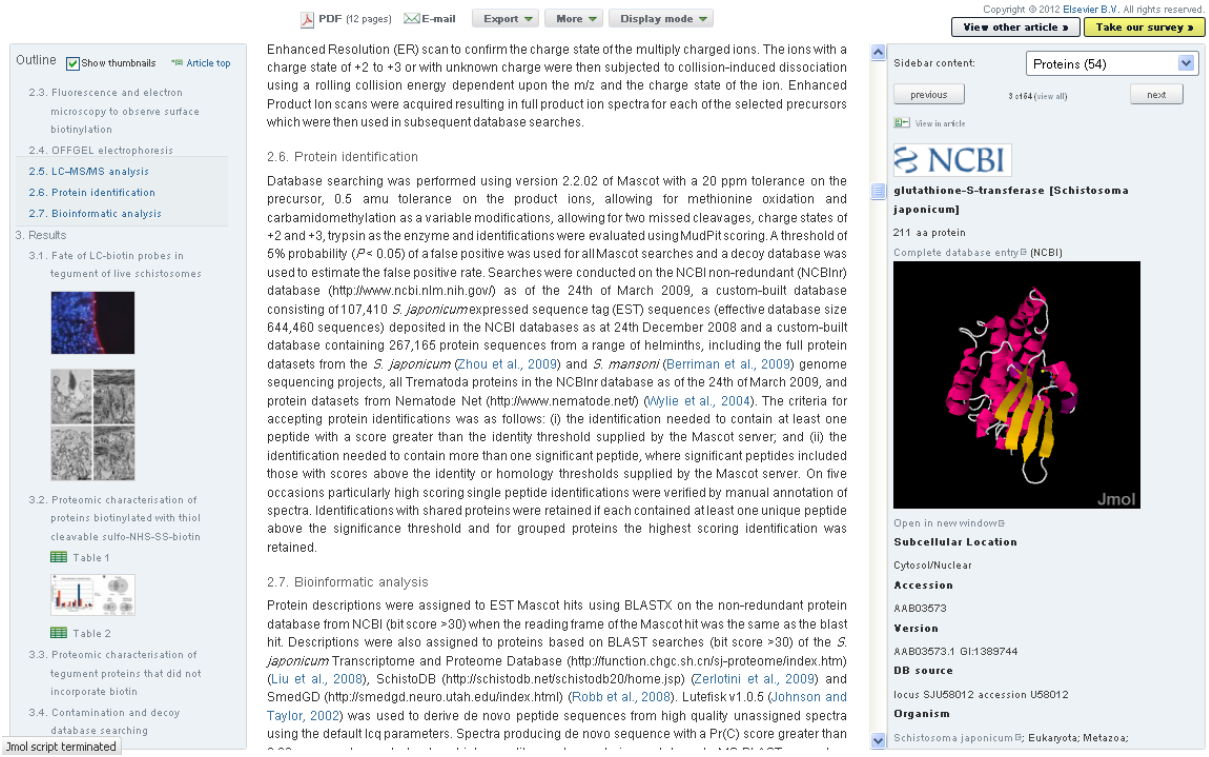

Figure 3. Context enhancement in the Article of the Future: visualizing data from the Protein Data Bank

For readers, the Article of the Future makes it possible to interact with the content to explore subjects further and in more detail, providing deeper insights in a more efficient and effective way. Researchers save time because they are able to determine the relevancy of an article more quickly, and can use improved linking and navigation to find images, references, or other material within the article right away.

Article of the Future evaluation

As mentioned, the Article of the Future project has been undertaken in collaboration with some 140 scientists, coming from various disciplines and in different stages of their scientific career. With the input of these scientists, 13 prototypes were created and presented to the research community. We evaluated these prototypes with other scientists, and received feedback on them from hundreds more.

Testing user behaviour

At the end of 2011, we conducted an empirical study to compare the latest design variant of the Article of the Future and the traditional (pre-2012) SciVerse ScienceDirect article design (see Figure 4).

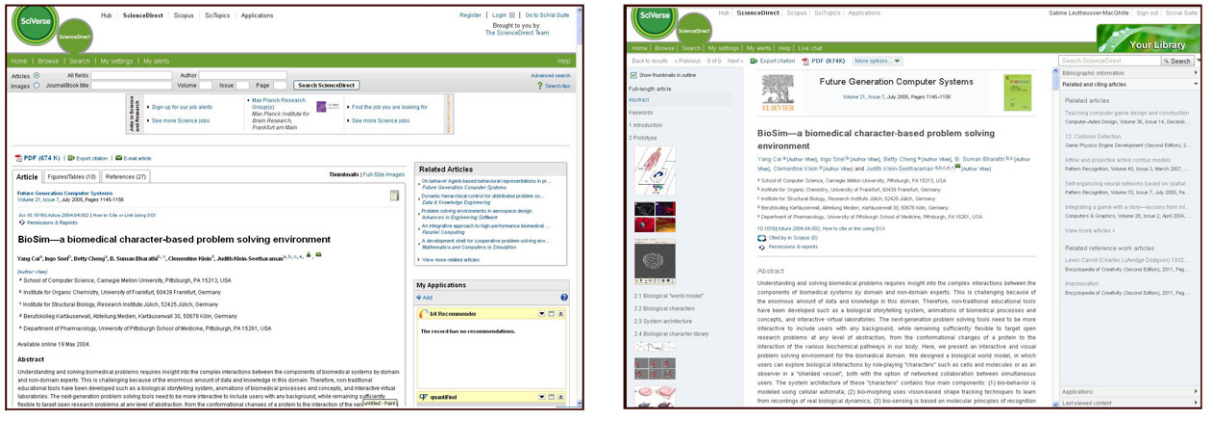

Figure 4. Pre-2012 ScienceDirect article page (left) and Article of the Future format (right)

Sixty-four scientists in the first half of their scientific career participated in this study. Our main findings are listed below [4]:

1. Users immediately start focusing on the article text, then gradually and naturally discover the left navigation first and the right pane second. Everything seems to fall in place at the right time, as users interact with the content rather than with widgets.

2. Using the Article of the Future design, users spend a larger fraction of their reading time online than using the traditional (pre-2012) SciVerse ScienceDirect design. With the new design, users also less often download the PDF for further reading and inspection (see Figure 5a).

3. With the Article of the Future design, part of the additional online time is used to inspect the extra context and content provided – with a great level of satisfaction as the Article of the Future design is preferred in a 4 against 1 ratio (see Figures 5b and 5c).

4. The Article of the Future design is especially effective in determining whether an article is not relevant: a 34% time savings is achieved in those cases (see Figure 5d).

The conclusion that can be made from these findings is that the Article of the Future provides an effective online experience for readers: it allows readers to determine the relevancy of an article more quickly, and for relevant articles, it delivers more information and context than with the traditional (pre-2012) SciVerse ScienceDirect article design in the same time.

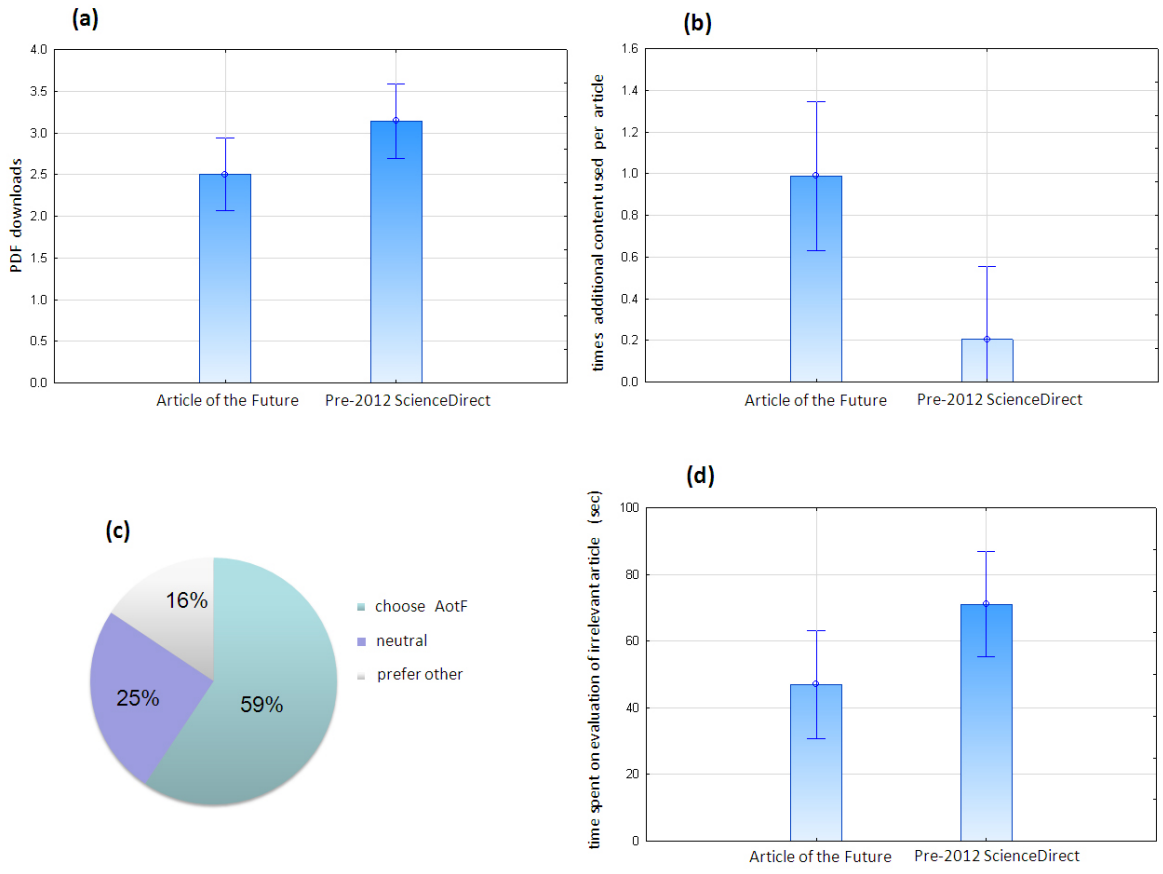

Figure 5. (a) Users less often download the PDF for further reading and inspection. (b) Part of the additional online time is used to inspect extra context and content. (c) The Article of the Future design is preferred in a 4 against 1 ratio. (d) The Article of the Future design is especially effective in determining whether an article is not relevant.

User feedback through surveys

When we launched the Article of the Future prototypes on www.articleofthefuture.com, we also added survey forms to be completed by visitors. (See Table 1 for some of the questions.) From the hundreds of completed user feedback forms that we received between June and December 2011, we learn that:

1. Of the respondents, 75% agree that the Article of the Future design contributes to obtaining a better understanding of the research described in the article.
2. These percentages, however, do vary from discipline to discipline. For instance, while in parasitology 85% agree with this statement, in mathematics it is only 65% (with a higher percentage of 'neutrals').

How does the new presentation format and extra features contribute to obtaining a better understanding of the research described in the article?
Please indicate if there is a specific task that is particularly affected as a result of the new article format
What is your opinion on the overall readability of the main text content area compared to how articles are usually presented in HTML form on journal websites?
Does the article outline shown on the left side help you to navigate easily within the article?
Does the approach of showing additional content/features in the right sidebar help when reading the article?
What did you LIKE THE MOST about the article prototypes?
What did you LIKE THE LEAST about the article prototypes?
How would you rate this new presentation format of a research article overall?
How would you PRIORITIZE the following new content specific article features in terms of usefulness?

Table 1. Some questions from the Article of the Future prototypes survey

Overall, the survey feedback on the Article of the Future design has been very positive. Appreciation covered all areas of the design, ranging from easy navigation provided through the left-hand pane, side-by-side display of text and images, additional information on references at the right, and interactivity in graphs and plots. Negative feedback mostly concentrated around longer download times and still a too cluttered presentation – the former is something that will be addressed at release time in January 2012, while improving the latter is an essential part of the right-hand pane release due later in 2012.

Data sets and SciVerse Applications

Next to the formal scientific record as an article in a peer-reviewed scientific journal, both raw and interpreted data become increasingly important in the communication and validation of scientific research[5,6]. This trend is accelerated by funding agencies requiring research data to be made accessible for re-use by other scientists through clear research data preservation policies[7]. It is therefore expected that over the forthcoming years the amount and size of available research data sets will be exploding[8,9].

Unfortunately, although scientists do indicate that access to data sets is very important for their research, they also say that access to such data is not easy[10]. On the other hand, access to the formal research article is very easy (and important). One of the objectives of the Article of the Future is to support scientists by improving the discoverability of data sets as much as possible, by[11]:

- either simple linking (and moving) from the article to the associated data, or
- through the use of applications to show the data in the context of the article.

SciVerse Applications enable deep integration of research data into the Article of the Future design on SciVerse ScienceDirect[12]. Such integration does not just consist of a link to or

a list of the data sets that are (remotely) available for the article, but can offer very data-specific functionality – highlighting the data in a form that is optimal for the understanding and re-use by the reader when reading an article. Furthermore, SciVerse Applications is an open platform, allowing any developer to build data-set applications or other solutions to improve research discovery.

Below we list three examples of such data-set applications – one built by Elsevier (with the help of NCBI, the National Center for Biotechnology Information in the USA), one built by a data set repository owner (PANGAEA®, Data Publisher for Earth & Environmental Science), and one by an individual developer unrelated to either Elsevier or the respective data set repository owner.

Genome Viewer

The Genome Viewer[13] provides functionality for viewing and analyzing sequence data of genomes and also genes mentioned in SciVerse ScienceDirect articles. The Genome Viewer scans an article for author-tagged NCBI accession numbers, of which a list appears in a dropdown menu. When an accession number is selected, the Genome Viewer will be refreshed with the associated sequence map (see Figure 6a).

The Elsevier Genome Viewer was developed in close collaboration with the NCBI team that developed the NCBI's Sequence Viewer[14] and is based on the same JavaScript code and style sheets.

PANGAEA supplementary data

Articles having supplementary data sets submitted to and stored at the PANGAEA® data library[15] display a Google Map indicating the geographical coverage of each such data set. Clicking on the data-set indicator on the map reveals information about the data set, along with a link to PANGAEA where one can view the full information about the data set and download it (see Figure 6b). The PANGAEA application[16] has been developed by PANGAEA.

Exoplanets+

The Exoplanets+ application [17] extracts exoplanets (extrasolar planets) mentioned inside articles and displays exoplanet data right inside the article view. Exoplanets+ combines

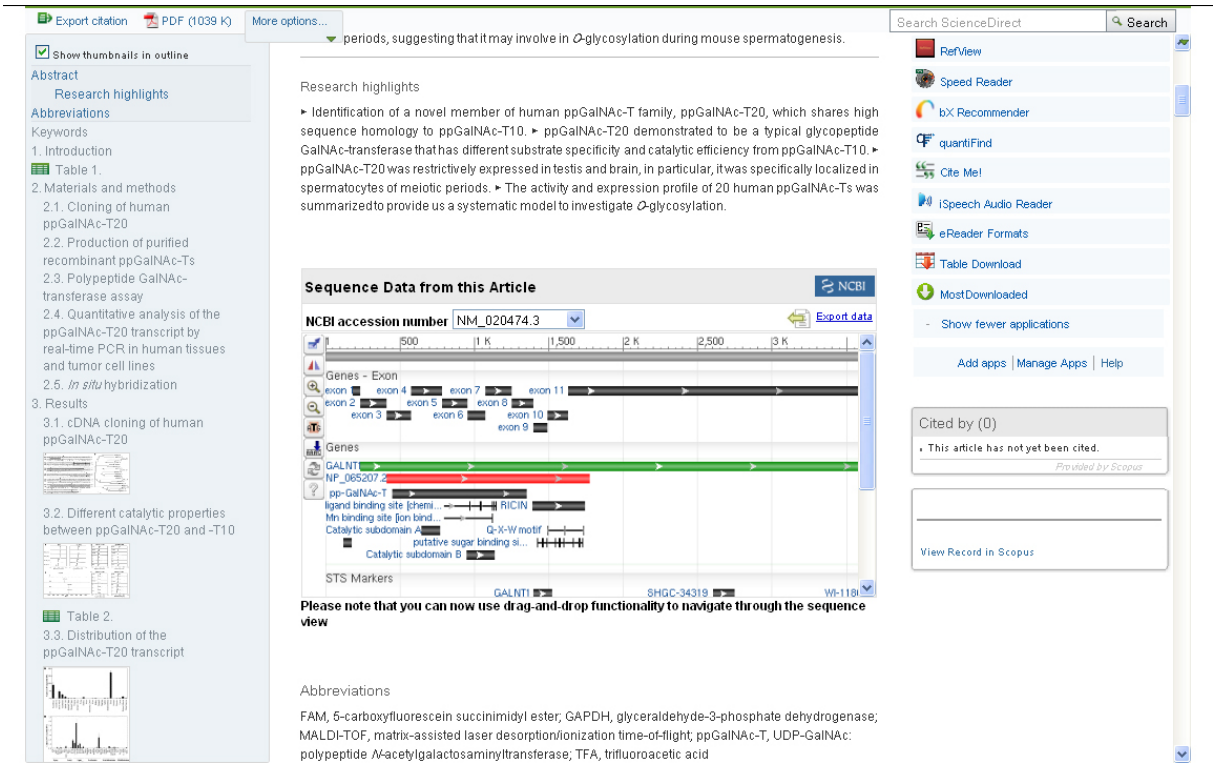

Figure 6. Using applications in the Article of the Future to integrate data from NCBI GenBank (a), PANGAEA (b), and various data sources in astronomy (c)

Figure 6. Continued

and displays rich and visual data of more than 450 planets from the following sources: Exoplanets.org, Exoplanet.eu, Visual Exoplanet, NStED, and SIMBAD Astronomical Database (see Figure 6c). Exoplanets+ was developed by Soe Thiha in the Apps for Science Challenge organized by Elsevier Developers Network[18].

Conclusions

In 2011, the Article of the Future project delivered the next milestone in its journey to explore better ways to create and deliver the formal published record. This milestone consisted of presenting a new format improving the article presentation, enriching the

article content, and adding article context – functionality and features that were developed in collaboration with many research scientists and developers in the scientific community.

A large number of user tests, behavioural studies and survey feedback demonstrate that the Article of the Future format is valued by the scientific community, and improves both efficiency and contextual understanding of scientists when browsing and reading scientific articles. Furthermore, the Article of the Future design in combination with SciVerse Applications provides great opportunity to connect the formal scientific article with associated data sets.

Key elements of the Article of the Future design will be rolled out and integrated into Elsevier journals and on SciVerse ScienceDirect in the course of 2012.

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