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'OnePoint' – combining OneNote and SharePoint to facilitate knowledge transfer

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The identification and development of novel drugs requires a multidisciplinary team of individuals whose membership changes during the lifecycle of a project. Incomplete knowledge transfer across this team can be a barrier to effective decision-making and efficient drug discovery. We have deployed a new infrastructure supporting information storage and distribution within small teams using Microsoft's SharePoint™ server technology in conjunction with the desktop application OneNote™. This delivers a user-friendly collaborative workspace that is fast, flexible and carries a low training burden. Demand from drug project teams for this 'solution' has now resulted in site-wide deployment to over 500 people across research.

The pharmaceutical industry is facing massive challenges to its traditional business model from rising research costs, stalling productivity, increasing competition from generics, and from the need for more rigorous safety and comparative efficacy data. Change is also being driven by opportunities, such as a deeper knowledge of targets and biological processes [1,2], and enabling technologies such as high-content screening [3]. An early response to these pressures has been to focus upon improving efficiency through outsourcing, the implementation of productivity metrics [4], the design of more efficient workspaces [5] and the analysis of drug discovery as a process that can be optimised [6,7].

There is also the potential to improve productivity through more effective management and use of knowledge to drive better and faster decisions. The combination of two Microsoft products – OneNote and SharePoint (which we have termed 'OnePoint') has been applied to deliver an easy-to-use, searchable, open-access storage system that can be shared across a small team. Early trials to assess the potential of creating such a collaborative environment have now resulted in a site-wide roll-out across research projects (*ca.* 500 people).

Drug discovery teams

Developing potential new drugs requires many individuals from different disciplines to work together as a team with the shared goal of identifying a compound with a specific combination of physical and pharmacological properties. Essential to the success of this group is effective and efficient knowledge-flow within the team. Pfizer, like many large pharmaceutical companies, has co-located individuals to work within their disciplines, to take advantage of local expertise and to allow efficient sharing of department-specific resources. These same individuals, however, also form part of one (or more) cross-discipline team charged with identifying new potential drugs. Consequently these drug teams are not always closely located. Within Pfizer, it is not uncommon for team members to be located in different buildings on the same site, or for some team members to be based at sites in different countries. Although this enables Pfizer to draw upon its global scale, it can produce a significant geographical distribution of drug team members that results in a barrier to efficient knowledge transfer and hence to effective decision-making.

Data storage

Pfizer, like all major pharmaceutical companies, has invested significant resources to provide company-wide access to compound-related data. Each compound is given a unique internal identifier, which is used to index compound-specific data, be it defined (e.g. structure), calculated (e.g. $c\log P$) or measured (e.g. solubility). This initially appears to offer a 'perfect' solution – globally accessible data on all compounds delivered to a scientist's desktop within seconds in a format that facilitates data

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1359-6446/06/$ - see front matter doi:10.1016/j.drudis.2009.06.015

mining and further analysis. Large-scale pre-defined databases, whilst ideal for storage of high-throughput data with simple endpoints, are less accommodating to more complex data, such as *in vivo* studies. Such bespoke studies may never reach the corporate database because of the barriers to publishing such as defining the study protocol, providing additional qualifying metadata or simply because the 'cost' of publishing outweighs its perceived value. Consequently, a significant minority of data that are generated can remain in an individual's lab book and may be reported only by email or even verbally. An additional layer of complexity results from the number of people who may contribute to the study and the analysis of its outcome. For example, an *in vivo* study is only of value when the observed pharmacological endpoint is viewed in conjunction with measured drug plasma levels that have been scaled by protein binding in that species. Within Pfizer these studies are often performed by specialists in different groups and no single person has a vested interest in combining all the data into a single report. Consequently, although all the data may be stored, it is at worst in several laboratory notebooks and at best, in the corporate database under a range of disconnected endpoints.

Arguably, of much greater value to a corporation than its raw data is the knowledge that can be extracted from it. This requires the assembly of all the pertinent data from a particular study, analysis by an expert and the generation of a conclusion from the sum of these data. It is the exchange and long-term storage of this knowledge that has historically been challenging to manage, both within a team and across the organisation. Typically, such a document would be circulated to the current members of the project and then filed in a document repository.

Corporate knowledge-sharing systems

The most certain route to pass information between individuals is by email; however, this ubiquitous form of communication is far from perfect. Inappropriate distribution lists can result in those who have no need of the information being swamped by unwanted messages (spam); others who would value the information may be omitted, and new project members have no easy access to historic information. Even an appropriately circulated email costs the recipient time to manage and store locally if the information is not immediately useful.

An improvement over email is a company-wide storage system. These are highly effective at ensuring the permanent archival of documents, but only partially effective at knowledge dissemination or at facilitating historical mining. Navigation through a folder-based filing system that is intuitive to one user can appear impenetrable to another. Further, endeavouring to determine the content of a document before opening it based upon the file name (along with any metadata that may also be stored), can be imprecise and users will quickly tire of searching after several unsuccessful attempts – especially if this process is restricted by the speed of the network. Even with a good document storage system, a clear filing structure and the inclusion of metadata, knowledge can still be buried – for example in the minutes of a meeting. Although to some extent, some of this knowledge-loss can be mitigated by the incorporation of effective search engines, it often still requires significant investment by an individual to run searches. This can result in the most valuable outcome of an experiment – the knowledge it creates – effectively becoming 'lost' to those not intimately involved in its creation. Addressing this loss of knowledge could have a significant impact upon the efficiency of the drug discovery process by reducing the potential for poor decision-making or re-discovering something already known within the organisation.

OneNote and SharePoint

The past few years have seen an explosion in methods for collaborative sharing of information – often captured under the umbrella term 'web2' [8,9]. One of the most widely recognised examples of this is the wiki; the online encyclopedia Wikipedia being a great example of how impactful such technology can become (see: http://en.wikipedia.org/wiki/Main_Page). Wiki pages allow an individual to add or edit information which is then visible to anyone else. Whilst powerful, in its current form, this technology still poses a barrier to information dissemination if the data-creator has no interest in learning how to edit pages or attach documents. Another form of collaborative information-sharing has become possible by combining two off-the-shelf products in a manner that has started to revolutionise the sharing and storage of knowledge within project teams. Microsoft Office OneNote 2007® is a desktop application which is a component of the entry-level Office suite (see: http://office.microsoft.com/en-gb/onenote/HA101656661033.aspx). It is a note-taking program that has been promoted as a means for an individual to store and organise information. Microsoft SharePoint® services is a server-based operating system that includes the ability to integrate with the Office suite by acting as a host for documents (see: http://www.microsoft.com/sharepoint/prodinfo/what.mspx). In particular, SharePoint can host a OneNote notebook, which, in turn, allows a notebook to be shared by multiple users.

OneNote is an exceptionally intuitive application to master. The user can type text anywhere on an electronic page. Alternatively, content can be added using drag-and-drop or cut-and-paste actions, directly exported from Internet Explorer or printed to OneNote from any application. Content can include documents, pictures, text or hyperlinks. Pages can be organised inside folders (termed 'sections' or 'section groups'). A notebook typically comprises several section groups, sections and pages, all of which can be renamed and moved around the notebook allowing for the dynamic reorganisation of content. Similarly, items can easily be rearranged within a page, and hyperlinks between pages inserted to aid navigation.

Documents, once embedded, can be opened in their native application (double-clicking the icon), edited and saved in the normal manner. Users can type text or paste a picture alongside a document to act as a search aid (metadata). Similarly, conclusions from an attached study report can be added to reduce the need to open every document to get 'the bottom line'. OneNote automatically indexes any text on a page, enabling rapid searching throughout the notebook.

Hosting a notebook on a SharePoint server stores a copy of the entire notebook which then acts as a central copy in addition to the local copy stored on each user's machine. When a user makes changes, these are first performed upon the local copy, and then automatically synchronised to the server whenever a network connection is made and OneNote is open. For multiple users,

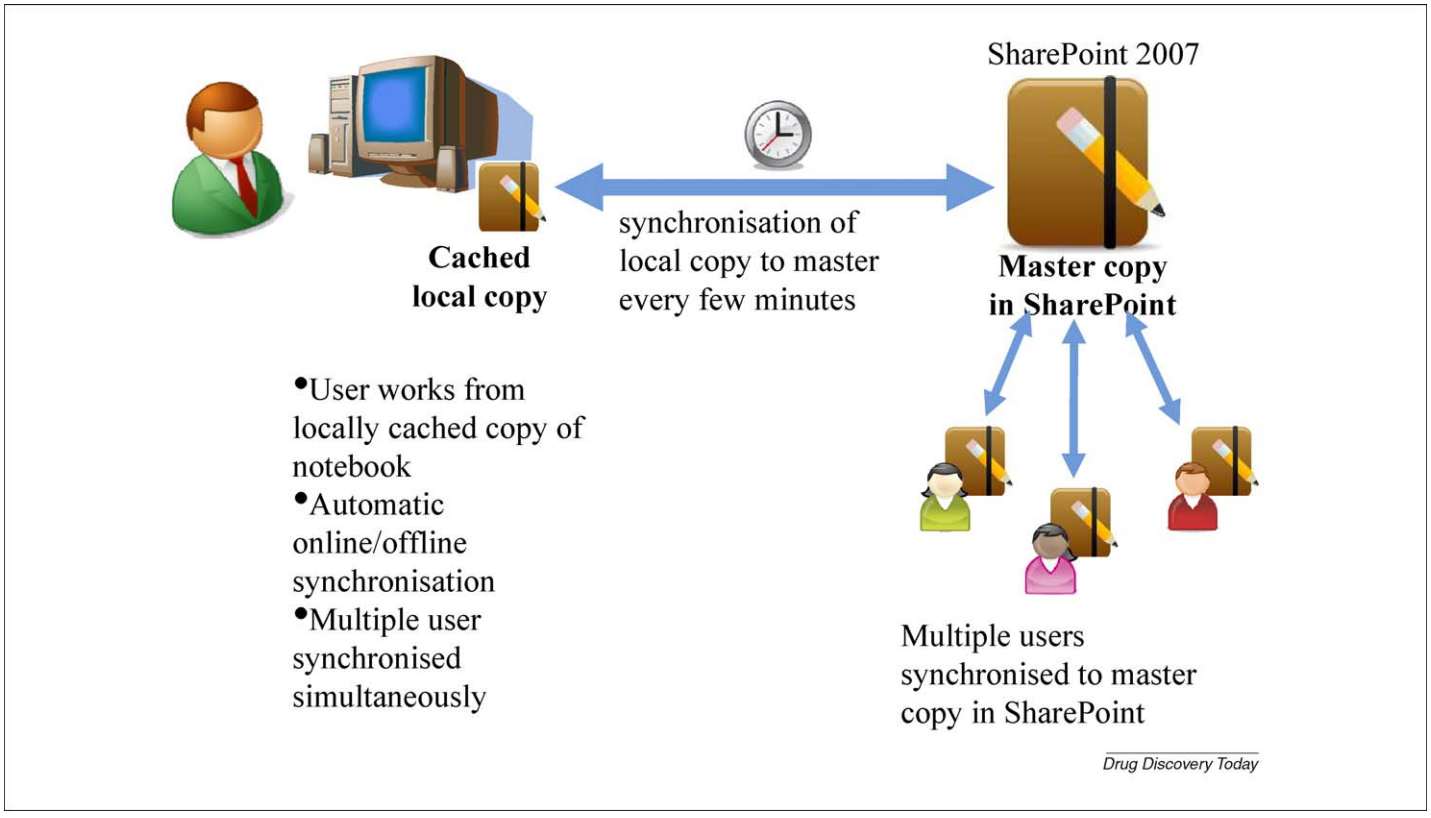

FIGURE 1

Synchronising local and SharePoint copies of a notebook.

any changes made by an individual are first replicated onto the server copy then distributed to all other networked local copies (Fig. 1).

When a new project member opens the project notebook, it will first be downloaded to provide a cached copy on the user's internal hard drive. This is subsequently re-synchronised every few minutes. Because the encryption of entire hard drives is now common, creating local copies of corporate information does not pose a significant security risk. We have found that the size of a typical mature project notebook is well under 1 GB and consequently does not tend to be limiting given the capacity of modern hard drives. SharePoint can be configured to hold several versions of OneNote files, thereby providing automatic back-up of documents. One of the greatest strengths and greatest weaknesses of OneNote is the lack of a check-in/check-out functionality. Not having a check in/out process improves usability for the user but does introduce the risk of two users undertaking simultaneous edits. Different objects may be concurrently edited on the same page by different users, and generally this is well-managed within OnePoint without the user noticing (apart from seeing new content appear before their eyes). However, the simultaneous editing of an embedded (attached) file can cause synchronisation errors. When this happens both edited copies are stored with a warning and the user can reconcile these differences when appropriate. Whilst this may be perceived as a major drawback, in practise this has proven a surprisingly rare occurrence and is almost completely avoided by using workflows that do not require multiple users to edit the same embedded files. In fact, as users become familiar with OneNote, they tend to embed fewer files, because all the essential editing functionality is already available from within OneNote (with the added benefit of handwriting recognition if the user has a tablet PC).

OnePoint has filled a niche in our corporate document and knowledge management systems, sitting at a team level where small groups of individuals can share information dynamically (Fig. 2). Typically, project notebooks are shared by 20–40 members of whom about half will regularly contribute. It has also provided an effective tool for individuals to maintain personal notebooks. OnePoint is not suitable for company-wide information sharing because there is a need to store a local copy of the notebook on each user's PC. Also with much larger number of participants, the potential for simultaneous edits to cause conflict errors becomes proportionately larger. Further, its lack of auditing and document control makes it unsuitable for business-crucial document management.

Our decision to adopt this solution in preference to others that are available fell to several key factors – cost, deployment speed and usability. Because Pfizer already uses SharePoint as a storage medium, the cost of implementation was restricted to the purchase cost of OneNote licenses which are relatively inexpensive. There were no technical barriers to deployment because existing infrastructure could be used without the need for significant customisation. Finally, the intuitive graphical interface resulted in a low training burden (see below) and in high levels of uptake. The latter cannot be underestimated; we have previously seen significant barriers to user adoption of programs that are either complex to learn or use.

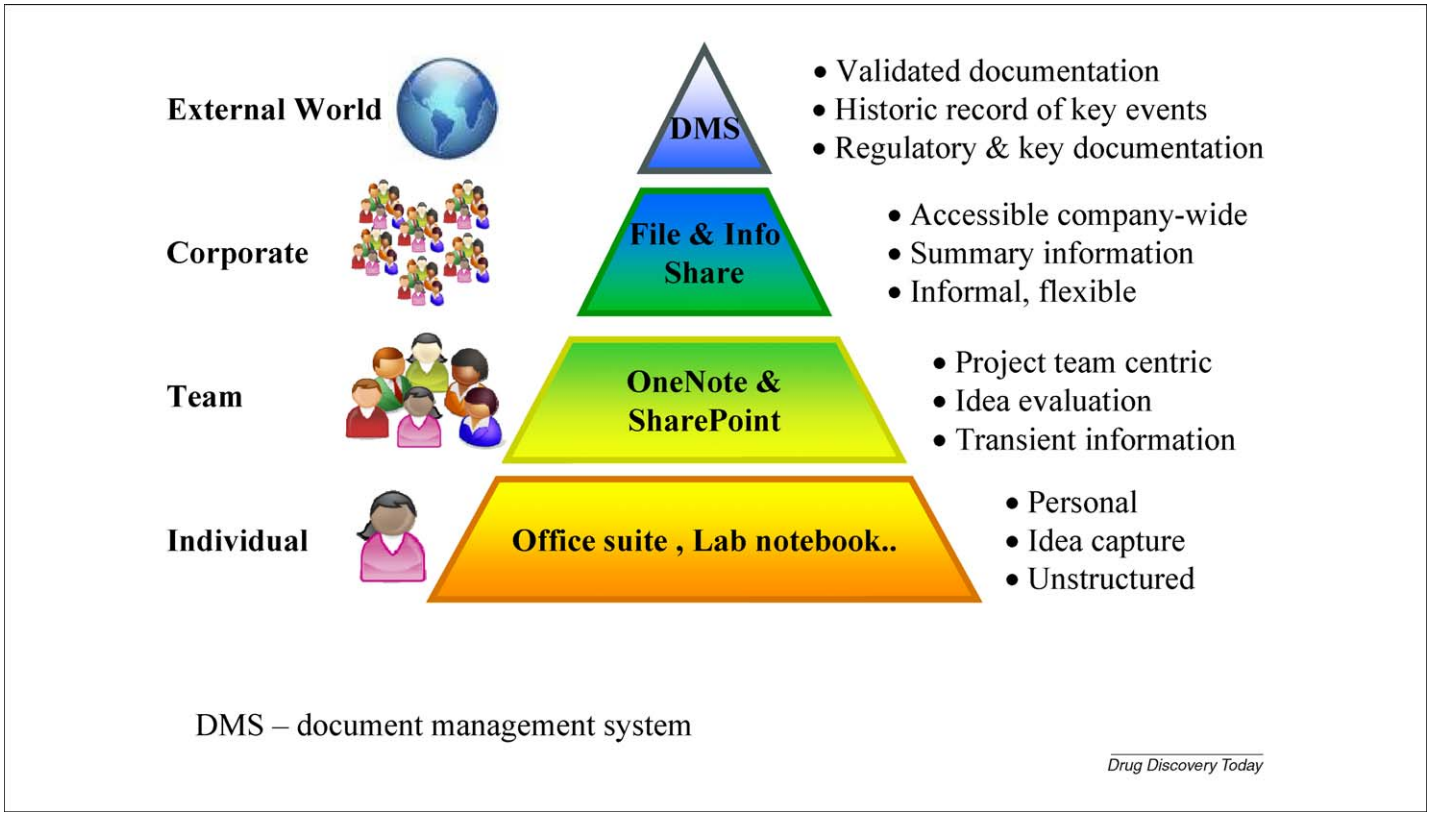

FIGURE 2

Fitting OnePoint into a corporate environment.

Our experiences

The training burden has been remarkably low for a new application. We have found that a one-hour demonstration lecture is sufficient training for users to rapidly become proficient users. In fact, the majority of this training has been focused upon 'best practices' (Box 1).

A key advantage of a flexible, informal storage system is that teams can 'personalise' it to suit their needs and workflows. This does, however, introduce the attendant risk for indiscriminate 'dumping' of data in an unstructured manner. To address this, projects are provided with a basic filing structure where section groups are organised along discipline lines. This has two clear advantages. Firstly, it is fairly intuitive for users to navigate to find information and secondly, it instils ownership for the content held within these sections. Historically, this culture of data management including the deletion of obsolete information was rather rare on network file shares.

Early agreement within a project on when to merge information from different disciplines was also important. Most projects agreed to create specific sections for compounds when they progress beyond a key stage – typically at the onset of *in vivo* studies, because this tended to be the point at which conclusions can only be made by combining data from different studies across disciplines. For the relatively small numbers of compounds that progressed beyond this point, reports (or links to them) are co-located on a single page alongside a summary of conclusions of these studies. This quickly becomes intuitive and of value to the team members – particularly those without the skills to judge critically the contents of all documents, but who still wish to see the study outcomes.

Another consequence of the implementation of OnePoint has been the ability to start to organise knowledge such as rationales for strategies. Previously, such knowledge had rarely been recorded; however, there is significant value in sharing this knowledge for others who may wish to pursue a similar course of action, or as a tool for the retrospective analysis of project progress. Facilitating the open exchange of ideas in real-time also allows peers to contribute to the discussion and influence the direction of the project; this ultimately yields better decisions. Having such an

BOX 1

Good working practise for using OnePoint collaboratively.

- OnePoint is not a replacement for existing data-entry processes (but it is great for capturing metadata, decisions, interpretations and summarised data).
- Use a discipline-based folder organisation, assign responsibility for content and regularly remove unwanted data.
- Data-generators are responsible for adding their content.
- Insert files and add comments/conclusion/summary alongside to aid subsequent retrieval.
- Avoid co-editing documents within OneNote – store such documents directly in SharePoint and use check-in/check-out options.
- Manage meetings with OneNote (add agenda, ask presenters to directly add their slides; append minutes to the same page).
- Do not email documents – e-mail a link to a OneNote page.
- Improve navigation through the notebook by adding links to connect pages.

open system also supports junior project members, who can more quickly learn project strategies and tactics.

OnePoint has driven a reduction in the volume of email traffic, as data are easily stored and retrieved centrally reducing the need to circulate it by email. This has the benefit of creating a much more inclusive environment because everyone has access. Meetings are particularly well suited to this solution. Agendas are added to a predefined section, project members can add or amend agenda items and attach content to be discussed (or hyperlinks to that content if it is held elsewhere). The meeting organiser hosts the meeting from within OneNote, and minutes are recorded directly onto the page, either during or after the meeting. This has reduced the email traffic typically generated by a meeting to a trickle! Essentially the OneNote page becomes the agenda, a store of the presentation material, and a record of the outcomes.

The ease with which text, graphics and hyperlinks can be co-located has made OnePoint particularly attractive for the organisation of literature references within groups. Inclusion of a graphical abstract and the hyperlink to download the pdf from the publisher's website makes this highly effective communal store of key information. Figure 3 shows a screen-shot from a typical project notebook.

After a few months of use, we surveyed all those using OnePoint (Box 2). It is clear that of those who replied, the majority have found it a positive experience with 75% reporting that it positively impacted upon their work, whilst a small group (9%) saw a negative impact. It is clear no solution will ever suit everyone, depending upon the individual's specific needs and work-patterns. For example, data-creators who have no need to retrieve old data will derive little benefit from filing information in any storage system. We identified a key group of individuals for whom OnePoint was particularly valuable – those who are dependent upon information from others to make decisions. These decision-makers believed OnePoint had improved their access to information, with all seeing a time-saving benefit as a consequence. The majority of decision-makers (76%) save in excess of 30 min a week.

BOX 2

Survey results from users following implementation.
When analysing the survey feedback, we identified a subgroup of individuals who relied upon information from others to make decisions (termed 'decision-makers'). 76 users responded.

- 67% of all users and 80% of decision-makers believed that 'OnePoint makes it easier to get their job done'.
- 57% of all users and 55% of decision-makers had seen a reduction in the size of emails sent and received.
- 75% of all users believed 'OnePoint had positively impacted upon the way they worked' (16% saw no impact and 9% saw a negative impact).

For decision-makers:

- 60% agreed with the statement that 'it has improved their access to decision-making information'.
- 76% are saving in excess of 30 min a week (24% saved 10 min a week, 41% saving in excess of an hour a week).
- 85% believed that it has enhanced or strongly enhanced the way in which they work (10% believed it negatively impacted and for 5%, it had no impact).

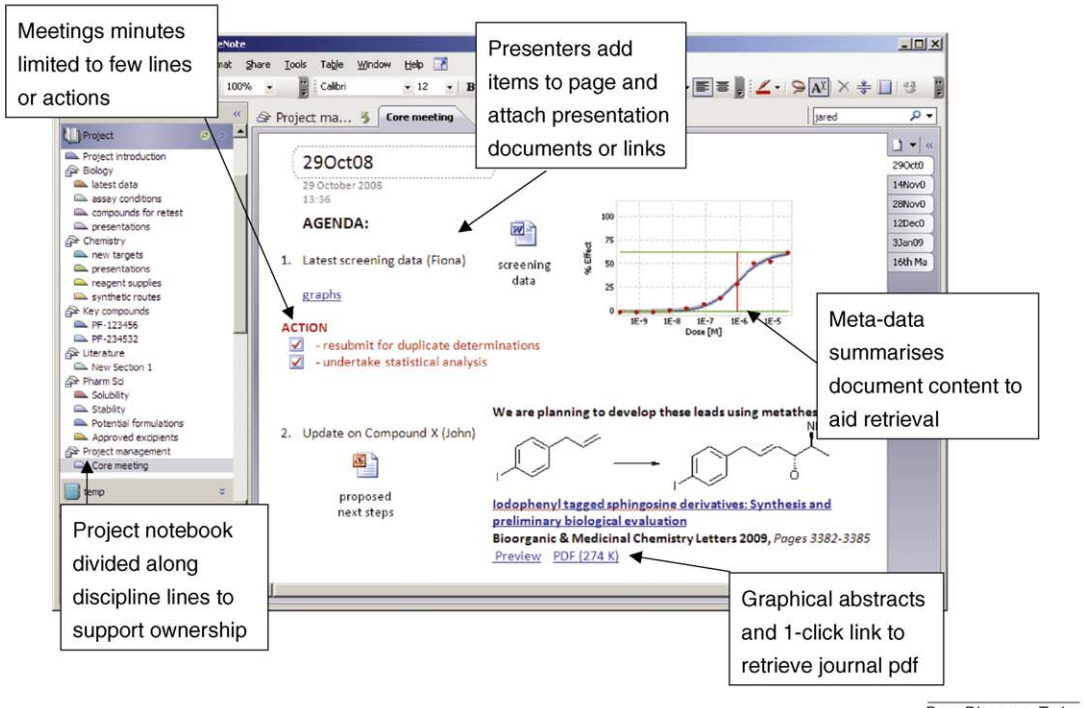

FIGURE 3

A typical project notebook.

Weaknesses in the current implementation

Whilst we have implemented a site-wide roll-out to over 500 users, there are still some limitations for which we are developing further solutions. Shared notebooks work well within a small team, but are not scalable across larger groups. For these cases, we are developing solutions that allow sections of a notebook to be browsed without the need to first download a copy [10]. Conflict errors caused by the simultaneous editing of a file by multiple users have been infrequent and do not result in data-loss because both copies are stored. When they do occur, however, the user's confidence in OnePoint is undermined. An improved method to check if anyone else on-line is editing a document or allowing its reservation could be a useful enhancement, as the majority of edits are undertaken whilst on-line. Users have also requested automatic tagging of who has made edits to an object or page. This would serve two purposes – allow some form of audit-control and also to allow others to search or receive alerts for changes made by an individual.

Whilst this current solution works well to allow teams of individuals to efficiently share information, it does not map the complex processes of drug discovery. We, and others [11], are also developing bespoke solutions to allow more detailed knowledge-management specific to drug discovery. For example, recording the design rationale for compounds to allow retrospective analyses, and tracking the progress of compounds through screening cascades with automatic linking to all the data generated during that process would be of significant value.

Taken as a whole, these limitations have not proven a sufficient impediment to wide-scale adoption by users and we hope that these will be resolved by future software developments.

Conclusions

The combination of an intuitive interface, the speed of access from a local copy and the invisibility of the underlying technology has all helped make OnePoint a popular solution. The ability to work in a highly collaborative environment has reduced the administrative burden of project work (reporting, storing and sharing documents), and has increased project engagement. It is also facilitating a cultural shift to more open working, an increase in peer-scrutinised decision-making and a reduction in 'reporting by email'. This solution has been applied to traditional drug discovery projects and to small groups of individuals with a shared special interest and who need to work collaboratively. The implementation costs and overheads are relatively low. Currently the whole of the discovery effort at the Sandwich site (~500 users) is migrating from several legacy network storage systems into SharePoint, and the great majority of these projects are now successfully using OneNote/SharePoint to host project notebooks.

Conflict of interest

The authors have received no payment for this manuscript and have no financial connections with Microsoft. Since the preparation of this manuscript, the authors have agreed to work with Microsoft under a Technical Adoption Program (TAP) to test and give feedback on future versions of this software.

Acknowledgement

The authors would like to thank Alex Alex for useful discussions.

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9 See also eRooms and collaborative software (http://en.wikipedia.org/wiki/List_of_collaborative_software)
10 Microsoft has released a 'powertoy' which partly solves this by allowing the publication of a browser-compliant version of the notebook but it does not support attachments or hyperlinks that may be on the page (see: http://www.onenotepowertoys.com/2007/07/07/onenote-web-exporter/)
11 Graeme Robb (2009) Presentation – Hypothesis-driven drug design using wiki-based collaborative tools. UK-QSAR and ChemoInformatics Group Meeting, 14th May, Sandwich, UK