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1. ABSTRACT

A constant problem for field archaeologists is the need for familiarity with the core concepts of a diverse range of specialist disciplines. Soils and sediments are an integral part of archaeological sites, yet the teaching of soils in archaeology degrees is variable and many archaeologists complain they are lacking in the confidence and skills required to describe and interpret the deposits they excavate. SASSA (Soil Analysis Support System for Archaeologists) is a free-to-use, internet based system designed to familiarise archaeologists with the concepts and possibilities offered by geoarchaeology (the scientific study of soils and sediments).

SASSA consists of two core components: the knowledge base and field tool. The 'front-end' of the website is the knowledge base; this uses Wiki technology to allow users to add their own content and encourage dialogue between archaeologists and geoarchaeologists. Whilst the field tool uses an XML data structure and decision tree, decision support system to guide the user through the process of describing and interpreting soils and sediments. SASSA is designed for use on both 'static' (PC) and 'mobile' (PDA and laptop) hardware in order to provide in-situ field support as well as offering office-based 'reference book style' help. This article introduces the aims of SASSA, presents SASSA as a user might experience it, and discusses the computing technology used to construct the system.

2. BACKGROUND

2.1 Soils and Archaeology

The relevance of soil science to archaeological investigations has been recognised for several decades. The early work (1960 – 1970s) of Cornwall, 1958, and Dimbleby, 1966 and subsequently Limbrey, 1975 was instrumental in demonstrating the potential contribution of soil science to archaeology, but with a marked emphasis on environmental reconstruction from analysing buried soils. More recently, there has been the emergence of geoarchaeology – the application of earth science techniques to archaeological questions - based on the recognition that the bulk of many archaeological sites consist of soils or sediments rather than artefactual or structural evidence (Butzer, 1982; French, 2003). Soils and sediments are integral to the archaeological record and thus require analysis and interpretation. Over the last 20 years there have been major advances in analytical techniques which have enabled new questions to be addressed, for example, with respect to sourcing of soils or added materials (Wilson *et al.* 2006), on-site processes of accumulation and re-distribution (refs), post-depositional alteration (diagenesis) (ref) and bioturbation (mixing by flora and fauna) (Canti, 2003), and impacts of anthropogenic processes such as cultivation and manuring and habitation (ref; Wilson *et al.* 2007). However, there has been an increasing gulf in the development and validation of research analytical tools and their wider application by the archaeological user community.

The publication of guidelines in geoarchaeology by English Heritage (2004) has raised awareness of soil science within archaeology, but there still exists a gap between research techniques and the answering of questions important to archaeologists.

An informal consultation exercise with field archaeologists revealed the problem as perceived by archaeologists is:

- Soil analysis is expensive and time consuming and often provides little useful or new archaeological information.
- Geoarchaeology involves dense terminology and scientific language making many reports and books on the subject virtually unintelligible to the non-specialist.
- Soil analysis involves extensive field recording and sampling which is time consuming and generally requires specialist input.
- There is a general lack of training in soil science that makes field interpretation and identification of key questions difficult for field archaeologists.

It was generally felt that although a substantial geoarchaeological knowledge base already exists, what is lacking is presentation of this material in a manner that is easily accessible, informative and comprehensible to archaeologists who are non-specialists.

By contrast many geoarchaeologists complain that at times they are asked to attend on-site, to find there are no defined archaeological questions for them to address. The result can be a day spent describing and sampling soils and sediments with no purpose. This only serves to reinforce the impression of archaeologists.

2.2 The SASSA Project

Based on initial consultation with commercial archaeologists a need was identified for an open-access, web based system (SASSA) providing:

- Tutorial type training relating to soil processes in archaeological contexts.
- Information and help with field recording and field interpretation of soils and sediments. On the spot, field access to such help was also felt to be important.
- Information on soils techniques, from field based to specialist laboratory methods, linked to archaeological questions.
- A database of case studies providing details of studies where soil analysis has successfully been applied to archaeological questions.
- A comprehensive glossary of soil and geoarchaeology terms designed specifically with archaeologists in mind.

The SASSA project is funded through the UK's Natural Environment Research Council (NERC) knowledge transfer programme. This two year project, based at the University of Stirling, aims to familiarise archaeologists with the concepts and possibilities offered by geoarchaeology, in which techniques and methods are clearly linked to pertinent archaeological questions.

The system consists of two discrete but closely interlinked components (Figure 1); a knowledge base built around wiki software, and a field tool that uses an XML data structure and decision tree technology.

Figure 1: sassa system.jpg The structure of SASSA

Whilst the field tool is accessed through the knowledge base it is a stand alone system and its use requires a separate registration process.

The key features of SASSA are:

- Flexibility and mobility regarding operating platform. This includes graphics light versions for PDA and Smartphone hat enables lower cost access via phone networks, and a downloadable version to work independently of internet connections or phone coverage.
- Interactive and evolving resource. The use of wiki software and flexible editor options means that SASSA can evolve and adapt to user needs beyond the end of the development project (December 2007).
- User input and testing during the development stage. The project has involved close co-operation and consultation with field archaeologists from across the UK.

2.3 SASSA's Audience

SASSA's target audience are commercial field archaeologists, for whom it is hoped SASSA will function both as a decision support aid for use in the field and as a training and CPD tool in the office. In order to ensure that SASSA meets the needs of commercial archaeologists a user advisory group was assembled consisting of representatives from archaeology units and curatorial posts across the UK. The potential role of SASSA in university teaching, at both undergraduate and postgraduate level, however, cannot be understated, particularly as it these students that will become the archaeological workforce of the future.

The benefit of a web based system is the international presence, and the academic advisory group contains representatives from Europe, US, Canada and Australia to ensure an international element is present in SASSA from the start. The field tool and many of the case studies that “seed” SASSA are predominantly drawn from the development teams UK based experience, however, it is hoped that through the wiki, the international flavour of SASSA will develop over time. Alternative language pages and additional decision support trees aimed at questions and soils in different environments could potentially also be developed by users if an active SASSA community develops.

3. THE SASSA KNOWLEDGE BASE

The SASSA knowledge base aims to provide non-specialist archaeologists with reliable, accurate information on a range of earth science and geoarchaeological topics. Powered by MediaWiki software it consists of discrete, stand-alone informational pages that can be accessed via the search facility allowing focussed research on particular topics. However, the pages are also linked in such a way as to allow students or a reader to work logically through the individual pages in the manner of a tutorial for more general research.

3.1 The Structure of the Knowledge Base

One of the comments received from the user advisory group was although they had invested in a shelf full of specialist geoarchaeology texts they had “neither the time nor the head space” to read, digest, and interpret their contents in terms of his own projects and sites. By contrast the structure of internet web pages allows users to access relevant information quickly and in manageable chunks, without imposing the linear structure of a paper book.

MediaWiki software was chosen for this project because of the level of development and support for the software that underpins Wikipedia. One potential disadvantage, however, is the horizontal structure of pages characteristic of Wikipedia and Mediawiki. This means that a user coming to the site in the first instance has to know exactly what they are looking for in

order to find relevant information via the search facility. Crumbtrails and namespaces have been used in SASSA to provide a more structured feel and to aid the user in navigating between related web pages if they so wish.

Information pages are grouped through the use of “name spaces”. SASSA contains nine name spaces:

1. Main Page and SASSA project details
2. Field Analysis (including access pages to the SASSA field tool)
3. About geoarchaeology
4. Tutorial
5. Analytical Methods
6. Case Studies
7. Glossary
8. News
9. Help

In addition Mediawiki provides “special pages” that provide an advanced search facility and help administrators monitor changes to the wiki.

3.2 Overview of the Knowledge Base

3.2.1 Standard page layout

A standard page format helps the user navigate around SASSA, rapidly identifying the information they require, and ultimately add to or edit the site (Figure *: http://www.sassa.org.uk/index.php/Tutorial:Deposition). User feedback has been very positive regarding the layout and navigation of the SASSA website.

- A crumb trail at the top of the content page provides a link back through the nominal hierarchy of the knowledge base to the SASSA home page. This helps users develop a mental model of the site structure. These links are static and represent the fixed structure of SASSA, they do not replace the browser buttons that allow the user to retrace their steps through the site.
- At the bottom of the content page is a ‘back button’ and where appropriate a ‘forward button’. In the case studies and analytical pages the back link

allows the user to jump to the parent level. For example, from a page on soil colour estimation the back button would take the user to the field analytical methods index page. However, in the Tutorial and Field Analysis sections forward and back buttons provide a means to follow a linear path through the pages that mimics the layout of a paper book.

- The SASSA navigation bar down the left hand side of the page provides direct links to the home pages of each of the name spaces as well as access to the field tool. A quick search facility and link to external web sites are also provided. In addition users who are logged in will have access to an advanced search facility and the special pages through this left hand bar.

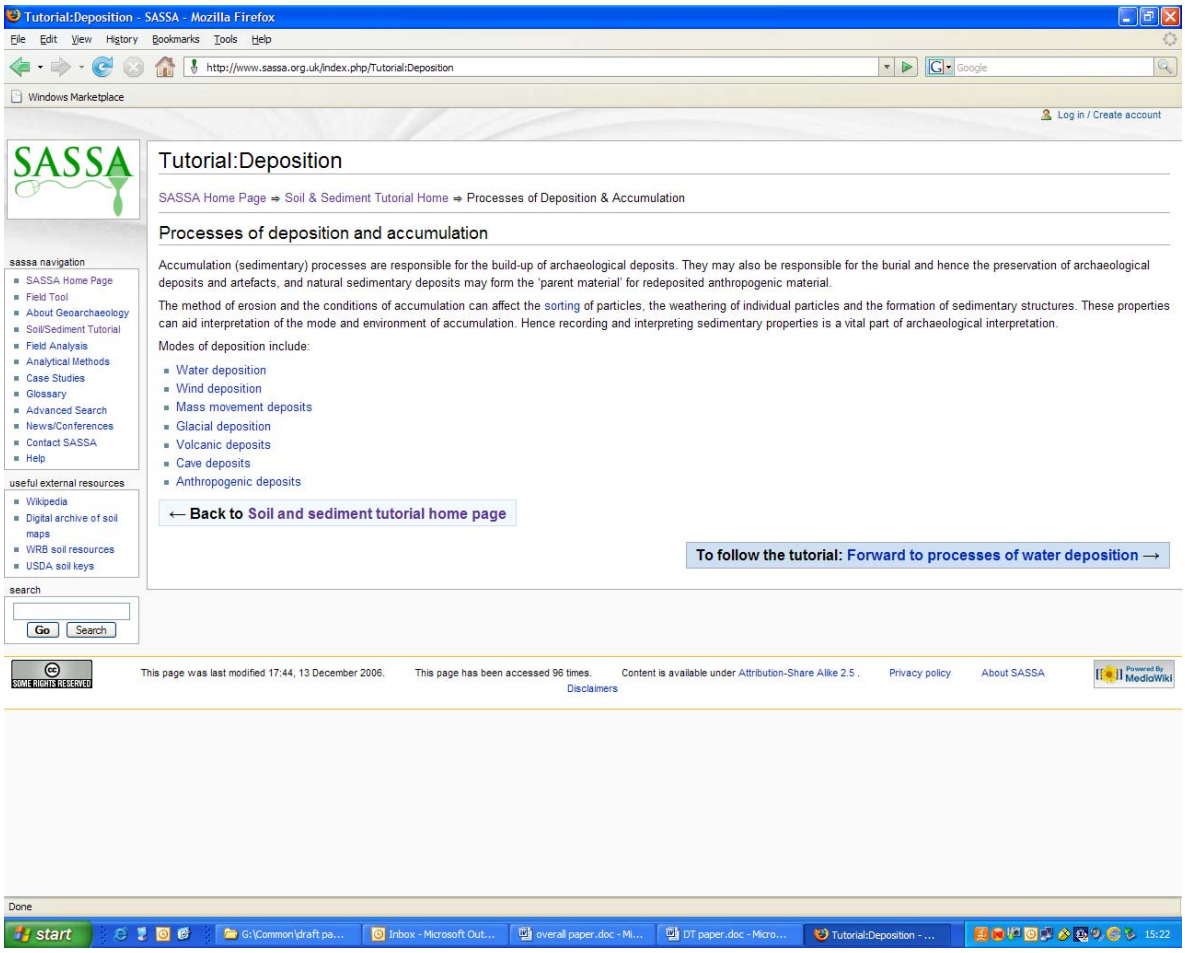

Figure *: Standard article page layout.

3.2.2 About geoarchaeology

The home page of the “Geoarchaeology” namespace provides access to pages outlining the scope of geoarchaeological research, and the broad archaeological questions that can be addressed through geoarchaeology. The aim of this area is to provide the reader with a broad overview of what is (and is not) geoarchaeology and of the potential for geoarchaeological research.

Figure *: Geoarchaeology home page

3.2.3 Soil / sediment tutorial

The “Tutorial” namespace provides classic text-book type information about natural processes of erosion, deposition and soil formation, as well as archaeologically oriented sections on post-burial changes and anthropogenic deposits. The page layout of the tutorial at the time of writing of this paper is as follows in Table *.

Table *: The structure of the SASSA tutorial, click on the section titles to view the pages.

Tutorial Home Page	Processes of weathering and erosion	Weathering; Water erosion; Wind erosion; Mass movement; Ice erosion; Tectonic and volcanic erosion; Anthropogenic erosion
	Processes of deposition and accumulation	Water deposition; Wind deposition; Mass movement deposits; Glacial deposition; Volcanic deposits; Cave deposits; Anthropogenic deposits
	Soils, soil forming processes and classification	Soil forming processes; Soil features; Soil profiles and horizons; Soil classification
	Processes of post-burial modification	Burial as a process of preservation; The burial environment; Processes of

		change in the burial environment; The effects of post-burial modification
	Anthropogenic soils, sediments and processes	Burning residues; Garden soil; Anthrosols and plaggen soils; Buried soils; Ditch and other fills

Forward and back buttons allow the reader to navigate through the pages in a linear manner, whilst for reference the hierarchical structure and search facility allows rapid consultation of individual pages.

3.2.4 Field analysis

The "Field Analysis" namespace can also be navigated in a linear tutorial manner, however, the main function of the field analysis section is to support the field tool and archaeologist with field recording and interpretation of soils and sediments. This section not only contains information about how to record basic soil properties such as colour, texture and structure following standard soil and archaeological schemes (e.g. Hodgson, 1976; Soil Survey Staff, 2002; MoLAS, 1994), but also why and when the archaeologists might want to record these properties. For example, there are two pages on soil colour, 1, explains different ways of recording soils (Figure *) and 2, explains the origins and meaning of soil colour (Figure *). This area also provides information about sampling - although there is considerable scope for expansion in this area - and a list of recommended field kit for soil description including the equipment and chemical for simple field tests.

3.2.5 Analytical methods

"Analytical Methods" provides information about the

3.2.6 Case studies

The “Case Studies” namespace contains a database of previous geoarchaeological studies. Accessing relevant literature can be difficult for archaeologists operating outside of universities. This database helps address this problem, whilst also providing material to illustrate the processes, questions, and techniques described elsewhere in the knowledge base.

Case studies are organised according to the techniques they employ, the questions they address, the geographical location, and the age and type of the archaeological “site”. To date the database includes studies from Europe, Africa, North America and South America that include examples of sampling, stratigraphic analysis, element analyses, micromorphology, magnetics and remote sensing.

A typical case study consists of a protected short summary page in the wiki and where possible this includes a pdf or a web link to a more detailed paper.

3.2.7 Glossary

A glossary was the most consistently requested feature of SASSA. The “Glossary” namespace contains an alphabetically arranged series of definitions for a large number (445 as of 10/10/2007) of earth science and geoarchaeology related terms. This area is not protected so users registered with editing rights can add to or amend the glossary.

3.3 Contributing to the Knowledge Base

The great advantage of the Mediawiki software is that it allows SASSA’s content to be continually updated and added to by the development team, and the wider academic and archaeological community. Contributions from geoarchaeologists and earth scientists are sought for tutorial pages on processes, deposit types and techniques; whilst, the user community can make a valuable contribution to the case study pages. It is hoped that both specialist and non-specialist users will contribute to the discussion pages allowing users to ask questions, discuss issues, and comment on the content of the related article pages.

The Mediawiki software that powers SASSA is designed by default to allow editing rights to all registered users. This is in line with Wikipedia policy. However, the need to ensure that SASSA is a respected and trusted authority in current geoarchaeological practice and without a team of full-time administrators to manage the site and correct deliberate and accidental problems, it was felt that such a model would be inappropriate for SASSA. Instead a process of post registration validation is required (Table *).

Table *: SASSA Wiki registration and user rights

	Non registered	System registered	Administrator registered	Administrator
View content pages	✓	✓	✓	✓
View discussion pages	✓	✓	✓	✓
Access field tool (separate registration)	✓	✓	✓	✓
View special pages		✓	✓	✓
Advanced searches		✓	✓	✓
Change preferences		✓	✓	✓
Watchlist		✓	✓	✓
Edit content /article pages			✓	✓
Edit discussion pages			✓	✓
Add pages			✓	✓
Review page history			✓	✓
Upload documents			✓	✓
Change user rights				✓
Block users				✓
Delete pages and documents				✓
Protect pages				✓

Unregistered users have free-to-view rights to all content based pages of the SASSA knowledge base. Web-based registration allows the user additional access to special pages such as advanced search facilities and updates on page changes, as well as to set their own view preferences and to create watch lists of pages. However, web registered users have no editing rights. Upon registration, users are prompted to contact the site administrator – a

designated member of the development team – in order to be given editing rights. This prevents damage to the SASSA site by automated “bots”. This approach protects SASSA from vandalism and helps to maintain content quality and accuracy as only trusted members are given editing rights.

However, a challenge still to be overcome by the SASSA project is to encourage legitimate users to register with the administrator and to actively contribute. Links from geoarchaeology pages on Wikipedia and extensive help files have been used in the hope they would boost activity. However, these measures have so far been ineffectual. It is crucial that steps are in place to encourage active participation before the end of the project.

A group of wiki editor ‘champions’ is planned to maintain the feel of an active site and to encourage contributions by other users. This group will be drawn from the academic and user community, and will be given training in wiki editing.

4. SASSA FIELD TOOL

4.1 The User Experience

The field tool is designed to support field archaeologists in the description and basic interpretation of soils and sediments. It will operate on a range of platforms (PC, laptop, PDA, smartphone) either through an internet connection (fixed or wireless) or phone network, and all pages can be printed for paper-based recording if necessary. The aim is to provide non-specialist archaeologists with the field-based support necessary to describe their soils effectively, and to identify key archaeological questions where soil science techniques may be applicable.

The field tool uses an XML database to record user’s site and soil data. A separate registration and login from the rest of the SASSA site is, therefore, required. Registration with the field tool is completely free and is open to all. When a new user logs in, they are presented with the field tool home page, which allows the choice of one of two options: the interpretation tool and the soil description tool.

The description tool provides a format and help with describing soils and sediments. SASSA does not aim to replace the context recording sheet, rather to complement it. The focus of the tool is on providing not only the information necessary for a user to record soils, but also the background as to "why" they may wish to record extra information and in what circumstances it may be beneficial to invest extra time and efforts.

The interpretation tool is a decision support system that walks the user through a series of questions to provide help with common field questions relating to soils and sediments. For example, "Is this a buried soil?" or "Has this deposit been affected by bioturbation (mixing by earthworms and other animals)?" Again the emphasis is on enabling the user to develop there own understanding of their soils rather than attempting to provide definitive answers to complex questions.

You may register and log in to try the field tool at http://www.sassa.org.uk:8080/sassa/fieldtool See sections 4.11 and 4.12 for more information on using the field tool or refer to the on-line help pages provided by SASSA.

4.1.1 Soil description tool

Field archaeologists already critically examine the soils and sediments that comprise their sites. Experienced field workers are finely attuned to the subtle differences that differentiate contexts. Despite this, context sheets often record little more than soil colour (a transitory and subjective property) and texture. Terminology and relevance are two of the reasons why further detail is not routinely recorded, particularly on time constrained, developer-funded excavations. It was felt that using SASSA to specify soil information that should be recorded would be overly restrictive and unreasonable. Such an approach would do little to improve the image geoarchaeology has acquired for costliness and irrelevance. Rather the description tool provides a flexible, mobile format for recording soils information, with detailed support on the why, when and how of recording soil properties through linkages with the SASSA knowledge base.

Structure and content of SASSA description tool

Soils information is stored hierarchically according to site, trench or section, and context. A user may generate multiple sites, each site may contain multiple trenches or sections and each section may contain multiple contexts. However, only one soils description can be made for each context. It is left to the user to define these levels and to ensure that the labelling conforms to the site standard. Images can be uploaded at all levels of the description.

If wished general information other than an identifier can be entered at each level but is not required. A development in progress is that of an editor tool which would allow users with downloaded standalone copies of SASSA to edit the forms, either to cut unnecessary data fields or to add more if they wish to tailor the form to their own recording methods and needs.

Colour, composition, structure, texture, stones, inclusions, roots, sedimentary features, soil features (iron pans, concretions etc.) and boundaries can all be described. Drop down menus and radiobuttons provide possible answers for each part of the description, and information buttons link directly to protected pages in the knowledge base, explaining how and why to complete each section.

SASSA is not intended to act as a long-term data storage facility as there is no on-going financial support to increase storage capacity or manage the database. Users are advised to back up data regularly and to delete information when it is no longer needed. All information can be exported in either rtf or pdf format for inclusion in the excavators own site archive. An example SASSA report can be accessed by clicking here.

Potential applications for the SASSA description tool

Whilst it is possible to use SASSA to complete detailed soil descriptions, the flexibility of SASSA means that for more routine use only certain properties need be recorded. SASSA helps provide the excavator with the confidence to identify which properties are most pertinent. The descriptions will not only preserve a fuller description of the soils and sediments, but can also provide much needed field information to geoarchaeological and environmental specialists who are often on-site only for a limited time. The mobility of

SASSA means that field workers in remote locations can pass photographs and supporting descriptions back to team members for advice and discussion. Staff and student training is also an important possible use for the system both on-site and in the office.

4.1.2 Soil interpretation tool

The SASSA interpretation tool provides “answers” to common, context-specific queries. Currently the list of queries includes:

- Is this a buried soil?
- Is this the “natural”?
- Has this deposit been affected by bioturbation (earthworms)?
- Has this deposit been affected by waterlogging (gleying)?
- Is this a colluvial (slope wash) deposit?
- Is this a water-lain (alluvial) deposit?
- Has this deposit been affected by down washing of iron (podzolisation)?
- Has this deposit been affected by in-situ burning?

Using the interpretation tool

The SASSA interpretation tool can be accessed in 2 ways:

1. Directly from the field tool home page for quick non context specific soil analysis.
2. From the context level of the soil description tool for context specific soil analysis. This option allows relevant data saved to that context to be imported directly into the decision tree.

At either level the user chooses a query from the list. The user is then presented sequentially with a series of questions and answers in order to help answer the query. The structure of a typical decision tree is shown in figure *. The user cannot answer question lower down the tree until they are reached but they may at any time return to and edit the answer to questions higher up in the tree.

Once the tree is completed the user is presented with a score between 0 and 100. A score of 0 is a strong negative, 100 is a strong positive and 50 denotes either insufficient information or conflicting evidence and hence no diagnosis is possible. A table explaining the results is also presented. More important than the score though are perhaps the links to information about how the interpretation was made, what other information might be looked for, what the confounding factors not accounted for by SASSA and ideas of further field and laboratory tests that could be carried out to confirm or refute the findings, or to take the analysis of the deposit further. This follow on information ensures that SASSA does not encourage users to blindly follow the decision tree. Instead the tool encourages users to examine and question their deposits differently. An example of the interpretation tool output can be accessed by clicking here.

Again there is the planned development of an editor tool to enable users to create their own decision trees, perhaps suited to localised conditions or questions. With the involvement of an experienced geoarchaeologist this could provide specific support with sampling as well as interpretation. A future development of the project could be to create a repository of decision trees and queries to extend the range of the SASSA interpretation tool.

4.2 SASSA Field Tool Software

MB, JC and DC to complete.

5. MOBILE DECISION SUPPORT

JC to comment and edit

The need for a focus on field questions and problems was a theme that came through strongly from user feedback at the very beginning of the project. If SASSA was to support archaeologists working in the field it, therefore, it needed to be made available in a form that could be taken out and used on-site either in paper form, or via laptop, PDA or smart phone devices. Mobile computing is a new technology by which users access services via a range of devices, regardless of their location or movement (Zaslavsky et al, 1998).

Complexities and uncertainties arising from making SASSA available for a wide range of mobile devices for field use include changes in mode of operation, high variability in performance and reliability, issues surrounding visual display capabilities, finite sources of energy, patchy wireless coverage, and facilitating recognition by the system of the user and device. The often wet and dirty working environment and the cost implications of mobile devices for SASSA users also had to be considered.

The approach taken for SASSA was to provide a dual mode system with the full system for use on PC and laptops, and an ‘image light version for use on a PDA via either a wireless internet connection or phone network download. A standalone version of the entire SASSA system and supporting software has also been developed. Currently this can auto-run from a 512 Mb memory stick and eventually will be available for download from the website.

6. USER FEEDBACK

The SASSA project has included four main phases of user testing and feedback. In the first instance views were sought prior to the submission of the funding application. This took the form of a general request for views on the application of geoarchaeology in commercial projects, the usefulness of a web-based resource and the needs of the target community in commercial archaeology. This took the form of targeted e-mail and phone conversations with existing contacts internationally. An e-mail request submitted to all registered commercial units in the UK, and a general request for views internationally through the medium of archaeology-based discussion groups. The user and academic advisory groups for the project were drawn from amongst the respondents to this survey. Once funding was secured, an online questionnaire was used to gather information on the existing level of geoarchaeology knowledge, the perception of geoarchaeology’s strengths and weaknesses and user needs. The responses to this questionnaire were used to draw up a wish list of features and shape the project, in particular the field aspect.

7. THE FUTURE OF SASSA

For the foreseeable future the SASSA server will be housed and maintained at Stirling University by the development team. However, the support that will be offered after the end of the project is intended to be minimal (Wiki software updates, registration of users and policing of content, hardware glitches etc.). Beyond the end of the project it is the wider geoarchaeological and archaeological community who will shape the future of SASSA.

The internationalisation of SASSA is a key area for future growth. The wiki structure of the knowledge base freely supports alternative language versions, whilst the editor function for the field tool allows users to translate the soil description and interpretation tools into their own language. Where this happens a database of translations and new interpretation tools outside of the authors experience of UK geoarchaeology should be made freely available to all.

The software configuration and approach taken by SASSA, however, is suited to a range of different applications both in archaeology (for example plant macro and pollen identification and analysis; borehole logging) as well as in other disciplines.

8. ACKNOWLEDGEMENTS

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