Open Source at the University of Johannesburg.[1]

Executive Summary:
Free/Libre Open Source Software (FLOSS) is an important alternative to propriety software. While companies who develop propriety software are often market leaders, users of such software never own the software but only the right to use the software. FLOSS vendors, on the other hand, often grant users rights to own, use, explore and change software to support themselves and their communities. Currently University of Johannesburg members make use of FLOSS to support administrative, teaching and research objectives at the macro, meso and micro levels. However such use of FLOSS is neither supported through appropriate institutional strategic goals, nor is there any support in the use of FLOSS provided. Senate requested that a Task Team explore the present and future use of FLOSS at the University of Johannesburg taking into account local and international trends.

A number of theoretical positions were considered in the development of the recommendations on the use of FLOSS within the University, and include:

- The need for a revaluing of technology and people's time, in terms of changing perceptions of scarcity and abundance management;
- The need for encouragement and support for creative staff, who are often relegated to the periphery of institutional practices with little or no support; and
- The metaphor of a 'sandbox' is used to isolate a software development environment from enterprise technological systems and to support FLOSS development.

Local and international used of FLOSS in education is widespread. However, the use of FLOSS does not necessarily lead to innovation, decreased financial costs or improved administration, teaching and learning practices. The adoption of FLOSS practices as part of a complex university environment should be for strategic reasons to support members who already make use of such tools, to provide integrated leadership and to support innovation.

The University of Johannesburg has two alternatives: either to continue with the current lack of support for FLOSS initiatives; or to find ways to treat FLOSS as a strategic goal in order to provide leadership, innovation and support.

Recommendations are made at two levels: institutional (macro) and departmental or individual (meso and micro).

At the macro level the creation of FLOSS Innovation Services is recommended in order to provide:

- Leadership in and innovative use of FLOSS emanating from Academics (Teaching & Learning and Research) and Administration;
- Resources (management, support, hardware and software) ;
- Management by the ICT Committee;
- Support of the use of open standards;

[1] Written by Alan Amory

- Development of student skills in supporting technology, and innovation; and
- Appropriate access to the FLOSS Innovation Services.

Departmental and individual use of FLOSS should be supported through:

- Development of a FLOSS software repository that could be part of the intranet and would serve to provide easy access to institutionally supported FLOSS and user manuals;
- The use of a single GNU/Linux product (for example Ubuntu); and
- Development of workshops for the use of FLOSS in teaching & learning, research, and administration.

Open Source at the University of Johannesburg
Report requested by Senate

Definitions

Free/Libre Open Source Software (FLOSS):

The production and distribution of software can follow a number of different routes. Software, such as the products created and marketed by Microsoft, is termed proprietary as the companies that manage such software own all the rights to the software, including the file formats, and grant you a license to use the software. Software produced through collaborators that are often widely geographically distributed is referred to as Open Source. Such software may still be owned by those who create the software and make use of open or proprietary file formats. The third type of software, irrespective of how software is produced, makes use of the General Public License (GPL) that grants you as the user the freedom to:

1. Run the software program, for any purpose;
2. Study how the software programs work, and adapt these to your needs. Access to the source code (computer language) is a precondition for this;
3. Redistribute copies so you can help your neighbour; and
4. Improve the software program, and release your improvements to the public, so that the whole community benefits. Access to the source code is a precondition for this. FLOSS is usually associated with the Free Software movement but is used in this document to refer to both positions.

For this report FLOSS is defined to include all Open Source and GPL licensed software.

Introduction

The use of Free/Libre Open Source Software (FLOSS) at the University of Johannesburg is considered in this report. The terms of reference for the Task Team included:

1. To determine the current use in administration, teaching & learning, and research, of FLOSS at the University of Johannesburg;
2. To investigate the use of FLOSS at international institutions of higher education; and
3. To make recommendations on the use in administration, teaching & learning, and research, of FLOSS at the University of Johannesburg.

However, before defining the terms, reporting on a survey conducted at the University and making recommendations, a few interesting concepts are explored to develop some understanding of the use of FLOSS globally. First, the concept of scarcity versus abundance is considered. Second, the concept of a 'sandbox', and lastly, educational uses of FLOSS are discussed.

An excerpt from an article written by the editor of Wired is given to frame the scarcity versus abundance debate.

Scarcity versus Abundance Management

> "When scarce resources become abundant, smart people treat them differently, exploiting them rather than conserving them. It feels wrong, but done right it can change the world. The problem is that abundant resources, like computing power, are too often treated as scarce. Consider another example: Wired's IT department used to send out occasional emails telling employees it was time to

"delete unneeded files from the shared folders"—their way of saying they had run out of storage room on the servers. Because we're good corporate citizens, we all dutifully scanned through our files, deleting those we could live without. Perhaps you've done the same. One day, after years of this ritual, I began to wonder just how much storage capacity we actually had. Turns out, not so much: 500 gigabytes. At the time, a terabyte of memory (1,000 gigabytes) cost about $130. I had recently purchased a standard Dell desktop PC for my family, which the kids used for playing videogames; it came with a terabyte internal hard drive. My children had twice as much storage as my entire staff.

	Scarcity	Abundance
Rules	Everything is forbidden unless it is permitted	Everything is permitted unless it is forbidden
Social model	Paternalism ("We know what's best")	Social model Egalitarianism ("You know what's best")
Profit plan	Business model	We'll figure it out
Decision process	Top-down	Bottom-up
Organizational structure	Command and control	Out of control

How did this happen? The answer is simple: We had gotten stuck thinking that storage was expensive, when in fact it had become dirt cheap. **We treated the abundant thing—hard drive capacity—as if it were scarce, and the scarce thing—people's time—as if it were abundant**. The corporate bureaucracy had gotten the equation backward. (Let me hasten to add that my office quickly added a heap of storage, and those emails don't go out anymore!)." (My emphases) [2]

The example explored by Anderson above is not presented as a critique of current, or perceived, practices at UJ, but as an attempt to think about how:

- Our world is changing;
- Technology is, and will continue to, influence our lives,
- To support our scare resource, the staff, and
- Learning and teaching in the 21st century should be concerned with abundances and scarcity.

Any complex system, such as a university, needs to make optimal use of all forms of resources, especially human capital, to maximize benefits to all stake holders. It could therefore be argued that complex systems would make use of both Scarcity and Abundance management approaches. An organization needs to harness staff and student talents to creatively solve simple and complex problems. Therefore, spaces that are structured from an "Out of Control" perspective might yield interesting solutions and outcomes. However, systems that support the organization in its functioning, need to be managed from a "Command and Control" perspective. This is particularly true for Information and Communication systems. A failure for any enterprise system could compromise the organization. However, the failure of a system under review, or development, that is not yet deployed at the enterprise level would have little, or no, impact on a functioning organization.

[2] Anderson, C. 2009. Tech is too cheap to meter: It's time to manage for abundance, not scarcity. Wired 17(7).

Providing spaces for creative individuals to dream products, services and commodities might lead to innovation. Such approaches appear to be the driving force in many successful international companies (think Google). Pascale and Sternin (2005, 73-74)[3] wrote in the Harvard Business Review "There are people in your company or group who are already doing things in a radically better way. The process we advocate seeks to bring the isolated success strategies of these 'positive deviants' into the mainstream". What a wonderful term – positive deviants! Spaces for such positive deviants to work and prosper in organizations can lead to unexpected outcomes that might support the growth and development of UJ. The concept of a 'sandbox' might help us understand how we could provide a safe place for positive deviants to ply their trade.

What is a sandbox?

From a computer science perspective, a sandbox is conceived as a protected development environment for the evaluation of new and untested code. Such environments are isolated from the production systems but provide access to all organizational and development resources. In such a system, newly created software can be tested in a safe and protected environment where malformed code cannot penetrate and created disruptions in the 'real world'. The concept of a sandbox should be familiar to any parent whose children play in a protected surroundings to learn about their world ('Let us eat some sand!').

Approaches to FLOSS Internationally and Locally

A recent review (van Rooij, 2009[4]) focused on open-source software related to teaching and learning in higher educational institutions in the USA and identified four themes dominant in the literature:

- *Social and Philosophical Benefits*
  - Propriety software licenses were viewed as an injustice and as a means to contribute to the "privatization and the depletion of public domain knowledge" (p 687);
  - Use of open source is part of a social movement and public education;
  - Open source software allowed institutions to modify the software to support institutional objectives; and
  - Open source offered little support to institutional administration, teaching and learning practices.
- *Software Development Methodological Benefits*
  - Those most likely to benefit from the open-source development system are the developers themselves (developers making software for their own purposes); and
  - The use of a co-operative development system might influence teaching and learning practices.
- *Security and Risk Management Benefits*
  - Developers of open-source software often argue that such software is more secure as 'many eyes' examine such software, but "security challenges are grounded in bad design, not source code access" (p. 689);

[3] Pascale, R., & Sternin, J. (2005). Your company's secret change agents. Harvard Business Review, 83(5), 72-81.
[4] van Rooij, S. W. (2009). Adopting Open-Source Software Applications in US Higher Education: A Cross-Disciplinary Review of the Literature. Review of Educational Research, 79(2), 682.

    - Talent required to develop and manage secure open-source software may be a larger hurdle that originally argued; and
    - Open-source adoption requires that institutions be predisposed to such software and that staff have the appropriate technological skills.
- *Total Cost of Ownership Benefits*
    - Little systematic research to support the assumption that open-source is less expensive to use than commercial software; and
    - Use of open-source needs to be a strategic/philosophical decision rather than a financial one.

The findings of van Rooij (2009) do not consider a number of important practices, including:

- Both locally and internationally, FLOSS supports many important enterprise activities such as web services, mail and database management;
- The FLOSS method of software developments supports collaborations and social learning, a cornerstone of contemporary learning practices, and is part of agile programming techniques used successfully in companies such as Hewlett-Packard;
- While security to enterprise systems is integral to modern business practices, secure access to systems such as on-line writing and social networking do not require the same level of access control; and
- The total cost of implementing FLOSS solutions may not be cheaper than commercial software. With the introduction of FLOSS solutions funds that were previously spent on propriety software licenses, often owned by non South African companies, are used to support the development of human capital.

The Gartner group posited that FLOSS is part of the higher education landscape and the use of such software will grow in the future. They warned that decisions related to the use of FLOSS need to take into account both principled and practical issues. They recommended that institutions who wish to include FLOSS into their organizations need to:

- Select products supported by a sustainable community;
- Match products to the culture of local developers and user;
- Avoid FLOSS not built on open standards;
- Make conscious risk-based decisions about whether the institution will depend on internal resources or external services to support FLOSS implementation; and
- Develop and prioritize an overall sourcing strategy for FLOSS.

The implementation of an e-learning system at the Open University (OU) in the UK (Sclater, 2008)[5] is an example that illustrates the successful use of FLOSS in higher education:

- The OU selected the open-source learning management system Moodle (up to 50% of the market) to support their 180,000 distant students;
- Considerable financial investment was needed to enhance the Learning Management System in order to provide the functionality and integration with existing systems that they required;

[5] Sclater, N. (2008). Large-scale Open Source eLearning Systems at the Open University UK. Research Bulletin, Educause Center for Applied Research: Boulder, Colorado, 12.

- All enhancements developed by the OU team were returned to the Moodle community;
- Access to the underlying code allowed for rapid changes to the system in order to provide the appropriate pedagogical support to OU staff and students; and
- The OU team offers insights into the use of Moodle to other institutions through the development of partnerships.

Therefore, the development, deployment and use of a FLOSS LMS at the OU was not cheaper than the deployment of a propriety system but supported the development of human capital, allowed the OU to respond rapidly to requests from the user community, permitted developers to easily add new functionality into Moodle, provided opportunities to improve Moodle's functionality and to develop partnerships.

While, at the institutional (macro) level, the deploying of enterprise FLOSS solutions may not decrease the total cost of ownership, the use of FLOSS at the departmental (meso) or individual (micro) level might offer some financial savings. Small organizations, such as schools, with the appropriate technical expertise, were able to decrease the total cost of ownership through the use of FLOSS systems (Becta, 2005)[6]. The use at meso- and micro level of software such as Freemind, Gimp, Inkscape, VLC media player, Open Office, Open Project, and PrimoPDF could decrease the total cost of ownership. A couple of examples might clarify the use of FLOSS at the micro level:

1. Many publishers require authors to submit line art diagrams and figures for publications in the encapsulated postscript (eps) format. Expensive propriety software, with a steep learning curve, is available to produce publication quality line drawing and graphs. However, propriety and FLOSS office products, for example Microsoft Excel/OpenOffice Calc and Microsoft PowerPoint/OpenOffice Impress, allow authors to create graphs and diagrams that can be stored as Window's metafiles. These files are easily read by InkScape that can then be saved in the eps file format. Alternatively, OpenOffice Draw application natively supports the eps file format.
2. Most higher education institutions provide a software solution for reference management. However, some of these systems are web-based which might be a disadvantage in limited-bandwidth environments. In addition, moving data from one system to another can be difficult. The use of Firefox with the Zotero extension offers an easy to use FLOSS alternative where references are no longer 'owned' by institution propriety software. The Firefox-Zotero combination could also be used to develop students' skills in the management of reference and in the creating of references, or bibliographic lists.

The use of FLOSS at Higher Education institutions in South Africa is similar to that of the USA: FLOSS is mainly used to support specific Information and Communication services such as Web and email services. In relationship to LMS, a number of propriety and FLOSS systems are used in South Africa. The University of the Western Cape was a leader in driving the development and use of FLOSS at an institutional level for administration, teaching and learning (macro implementation). The Universities of KwaZulu-Natal, North West and Cape Town developed in-house systems to support teaching and learning. More recently the University of Cape Town moved to Sakai that is used by other universities such as UNISA and University of the North West. The propriety product, Blackboard/WebCT, is widely used by many South African Universities, including Johannesburg,

[6] http://publications.becta.org.uk/download.cfm?resID=25907

Pretoria and Stellenbosch. The University of KwaZulu-Natal recently migrated to Moodle and the Western Cape to Sakai. It is interesting to note that both UKZN and UWC developed in-house FLOSS solutions that could not be supported once the champions moved to other institutions. This highlights the scarcity of appropriate skills to support enterprise innovation in the South African higher education section.

At the meso level many departments make use of FLOSS operating systems and software. This is particularity relevant to the sciences and computational sciences in particular. For example, the JAVA language, a FLOSS programming language, is used universally to teach programming. Depending on computer literacy, academics make use of different kinds of FLOSS (micro level).

The stage is now set to look at the use of Free/Libre Open Source Software at the University of Johannesburg.

The Survey

Survey Design

The survey used at UJ included three sections:

- Current and future use of FLOSS,
- Current and future support for FLOSS, and

Questions posed included:

- What kind of FLOSS software do you currently use?
- What kind of FLOSS software would you like to use?
- What kind of FLOSS software might be of interest to you in the future?
- What kind of technological support do you currently need?
- What kind of technological support would you like?
- What kind of technological support might be of interest to you in the future?

The questions were distributed via an Acrobat form and on-line at http://www.kwiksurveys.com/.

Survey Results

Twenty seven responses were received. The replies for each question are given below.

Use of FLOSS

What kind of FLOSS software do you currently use? (Arranged in categories)

Anti virus: AVG

Browsers: Chrome, Firefox, IceCa

Database: MySQL, PostgreSQL.

Education: Freemind, Hot potatoes

Graphics: Gimp, Inkscape, IrfanView, PICASA

Multimedia: Audacity, Real Player, Video converter, VLC media player

Office: CutePDF, DoPDF, Google, Gnumeric, Open Office, Open Project, PDF viewer, pdfCreator

OS: linux, NetBSD, ubuntu,

Productivity: AxCrypt encryption, gnuplot, LaTeX, Maxima Algebra

Programming: CLISP, GCC C++, GNU compiler suite, JADE agent libraries, JAVA, QT widget library, Scala, SymbolicC++

Reference Manager: Zotero

Social networking: Dspace, SocNet, Thunderbird, WinSCP, YOLA

What kind of FLOSS software would you like to use? (Arranged in categories)

Browser: Firefox
Education: Moodle, Sakai, Survey Tool
Graphics: open source CAD
OS: Ubuntu, Edubuntu, SUSE
Productivity: Open Office
Programming: FLOSS languages and uitilities
Reference Manager: Zotero
Social networks: FLICKR, YOUTUBE, Novell Groupwise, Thunderbird, Voice Over Internet
Web development: Joomla, Kompozer, Quanta

What kind of FLOSS software might be of interest to you in the future? (Arranged from highest to lowest number of responses)
Scientific/engineering utilities
Qualitative data analysis package
Quantitative statistical package for the social sciences
Programming: Python, Ruby, CVS, GIT, SVN
OS: Linux, SUSE
Electrical Simulation
Web development: Joomla

Support required for FLOSS
What kind of technological support do you currently need? (Arranged from highest to lowest number of responses)
Support staff members need to provide support for Linux
Linux setup, configuration and maintenance support required
Support staff members need to be educated to support FLOSS
Publication of network and other services configuration information
University systems to support Web standards (HEDA and procurement not compliant)
Use of Open Standard for all University documents
Use of and support for open source CMS (for example, Joomla)
Community for wikis, FAQs and help files

What kind of technological support would you like? (Arranged from highest to lowest number of responses)
Support for Linux OS
Linux configuration setup and maintenance
Overall switch to FLOSS environment.
FLOSS help desk
Mirroring of software and operating system updates.
Extensive / advanced training in use of FLOSS
The network firewall currently blocks ports used by CVS (for example) which makes it more difficult to collaborate on FLOSS projects hosted on servers outside of the university.
Support for open source CMS software (for example, Joomla)

What kind of technological support might be of interest to you in the future? (Arranged from highest to lowest number of responses)
Support for Linux OS
Linux configuration setup and maintenance
Overall switch to FLOSS environment with full support from IT
Extensive / advanced training in use of FLOSS

Discussion
A wide variety of FLOSS is used, or may be used in the future, by members of the UJ community. While individuals make use of many different types of FLOSS software, there are a few departments who make extensive use of a FLOSS operating system and utilities for teaching and research. The type of responses ranged from practical approaches (getting the job done) to philosophical position (evangelical use of FLOSS by UJ). However, the types of software used at UJ include the GNU/Linux operating system, computation resources, multimedia and graphical applications, production/ publication utilities, and software for research. There appears to be a lack of software at UJ to support scientific/engineering practices, qualitative and quantitative statistical research approaches, programming utilities, and on-line publication. In addition, respondents suggest that UJ make use of internationally recognized standards (for example, use of the Portable Document Format instead of Microsoft's documents).

With reference to institutional support for FLOSS at UJ, respondents requested assistance with GNU/Linux (especially drivers), open publishing and education/support in the use of FLOSS. In addition, many respondents requested that UJ make use of open- and Web standards.

While the survey attempted to understand the use of FLOSS by members of the University community, it should not be forgotten that ICS makes extensive use of FLOSS software (for example, databases, operating systems, and email systems).

Recommendations
Introduction
The University of Johannesburg currently makes use of FLOSS at the micro, meso and macro levels but neither provides institutional support nor leverages any strategic advantage. Therefore, it is necessary for the University to either allow current practices to continue, or to support FLOSS as a strategic goal in order to provide leadership, innovation and support.

The use of FLOSS within complex environments, such as the University of Johannesburg, needs to be considered from a number of levels (macro, meso and micro). Financial and operational constraints should also be considered. In addition, it is necessary to take into account contributions from creative human capital that might support administrative, teaching & learning and research activities in ways not yet known. Recommendations presented take into account the scarcity/abundance concept that argues that our scarce resources are in reality the staff and students of the University of Johannesburg and not information and communication technologies. The proposed model attempts to minimize financial costs while maximizing student and staff involvement.

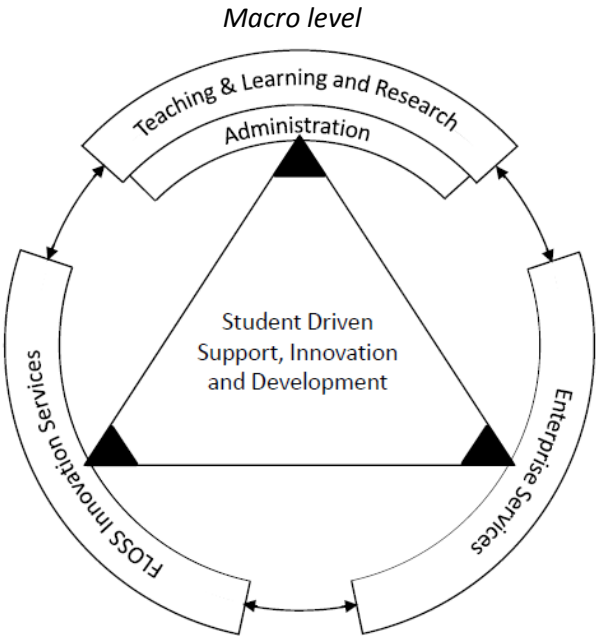

Figure 1. Proposed FLOSS Innovation Services

A model for the integration, use and support of FLOSS at the University of Johannesburg includes the academic and administration community interacting with existing Enterprise and FLOSS services supported by student-driven support, innovation and development (Fig. 1). The FLOSS Innovation Services are conceived as a 'sandbox' environment. The proposed model includes a number of components and constructs, including:

- Leadership in and innovative use of FLOSS emanates from Academic (Teaching & Learning and Research) and Administration 'positive deviants' who, working in a community of practice, explore new and interesting uses of software to solve real-world problems related to teaching, learning, research and administration. [No direct expenditure; indirect cost associated with staff participation].
- Resources (management, support, hardware and software) are provided by a FLOSS manager associated with the Enterprise Services. [Direct expenditure for staff (new posts 1 x manager - R 450 000 pa; 2 x technical support staff – R 400 000 pa), hardware (R 65 000) and hardware maintenance (R30 000 pa); low indirect costs].
- Terms of references of the existing ICT Committee extended to provide leadership for the development and use of the FLOSS Innovation Services. Innovations should support development of solutions at the micro, meso and macro level. [No direct or indirect costs].
- All FLOSS Innovation Services developed and used at UJ should preferably make use of open standards [No direct costs; indirect costs: staff time, may be required to reengineer existing services].
- Support for the use of the FLOSS Innovation Services by the wider UJ community is provided by students who not only develop skills in supporting technology, but become part of the innovation and development of the services. The concept is that through the processes of supporting staff in their technological skill development, students become part of a community of practice and learn new knowledge, skills and attitudes in the use of technology in a complex work environment. [Direct costs to support students, however no additional funds required as the student assistant programme could support such student

activities (9 Faculties x 2 students support x 40 h pm x 10 months x R110.00 pm = R 792 000 pa); indirect costs – management and training provided by the Enterprise Services FLOSS manger].

- Access to FLOSS Innovation Services is controlled but does not require the same level an access control as those associated with Enterprises Services. Part of the FLOSS Innovation Services may be open to the public. [No direct or indirect costs].
- FLOSS Innovation Service software solutions of value to the wider community and of suitable quality may migrate from this layer to the Enterprise Services layer. [Possible future support costs].
- Possible benefits of FLOSS Innovation Services require management and financial support for at least 5 years.

Meso and micro levels

Apart from the FLOSS Innovation Services, departmental and individual use of FLOSS is supported through:

- Development of a FLOSS software repository that could be part of intranet serves to provide easy access to institutionally supported FLOSS and user manuals. [Direct costs include technology and staff/student development; indirect costs provided by the Enterprise Services FLOSS manger and intranet support staff].
- The use of a single GNU/Linux product (for example Ubuntu). [Direct and indirect cost – training of the Enterprise Services FLOSS manger and student support members].
- Development of workshops for the use of FLOSS in teaching & learning, research, and administration. [Direct costs (R 5 000); indirect costs supported through Academic Development and the Winter School].

A summary of cost is provided in the following table:

	Year 1	Year 2	Year 3
FLOSS manager	R 450 000	R 450 000	R 450 000
Technical support staff	R 400 000	R 400 000	R 400 000
Hardware	65 000	-	-
Hardware maintenance	30 000	R 30 000	R 30 000
Student support	792 000	792 000	792 000
FLOSS workshop	5 000	-	-
Total	R 1 692 000	R 1 672 000	R 1 672 000

In conclusion, it is argued that through the creative use of staff and students, the University of Johannesburg, could develop an innovation hub related to FLOSS at minimal risks and financial costs. The proposed model could provide a safe and supportive environment to foster innovative teaching & learning, research and administration.