IST PROGRAMME

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End-User Development - Empowering people to flexibly employ advanced information and communication technology

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D2.1 Industrial Action Plan

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Summary

This document contains the action plan for industrial collaboration in end-user development. It uses the findings of the EUD-net industrial forum as reported in deliverable 2.2 to identify areas for improving the adoption and of EUD by industry and society. Discussed is a need for risk management; the reward and accountability process; the cost-benefit and learning burden to both the organisation and end-user; and the need for both built-in testability and the encouragement of a professional culture.

Industrial Action Plan

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1. End-User Development

In this report we will be using the following working definition of End User Development (EUD):

Def. "*End-User Development is a set of activities or techniques that allow people, who are non-professional developers, at some point to create or modify a software artefact*".

EUD is increasingly necessary to successfully interact with society in both work and in leisure. We are becoming overwhelmed by information to make sense of and complex devices to control. To do so we are forced to interact with software in non trivial ways. The situation is unlikely to improve as there aren't and will not be enough experts to develop software for our needs, the onus is moving to end-users to support themselves and to this there is a need for appropriate EUD techniques.

2. Purpose of this Document

This document contains the action plan for industrial collaboration in end-user development. It begins with a description of the EUD market place as viewed by the network then discusses the results of the industrial forum and concludes with statements on future areas for collaboration. The aim of the action plan is to indicate area that with a short term horizon could benefit both the research and industrial communities involved in EUD.

The results described here arose from a set of workshops and an industrial survey organised as part of the EUD-net industrial forum (see deliverable 2.1 for further details). The Manchester workshop which the majority of the data comes from was structured as two discussions in which groups of participants responded to a set seed questions on their experiences and predictions of EUD. The survey was returned by 40 participants who were required to rate their agreement to a set of statements (see appendix) using a scale of *Agree*

Strongly, *Agree*, *Indifferent*, *Disagree, Disagree Strongly.* The responses were then mapped to a scale from 2 for agree strongly 0 for indifferent and -2 for disagree strongly.

3. The EUD Market Place

Fig 1 presents a model of the market for EUD technologies. It was created through analysis of the industrial forum discussions and survey. The model shows subcategories of producers along product and service lines and consumers according to the level of group interaction. Firms are supplying different classes of EUD technologies from development environments through end-user tailorable systems to appliances with EUD support embedded. An additional group of actors are system integrators and those providing auditing services who are helping organisations adopt EUD activities into their working practices efficiently and at reduced risk.
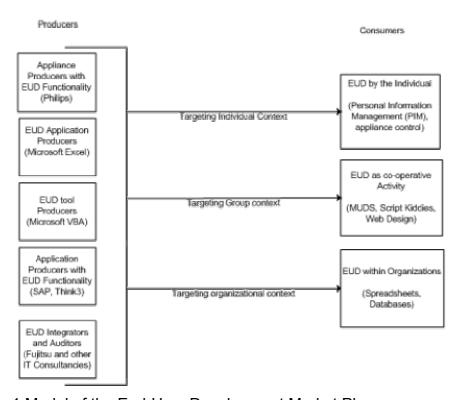

Fig 1 Model of the End-User Development Market Place

Appliance Producers - Manufacture domestic and commercial devices that use EUD techniques as part of their control mechanism.

EUD Application Producers - Develop applications that are freestanding End-user Development environments.

 EUD Tool Producers – Develop tools that can be integrated into other applications to provide EUD functionality.

Application Producers – Similar to appliance producers but solely software. They embed EUD techniques into their applications.

EUD Integrators and Auditors- This set of actors provide a service in support of the EUD activities of organisations, such as auditing of spreadsheets and giving advice on the adoption of EUD activities into organisations.

The consumer side has been classified according to type of social structure the EUD technology will become apart of, this help to highlight the difference in requirements between large organisational users such as business and the home end-user.

4. Industrial Concerns of End-User Development

The forum report (deliverable 2.1) details the meetings and survey activities of the EUD-net industrial forum. Here we present the results of the forum which were used to formulate the industrial action plan. Discussed is a need for risk management; the reward and accountability process; the cost-benefits to both the organisation and end-user; and the need for built-in testability and the encouragement of cultures of testing. The discussion is structured through the three high level themes which emerged on analysis of the forum discussions and survey: *managerial acceptance, the role of the end-user and software quality*.

4.1 Managerial Acceptance

The first theme to emerge from the discussions is the idea of managerial acceptance. That is whether decision makers within organisations think it is desirable to allow End-user development to occur. The issues grouped under managerial acceptance range from corporate strategy and risk, managerial control and accountability for EUD. To a lesser extent these issues impact on the domestic domain especially in the realm of family finance.

Corporate Strategy and Risk

Survey and forum participants saw EUD as a useful mechanism for decision makers to tailor information systems quickly in response to dynamic operating conditions. They believed that "it would empower the operators of the business to react to changing situation without the need to use specialist programmers". From the survey, respondents returned on average 0.97 out of a possible 2 agreement points that EUD brings **faster development** and 1.34 agreement points that **domain expertise improves the product**. The costs of introducing EUD are perceived as being low enough to be worth while with an average score of -0.53 (mild disagreement) to the survey statement on the existence of **cost barriers** to EUD.

The three responses to faster development, domain expertise, and cost barriers indicate that EUD is perceived as increasing the capability and agility

of an adopting organisation at an affordable price. Indeed the score of -0.25 (mild disagreement) returned to the statement about **development being the responsibility of software specialists** indicates that the ownership of systems development is seen on average by decision makers as being held by end-user rather than professional developers.

Interesting discussion points complemented and clarified the survey opinions. It was proposed by the industrial forum that EUD should be used only as a "tactical weapon" due to the perception of it being cheap, and therefore potentially dirty. This led to the idea that EUD'ed artefacts shouldn't be moved into the mainstream of an organisation or be used in critical tasks without being audited by professional developers. Others thought that organisations would have "core business processes supported by software which mustn't be touched by end-user because it would be too dangerous" and "other processes around the outside which the end-user should be able to tailor". This was reinforced by the score of 1.05 agreement points to the statement that **EUD can be dangerous**. The problem in deciding which process an End user could tailor would depend on having a mechanism to identify core and peripheral processes; one suggestion is the idea of a process risk map (see action areas). The risk map would be a "measurable business model" which allows an organisation to asses the risk of altering critical processes, this model could be used to place the end-user developer in a "play pen" of process which can and can't be changed. The underlying idea being that if the risks are quantifiable the consequences could be bounded. An obvious problem to creation of play pen approach is that it does not protect an organisation from developing a flawed spreadsheet model for a strategic decision. This could be as equally damaging as inadvertently affecting a core business process. For example Transalta lost $24 million due to a cut and paste error in one analysts spreadsheet (http://panko.cba.hawaii.edu/humanerr).

Overall, the main conclusions related to the strategic value of EUD practices were focused on the added corporate value in terms of better support for agile working practices, but also on the need for appropriate auditing and control procedures related to the organisational diffusion of an EUD artefact. Indeed, issues of management control were quite pronounced at the discussions, and are covered at some level of detail next.

Management Control

Naturally line management have a desire to maintain control over subordinate workers, EUD could impact this control dimension because the complexity of the artefacts may be difficult to audit and the activities of workers hidden creating a problem of ultimate responsibility for software quality. This is problematic as there is belief that **EUD creates a software quality issue** (strongly agree - 1.76) and that **EUD can be dangerous (eg data security)** (agree - 1.05). To protect against this we need first to allocate the responsibility for the quality, is it the worker, a user of a EUD artefact, a manager or an external authority such as the IS department. Another approach to quality is the auditing, but it is still not clear who would be

responsible for this auditing and the quality of the final software the line manager, the worker or any user of the artefact?

A mean of (Disagree -0.11) to **EUD can undermine managerial authority** indicates that although there is a slight perception that managerial authority will not be effected, the sample of respondents where not sure. During the discussions it emerged that this was because managers lacked control of EUD practices, even those occurring within their immediate span of responsibility, as at present most development is archaic and not immediately apparent.

Organisational demand for EUD

Discussion transcripts confirmed that organisations are naturally interested in EUD because it promises agility and effective reaction to external market pressures. However, the attitudes to EUD are shaped to a large extent by the culture of the organisation, and by the presence or absence of quantified benefits. Business cases are very important driver for organisations exploring new technologies or practices such as EUD.

In terms of the market sector, EUD tools such as Agentsheets will be in a competition with the following accepted practices:
- Tailorable (but not by users) COTS systems such as ERP packages;
- Application Generators, and
- Component Engineering.

Of these, tailorable COTS systems require a trade-off between ready-made functionality out of the box and power of supporting complex business practices specific to the organisation in question. The market has tended to go for the former, which has largely kept organisations "straight-jacketed" into these systems. However, technology adoption practices are often led by the business cycle, and changing markets may require more agile organisations which would favour the latter side of the trade-off, and, ultimately, benefit EUD acceptance.

4.2 The Role of End-user Developer

Worker Recognition and Responsibility

Survey respondees felt that *Using EUD tools could make their work more interesting* (mean of Agree – 0.89), and that *Using EUD tools will make then more efficient in their main job tasks* (mean of Agree – 0.84). This was supported by stronger agreement (1.34) with the statement that *The domain expertise of end users can create more effective software to support there task*, and disagreement (-0.50) with the statement that *Programming will always be too hard for the non-specialist.*

An issue that emerged in relation to control is that EUD could create a power shift and effect ownership in the workplace by creating unnecessary barriers to information access. It is potentially the case that those who may of previously

had informal access via conventional means may lose this acess this if they fail to be designated as an end-user developer. The power generated by EUD practices was seen as requiring stronger levels of accountability and some clear auditing practices.

At the same time, appropriate reward mechanisms and models should be put in place to reward EU developers for taking on the risk and extra work associated with EUD, to complement the credit amongst their peers.

Costs to End-users

Some costs for end users should be taken into account when designing appropriate conditions for EUD. For example, learning curve costs tend to be quite high because of the rapid evolution of contemporary technologies, where each new version of software creates a learning burden on the user. This is also compounded by the need for the EU Developer to go back and change the underlying code to make it work with the new technology.

The challenge of EUD systems is to make them so intuitive that the end-user doesn't realise that they are developing, in other words we should aim to remove the cognitive effort so the focus is on the task.

In summary, processes and polices are needed to ensure developers are both accountable for the artefacts they produce as well as being recognised for the extra work done. It was felt this duality of accountability and recognition for end-user development was vital for acceptance by both management and worker.

4.3 Software Quality

Survey respondents agreed fairly strongly with the statements that *EUD can be dangerous e.g data security* (mean of 1.05) *and that EUD creates a software quality issue* (a mean of 1.24)*.* To counteract this perceived risk, the discussion focused on promoting professional approaches to EUD, including customised Software Engineering methodologies. Testing practices and methods were perceived as an important sign of professionalism.

A general lack of a culture of testing was perceived because of the predominant paradigm of immediate results for short-term gain under increasing technical complexity. One way forward was to foster the transfer of testing practices from the user domain to the activity of software development. For example, marketing specialists and biologists would use sophisticated testing approaches in their professional activities, and the same culture should be transferred to their programming activities as EUDevelopers.

Another way to stimulate the social acceptance of testing is to make the responsibility of the end-user transparent. Highlighting the degree to which an EUD artefact has been tested is one technical approach to doing this, and if a spreadsheet is full of red boxes then the others may not believe the figures.

Testing could also be enforced through organisational procedures and rules.

5. Action Areas

In our survey work we have found out that the concerns of decision makers have tended to be of a social nature, the feeling is that we are in danger of creating technologies with potentially limit practical application. This is understandable as the majority of EUD tools are currently research prototypes, but it does point to a need for investigating further application domains and how EUD will work in practice. Therefore the areas for the immediate collaboration with industry are mainly social in nature and revolve around developing the infrastructure (policies, institutions, processes) to conduct real world trials of the current generation of EUD technologies.

All ready we have various EUD tools from visual languages through domain specific textual languages and simple programming by demonstration tools which have not really be tested in the wild. Even the spreadsheet the most established form of EUD has had limited studies of how they are actually used and their impact on organisational decision making. We therefore propose the following set of action areas which we believe will increase the adoption of the current generation of EUD technologies allowing the research community to gain valuable feedback on *in situ* use which will give direction to the development of the next generation of EUD tools.

5.1 Risk Models

There is a need for enterprise risk models in order that areas suitable for EUD can be identified within organisations. These risk models will help to decide which tasks are safe for managers to permit EUD and to identify "play pens" within the organisations where EUD can be fostered, A process-based view of the organisation should be used to protect core business processes. Without the existence of a "Play Pen" approach it is felt that end users could underestimate the complexity of what they are trying to achieve and possibly do harm to the organisation.

5.2 Reward Models and EUD Costing

Work needs to be done on understanding the necessary reward structure for workers involved in EUD. EUD introduces a new aspect to the way people work, some workers will be happy to learn new skills while others will see at interfering with there main job task. Mechanisms for motivating workers to take part in EUD will need to be developed together with assessing the level of EUD skills a worker has during the recruitment process.

Some organisations may need to measure and cost the time and equipment use dedicated to EUD activities in some way. The debate is whether it should be charged as a particular activity or as a general overhead. Work needs to be done in this area as it is vital for the acceptance of EUD by management.

5.3 Implementation Methods

Bringing EUD into the home, commercial organisations and wider society is not a trivial task. We need to study the diffusion of other disruptive technologies to guide processes of EUD adoption in different domains. In organisational

context, we also need to study the evolution and diffusion of EUD artefacts, which can often mature from individual productivity tools into institutionalised artefacts supporting core business functions.

5.4 Market Research

We need to know which domains have a demand for EUD. There can be a degree of push onto the market but ultimately for mass markets products demand needs to exist, otherwise EUD could appear to make some tasks more complicated than they need to be. The mass-market consumer is the target for EUD not the technology-savvy first adopter this must not be lost sight of whether for office, industrial or domestic contexts.

Need to collate success stories of EUD as well as cases where it has been unsuccessful. In doing so we will begin to understand better the contexts in which EUD can be useful technique for developing software.

5.5. Development Methods and Quality Assurance

Industry and academia need to look back at the body of Software Engineering and participatory development methods to see what's suitable for transfer to the EUD domain. It was felt that this process can introduce a degree ruggedness to EUD thus alleviating some quality concerns.

It should be the industry who plays the dominant role in this as it has the real world experience of how methods have been used in particular sectors and knowledge of how end-users have reacted when they have come into contact with these professional methods.

Transferring Professional Cultures: It is not just software engineering that has the concept of testing as fundamental part of it existence. From marketing to actuarial work domain experts test the work they are doing. It may be possible to "professionalize" EUD by transferring the vigorousness of the deployment domain into the process of developing new software. This will stimulate the development of a culture of testing within EUD.

5.6 Legal and regulatory frameworks.

Increasingly EUD artefacts such as spreadsheets can be seen as contractually binding, e.g. for the UK Government's Private Finance Initiative projects, the financial spreadsheet model has become the contractual document.

In some domains such as banking and nuclear power, the operations of firms are closely overseen by industry regulators to maintain the integrity of their systems. In these domains regulators need to understand how EUD changes the nature of work and it's auditability.

6. Conclusion

EUD is here to stay we must begin to consider the changes it will bring to business and society, or to take a less deterministic perspective ask what the requirements of society for this new technological artefact are. All too often research into End-User programming has concentrated on the technology, the low-level cognitive and machine centric interactions between system and user.

There is a need for End-user Development researchers to step out of their traditional HCI, Software Engineering and CSCW views. They need to collaborate with other non-IT research disciplines, regulatory authorities and a broad spectrum of industrial interests to realise the potential benefits of EUD. There is a need to look into how EUD systems and those sharing similar qualities are working today in organisations. In doing so we will realise that others are experiencing similar problems from user communities such biologists developing their own end-user programming languages to the increasing concerns of financial auditors on the operational risks created in the use of spreadsheets and end-user developed databases.

Appendix

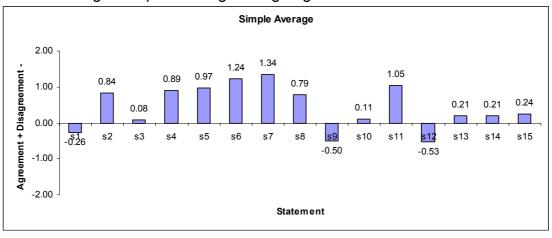## Fig 2 Graph showing average agreement to statements

Code	Theme	Statement	Score
S1	Development by specialists	Software development is the responsibility of software specialists	-0.26
S2	Improves efficiency	Using EUD tools will make me more efficient in my main job task	0.84
S3	Waste of time	Using EUD tools will consume time which I should be spending on my main job task	0.08
S4	Job enrichment	Using EUD tools could make my work more interesting.	0.89
S5	Faster development	EUD could speed up software development.	0.97
S6	Quality risks	EUD creates a software quality issue.	1.24
S7	Domain Expertise improves product	The domain expertise of end-users can create more effective software to support their activities	1.34
S8	Need for perceived net benefit	EUD success in the organisation depends primarily on the perceived benefits out-weighing the perceived costs	0.79
S9	Programming too hard for end users	Programming will always be too hard for the non-specialist.	-0.50
S10	Control risk	EUD can undermine managerial authority	0.11
S11	Operational Risks	EUD can be dangerous (e.g. Data security)	1.05
S12	Cost barriers	EUD is too expensive for organisations to implement	-0.53
S13	Cognitive priority	EUD work should focus on solving the cognitive issues first	0.21
S14	Socio-technical priority	EUD work should focus on socio-technical issues first	0.21
S15	Organisational priority	EUD work should focus on organisational issues first	0.24

Fig 3 table showing the statements and themes they address