A reflection on personal information management from an information systems perspective

Mark Gregory
Department of Finance and Operations
ESC Rennes School of Business, France

Give an answer to everyone who asks you to ***give a reason for the hope that is within you***. But do it with gentleness and respect. (1Pe.3:14-15)

ABSTRACT

This paper reconsiders the term Personal Information Management System PIMS and compares and contrasts it with the similar terms Individual Information System IIS as discussed by Richard Baskerville and User Generated Information System UGIS as introduced by Philip DesAutels. However, this paper contends (with Baskerville) that it is the personal work system constituted when a human user makes use of a PIMS which exhibits a systemic nature. The paper introduces specific research questions which relate to PIMS and demonstrates their emergence on the basis of reflection or reflexivity. It suggests as a potential contribution the theoretical and practical necessity for modelling a PIMS in order that the PIMS constructed using that model be maximally effective for the individual who uses it. That contention is the subject of ongoing research.

Categories and Subject Descriptors

General Terms

Management

Keywords

Personal Information Management Systems; Systems Approach; bricolage; abductive logic of enquiry

1. Introduction

This paper is an extended position paper written by a long-term practitioner and teacher of information systems who, in later life, is undertaking a Ph.D. examining the phenomenon of personal information management systems PIMS. The paper offers an information systems perspective which I hope will interest the vibrant personal information management (PIM) community to whose achievements I hope one day to add.

My other hope, as a teacher and researcher, is to diffuse and create useful knowledge – to make better bricks and to share those bricks with other builders.

My initial framework is that of ***personal work systems*** driven by ***personal knowledge*** as modelled and supported by ***personal information management systems***. Why?

There exist tools of thought and enquiry that take a systemic and systematic approach to problem identification, analysis and solution. One among these is the so-called ***Systems Approach*** [34], the underlying science of which is called ***cybernetics***. Cybernetics deals with complexity by seeking to control it, where control is to be understood as steering a course towards a better solution – from kybernetes, *κυβερνετες*, the steersman or helmsman. The helmsman applies her intelligence and experience, as amplified by the machine, the ship, which she controls, to create sufficient and appropriate variety to deal with and overcome the variety and complexity she is encountering in her turbulent environment. Norbert Wiener and Arturo Rosenblueth are generally regarded as the fathers of the science of control and communication in man, machine and animals [71]. They identified as fundamental to control the notion of feedback. Feedback is when the effect of a process (or things that come out of it) have a connection to its cause (or things that go in to it). The effects of feedback can be positive in terms of greater controllability or negative in terms of a loss of effective control.

Walonick [68] provides a useful introduction to the general systems theory of the biologist Ludwig von Bertalanffy. GST is a complementary approach to the issues of control and complexity which initially developed independently of the engineering-focussed cybernetic tradition. Walonick observes that:

> "A *closed system* is one where interactions occur only among the system components and not with the environment. An *open system* is one that receives input from the environment and/or releases output to the environment. The basic characteristic of an open system is the dynamic interaction of its components, while the basis of a cybernetic model is the feedback cycle. Open systems can tend toward higher levels of organization (negative entropy), while closed systems can only maintain or decrease in organization." [68]

This observation suggests the necessity that a system be open if it is not over time to decay. Specifically, a tool alone cannot improve the controllability of a system; only its use as part of an open system holds this potential.

The British cybernetician W. Ross Ashby first enunciated his Law of Requisite Variety in 1956 [13]: ***"Variety absorbs variety, defines the minimum number of states necessary for a controller to control a system of a given number of states"*** (albeit in a discrete state

controller). This can be summarised as ***"only variety can destroy variety".***

A simplistic definition of a system would be a set of interacting or interdependent components which together form an integrated whole. However, some argue that what makes a system viable is its capacity to adapt, that is, to develop increased order (negentropy). Thus Francis Heylighen [44] identifies a number of cybernetic principles. One among these is what he calls blind-variation-and-selective-retention (BVSR). Accepting as another principle that a stable system is to be preferred to one that decays towards higher entropy (disorder), Heylighen goes on to suggest:

> "BVSR processes recursively construct stable systems by the recombination of stable building blocks. The stable configurations resulting from BVSR processes can be seen as primitive elements: their stability distinguishes them from their variable background, and this distinction, defining a "boundary", is itself stable. The relations between these elements, extending outside the boundaries, will initially still undergo variation. A change of these relations can be interpreted as a recombination of the elements. Of all the different combinations of elements, some will be more stable, and hence will be selectively retained.
>
> Such a higher-order configuration might now be called a system. The lower-level elements in this process play the role of building blocks: their stability provides the firmness needed to support the construction, while their variable connections allow several configurations to be tried out. The principle of "the whole is more than the sum of its parts" is implied by this systemic construction principle, since the system in the present conception is more than a mere configuration of parts, it is a stable configuration, and this entails a number of emergent constraints and properties. A stable system can now again function as a building block, and combine with other building blocks to a form an assembly of an even higher order, in a recursive way."

In living systems the selection process is evolutionary. In a work system, the selection mechanism is no longer blind but can itself be purposeful, what Archer quoted in [43] identifies as "designerly enquiry". More generally – but certainly in a non-exhaustive manner – I would identify categorisation, classification, ontology and "programming" (broadly understood to include spreadsheet formulae, but also "traditional" computer programming) as among the intelligent behaviours which cause the order of a system to increase.

There exists a field of study called ***information systems***. Many hold that the field is also a fully-fledged discipline, although this view is disputed, for example by [42]. Hassan's paper is beautifully constructed but it is flawed. It invites us to study what bricks are without concerning itself sufficiently with how bricks are made. Specifically, it does not discuss the framework within which practical, useful, information systems are constructed. That framework can be summarised as a process of analysis of requirements and of synthesis of an information system which seeks in whole or in part to respond to the analysed requirements. An excellent framework for initial analysis is provided by the work systems method of Steven Alter [9].

Generally speaking, information systems are amplifiers on the forward path or components of the feedback path used to control a complex system, e.g. business information systems BIS are used to coordinate and control the work of an enterprise.

A personal information management system PIMS is posited as an information system which stores data used by an individual to yield information which she requires so as to be able to control her own activities. Her aim is to get work done more efficiently or effectively by more closely achieving desirable goals or outcomes. The primary process is embodied in a personal work system, where work is to be understood very generally so as to embrace play rather than to contrast with it.

An engineer designs and constructs a "better future", that is:

- she looks at an existing messy situation and identifies problems and problem owners; the latter are the clients for possible solutions – realisable improvements to the messy situation
- conceives of a product or artefact that might be useful in addressing that messy situation
- seeks to understand the needs or requirements for that artefact
- identifies the already-existing components that might contribute to that artefact
- identifies the constraints surrounding its realisation, particularly timescale and money budget
- makes a repertory of the competences needed to design and build the artefact
- assembles a team that has those competences or which can rapidly develop them
- identifies or develops a methodology to guide and constrain work of the team
- designs and builds the artefact
- checks the conformance of the built artefact to the original and developed needs of the clients
- trains the client in the use of the artefact
- implements the artefact, knowing and expecting that it will in part meet the client requirements, fully meet them, or exceed them - BUT that its introduction will create new problems and possibilities for the clients and those also affected by the development

An engineer might construct improved personal information management ***tools***.

A do-it-yourselfer, what the French call *un bricoleur*, makes something that is useful but typically in a less systematic manner than the engineer:

- she gets an idea for something she wants to make or a problem situation she wants to improve (e.g. a dysfunctional kitchen)
- conscious of her own skills and limitations, she follows steps similar to those that the engineer undertakes, always constrained by her own capabilities and resources

The motivations for *bricolage*, do-it-yourself, include inadequate access to expertise or cost saving. As [30] suggests, individuals have frequently to mash together various components so as to address their personal information management needs by means of what he calls user generated information systems UGIS.

A worker (or a player – I treat play as work much as some people treat work as play; the emphasis is on creatively finding a solution to an immediate problem while always seeking to learn how to solve that problem or others like it better next time):

- works within a work system
- follows a process within a framework
- brings her competence to bear on the work at hand
- plans a mini-project for getting the work done, identifying the actions or activities necessary to its completion
- sometimes has access to experts and existing tools
- sometimes engineers tools to amplify her competences

What do the engineer, the bricoleur and the worker have in common?

- They are all involved in problem-solving
- They are all part of a system and have some limited or constrained ability to improve the system of which they are a part
- They all understand something of the systemic nature of the situation, which is that any improvement will change the problem situation but will never completely solve it, since unanticipated systemic effects – sometimes positive, often negative – will emerge and then in their turn need to be addressed
- They work best, that is, they get more done more quickly, if they have:
  - a good problem-solving framework
  - competences, including modelling and design skills
  - they learn by doing and from doing (the latter being reflection)
- They sometimes see the need for, and either acquire or make, a new tool in order to amplify their competences

The glory of computerised information systems is that they embody tools and techniques either in an immediately-useful form (e.g. PIM tools), or they provide the possibility to create new useful tools comparatively quickly (e.g. PIM systems). However, information systems experts have not as yet contributed much to the study and practice of personal information management. Thus Baskerville [16] has very recently identified what he calls “individual information systems IIS” as a new subject of enquiry.

W. Ross Ashby’s law of requisite variety [13] and Conant and Ashby’s good regulator theorem [25], "every good regulator of a system must be a model of that system", can be used to demonstrate that an individual information system is and should be creatively designed, requisitely rich in its variety and that the model for the design should be as far as possible isomorphic with the work system of its user. This validates the intuitively attractive, "obvious" conjecture that every individual information system has to be specific to a particular user. Further, this suggests that this research has essentially to be grounded in modelling.

This thinking mandates that the individual should:

- Analyse her existing situation by making models of the existing situation and a projected better situation using appropriate modelling techniques. Concept maps [52]; [53] can be suggested for this purpose and are sufficiently simple to be used even by children (for whom they were originally designed).
- Build a solution – directly, or by first making a prototype that at least demonstrates potential improvement then proceeding to a better solution. Building a solution will normally imply using existing tools (perhaps in a mashup), may require new ones, but certainly require the user to understand the structure of the information she is processing as she carries out her work.

Attempts to short-circuit this process are analogous to the belief that all that is necessary to building a better kitchen is to acquire power tools from WalMart. Instead, the worker, the bricoleur and the engineer have all to ***learn***.

2. Personal Information Management (PIM) and PIM systems

This paper presents one aspect of the doctoral research of its author. That research concerns personal information management or how “better” to manage personal information: both in what William Jones calls KFTF, keeping found things found [46]; and how “better” to get things done (cf. David Allen and his Getting Things Done GTD approach [6]). The conference presentations made so far as part of that overall research are [31, 35–41]. The aspect that this

paper concentrates on is ***the nature of personal information management systems.***

When we have a purpose to achieve, we need and decide to take action. In order to act reasonably rationally we marshal the data that we need. We apply our knowledge, values and abilities to the data that we have and we decide an informed course of action which we wish or need to undertake. We catalogue the resources and tools available to us to undertake the action. We identify the process by which we will carry out the action. The action may be individual or it may require the cooperation of others in an ad hoc team brought together to carry out a project including many actions. We then together or alone undertake the actions. As we do so, we update the data we maintain, whether that be in formal organisational information systems (such as student records systems or learning management systems) or in less-formal personal information management systems. What we do may be informed by or evolve in accordance with the changing data.

When we have completed the planned action, we evaluate what we have done and decide to what extent we have achieved our purpose. Frequently we find that corrective or additional action is needed.

This process, which we can summarise as concerning decision making and problem solving, has previously been identified primarily in the organisational context by Herbert Simon and his co-workers [63]; [62]. In our work, we are concerned with the individual knowledge worker and manager.

Sometimes we evaluate what we have attempted and conclude that there is some element of failure: some or all of our purpose has not been achieved. We reflect on that failure; it may be that our purpose was not achievable with the resources available, or it may be that the purpose was in some sense incorrect or inappropriate, or it may be that the knowledge that we applied to the situation was inadequate or defective. We learn from our success, but much more from our failure; see [1–3]. Russell Ackoff's stance was initially similar to that of Simon; subsequently he broke from the discipline of operations research which he and Simon had helped to establish [4]. Thereafter Ackoff's stance was that of a systems thinker and practitioner, no longer concerned to identify algorithms but rather to understand heuristics – practical approaches to variably intractable problems – in what he termed systemic "messes" [2]. Messes are complex, multi-dimensional, intractable, dynamic problems that can only be partially addressed and partially resolved. They are "systems of problems" requiring planning rather than individual problem-solving. He commends an interactivist approach:

1. Design an idealised future for the system being planned for
2. Design the implementation of a decision as an experiment that tests its effectiveness and that of the process by which it was reached

Thus it appears that we are reflective actors in a goal-oriented (teleological) system that decides, plans, acts, evaluates and learns. We apply knowledge (both theoretical and practical) to carry out informed and decisive action. Our experience causes us to learn – our knowledge changes. We apply our developing knowledge to relevant data so as to make informed decisions and to solve problems.

3. PIM, PIM systems and personal knowledge management PKM

3.1. The origins of PIM

Vannevar Bush identified the Memex as a theoretical concept 65 years ago: [21] ; see also [22] ; [27].

The first modern reference to personal information management (which was also the last for many years) is by the psychologist Lansdale [49].

Deborah Barreau, a library scientist, has discussed personal information management ***systems***: [14]. She also identifies the vital need to preserve the ***context*** in which personal information is first encountered.

3.2. The phenomenon of interest: personal information management

The phenomenon I am strongly motivated to study is this: ***how people manage their personal information, particularly using computer-based tools, and how they can learn to do this better, that is, how they can extend their personal knowledge concerning personal information management.***

The extensive PIM literature is reviewed in [36].

3.3. User-generated information systems

I have previously identified "personal information management systems", abbreviated to "PIM system" or just PIMS. Further, I believe that this is similar to the phenomenon recently identified as a ***"user-generated information system" UGIS*** by Philip DesAutels, who also suggests as a formal definition:

> "A user-generated information system is defined as a set of component services, integrated by the user into a novel configuration such that the resulting information service is (1) qualitatively different from its components and (2) offers unique value to the user over and above the value of its inputs" [30].

This definition is itself based on a rather inadequate definition of information system cited from [19], who make the distinction:

> "An *information technology* transmits, processes, or stores information; while in contrast, an *information system* is an integrated and cooperating set of software-directed information technologies supporting human goals". [19] quoted by [30].

That definition may be inadequate in not distinguishing the emergent systemic property of an information system, that is, that a system is more than the sum of its components; that is, unless we see the integration process as itself adding structure and stability to the information system. DesAutels is careful elsewhere in his article to identify the systemic behaviour exhibited by Bob in his use and generation of his UGIS. DesAutels is also correct to identify and describe a user-generated information system as a set of components that can include services; elsewhere in his article he makes the useful observation that the fundamental building block of what he calls UGIS is the ***service***, technology or human based.

Elsewhere in the same article, DesAutels suggests that users create UGIS

> "On the fly, with little forethought, using easily assembled components. Tinkering and adaptation—hallmarks of the bricoleur – is [sic] the norm." [30]

The reference to the bricoleur is a reuse of the language of Claude Lévi-Strauss, who talks about the bricoleur (roughly- the do-it-yourselfer) who engages in bricolage (DIY or tinkering) in an anthropological context. For an application of this language to the strategic planning of information systems, see [24], where Claudio Ciborra and Tawfik Jelassi identified "serendipitous bricolage" as a common or even normative way of building ***strategic*** organisational information systems. Here Philip DesAutels is suggesting that the same phenomenon is at work in the construction of ***individual*** information systems; we can characterise that approach as "happy-chance mucking-about" until a useful result is achieved.

DesAutels describes but does not justify an architecture for UGIS which recognises four fundamental concepts which are summarised here as Table 1:

Table 1 Architectural components of UGIS according to DesAutels *Source:* [30]

Service	A ***service*** is two-way in nature; this is enabled by the capabilities of state, identity, and contribution. State enables a service to support multiple concurrent interactions. Identity allows a service to recognize a user, so as in the case of an email service the user gets customized content and protected access. Contribution allows a user to add and/or alter content on the service.
Platforms	***Platforms*** enable connectivity and communications within and between services, aggregators, users, and other platforms. The foundational platforms are communications networks such as the Internet, the GSM network, and the public switched telephone network (PSTN). They provide fundamental communications capabilities [30]. *NB: other authors might refer to* ***infrastructure****.*
Aggregators	***Aggregators*** are the tools that allow UGIS to be built in a literal sense. They serve as the enabling element for the creation and use of UGIS. Aggregators encapsulate the technical aspects of composing services into easy-to-use abstract forms, enabling mashups of services to be built by the masses [73]. They offer a means by which users can easily compose those services together to form meta-services of their own. All aggregators offer input, output, and processing capabilities, although the latter may vary widely in range. A fundamental attribute of aggregators is their ability to encapsulate technical complexity into simple abstract forms that are easily accessible by users. By doing so, they facilitate the integration, composition, and orchestration of multiple services and platforms by non-technical users via simple, interface-driven features and do not require—but may allow—programming in the traditional sense.
Content	***Content*** is an integral part of all services.

The issue of how to aggregate or integrate streams of information between different services or tools has always been difficult and remains so today. [69, 70] identifies the difficulty of integrating information much more precisely and is much less sanguine about how easily it can be solved. DesAutels suggests that his protagonist Bob integrates all the information he gains from various sources but does not describe how. The implication is that Bob carries out the integration or aggregation "in his head". That is acceptable when the amounts of information are small and distinct – his example concerns Bob picking up Bella from the airport and whisking her off to a romantic dinner. A small number of actions are coordinated using several different apps and services. But what if Bob needs to "systematise" the integration of diverse information sources and so render it a repeatable process and not just a one-off activity? DesAutels is silent on the detail of this issue. Nor is he particularly clear in describing the exact form of what he terms "aggregators", and specifically what processing capability is required of one. I suggest that they may take concrete form as, for example, Excel macros or JavaScript scripts; here I am following [73]. Thus an aggregator can also take the form of a function which transforms an input to an output. Such a transformation can only be general if both the input and the output are formally defined (that is, their syntax and semantics are explicit and constrained) and if a thinker defines a suitable transformation and that transformation is then implemented and tested for all reasonable combinations of input and output. Where both services are sufficiently

widely used, then there is an interest (perhaps commercial) in creating an aggregating device or service. [73] discusses the phenomenon of ***mashups***; these provide end-users with the ability to integrate at the webpage presentation level.

DesAutels reminds us of Toffler's [65] notion of the ***prosumer***—a portmanteau of 'producing' and 'consumer'—as one who will "heal the historic breach between producer and consumer" (p. 11). He sees the choice to prosume as dependent on opportunity and ability. He holds that until recently these variables have not been sufficiently present to enable most users of IS to become prosuming creators of IS, but that now they are.

I contend that the prosumers of personal information management systems need to be sensitised to the necessity for integrating information between tools (on one machine) and between services (more generally) and to be introduced to or trained in practical techniques for creating situation-specific aggregators when they do not exist. Those practical techniques, although not requiring a deep knowledge of software engineering, are not always trivially simple, especially since information items all too rarely encapsulate their semantics.

More generally, we are in a situation where a gap exists between capability (or individual competence) on the one hand and need on the other. Bridging that gap requires both tools and general knowledge specifically applied. It is the fundamental contention of this present research that no general mechanism exists to build these bridges and that therefore "all" that can be done is to help people to learn "enough" to be able to construct the necessary bridges at appropriate cost. The components of such bridges may be fairly general in their form and application even if each specific bridge has to be crafted for the particular circumstances of its use.

4. Why and how are PIM systems an appropriate focus for doctoral research?

4.1. Is research into personal or individual information systems justified? The story of Jane Doe

In [16], Richard Baskerville, a very distinguished American IS researcher, identifies the various but integrated aspects of a coherent, well-architected individual information system belonging to someone he identifies as Jane Doe. He identifies as unanswered questions:

1. ***How has Doe designed her system?***
2. ***Why has she made the choices, initiatives, and investments apparent in her individual information system?***
3. ***How does she plan and control her complicated architecture?***
4. ***How can our extant body of knowledge improve Doe's individual information system?***
5. ***What are the important relationships between Doe's system and other IS [information systems] (e.g., individual or otherwise)?***

We need answers to Baskerville's questions and to others, which must initially be sought by ***exploratory research aimed at a fuller understanding of what the phenomenon is***. For Baskerville concludes that:

"Individual IS may well be an extremely large, undiscovered, arena for future IS research." [16]

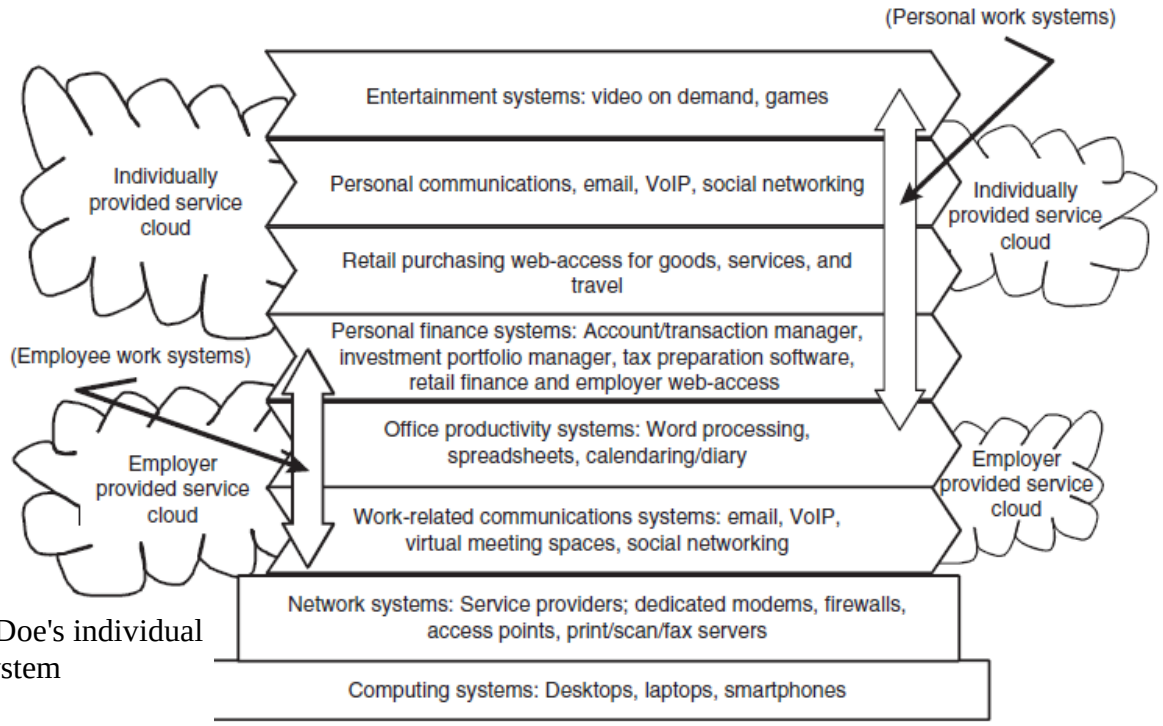

Figure 1 Jane Doe's individual information system architecture

Baskerville's posited IIS architecture [Figure 1] incorporates two kinds of system. One is the individual information system itself, largely an artefact made up of computer-based services. Second is two ***'work systems'*** denoted by arrows within this IS architecture diagram. One is Doe's 'profession[al]' work system as an employee. The other is the work system that serves Doe as a person. We note also the representation of information services consumed and produced as arising from, and sinking into, clouds. The term cloud is used here in its loose, IS perspective because the 'network' is evolving to the 'cloud'. This evolution is because of the increasing availability of not just low-level data services, but ***cloud-based business processes*** [32].

Baskerville reminds us that:

> "IS have been understood as ***social-technical phenomena*** from the earliest years [20]; [51]. Steven Alter [7] ***defines IS as a type of 'work system', 'in which human participants and/or machines perform work (processes and activities) using information, technology, and other resources to produce informational products and/or services for internal or external customers'***" (p 451).

Alter's definition can be read as excluding individual work systems with its reference to internal and external 'customers'. Baskerville holds that:

> ***"It overlooks the way in which individual IS have evolved into rather a complete and legitimate form of IS.*** As technological evolution has enabled more-and-more complex individual IS, it seems that ***these could easily become the most prevalent of all kinds of such systems…***

Individual systems still engage social aspects and organizational aspects. Certainly, ***these systems are socially constructed.*** It is not sufficient to regard individual IS as merely retail consumers of information, entertainment, and technologies. Very few individual systems are purely information sinks. ***People*** are not merely customers and game-players, but ***are actively collecting data and processing it into information for their various purposes, and feeding it outward. "***

4.2. The phenomenon of personal work systems, PWS, each of which includes a PIM system

Baskerville says that Jane Doe is a professional knowledge worker. Knowledge workers, among others, maintain ***personal work systems, PWS,*** which I here identify following Baskerville's suggestion. I suggest that an instance of a PWS characterises, that is a property of, each individual knowledge worker. We can say that each has a MySystem (that others might refer to as YourSystem). MySystem is the system by which I get work done. See Figure 2.

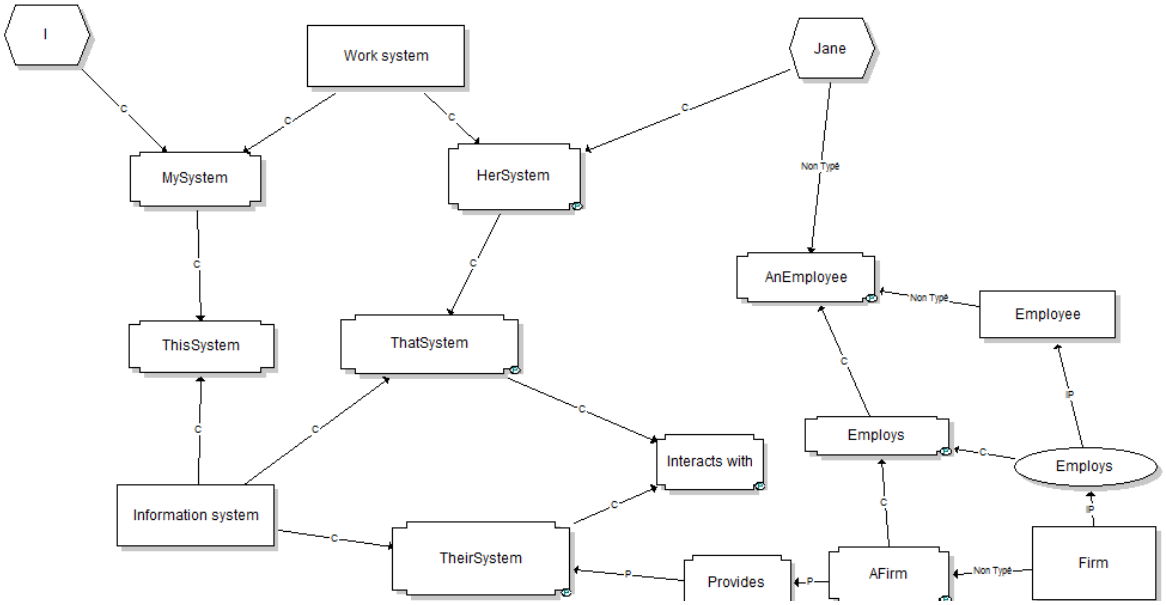

Figure 2 My work system, Jane's and how HerSystem interacts with other systems (Source: author)

Alter [8] defines a Work System as "a system in which people and/or machines perform a business process using resources (e.g., information, technology, raw materials) to create products/services for internal or external customers". I am myself a component of MySystem. MySystem is a work system; such a work system may also make use of information systems. Conversely, any given information system may form a part of many work systems. MySystem, my work system, will usually include a single personal information management system – personal, that is, to me. I might call it ThisSystem.

MySystem and YourSystem may interact. Usually this is at the level of messages (information-bearing data) which you create using YourSystem and transmit to me, where I may incorporate them (more or less) into MySystem.

Sometimes we explicitly share our information by means of a shared data store.

For now, we will define information as data together with "meaning" in the form of semantic structuring.[1]

Sometimes we share our ideas. These ideas and messages in general have a trace, a physical expression as data -- usually verbal, sometimes written, occasionally in other forms (pictures, diagrams, music, etc).

MySystem – I as I work - is thus a knowledgeable, skilled, and more or less explicit and structured: ***system for getting work done***.

4.3. What is the form and function of MySystem?

Baskerville posits and models an architected system. The diagram he has produced is his modelling of Jane Doe's information system architecture. Jane has not, in all probability, explicitly architected or even consciously designed her system. Instead Baskerville has created a model of the architecture he perceives Jane to have evolved.

If I show the model to Jane, Jane will react:

1. She may correct its expressed form, to add information
2. She will reflect on what her "system" is and how it might evolve.

Potentially, I and Jane will discuss the "real" system involved: Jane's interaction with and use of HerSystem, and of ***the individual information system ThatSystem which it incorporates***.

As can be seen from Figure 2, Jane's HerSystem is at least in part integrated with the system provided by her employer, which in the diagram is identified as TheirSystem.

Creating the personal work system MySystem is an act of ***creative design*** [26]. Schön in [61] points out the significance of design and of synthesis, going beyond analysis:

> "Designing in its broader sense involves complexity and synthesis. In contrast to analysts or critics, designers put things together and bring new things into being, dealing in the process with many variables and constraints, some initially known and some discovered through designing. Almost always, designers' moves have consequences other than those intended for them. Designers juggle variables, reconcile conflicting values, and manoeuvre around constraints – a process in which, although

[1] The relationship between data, information, knowledge and action is discussed in [36]

> some design products may be superior to others, there are no unique right answers."

The designed ICT-based artefact is ThisSystem: certain ICT resources collected and perhaps integrated together. The phenomenon we are investigating is MySystem: my use of the individual information system ThisSystem as a part of my personal work system. The ICT system, ThisSystem, may over time evolve. The work system MySystem is always changing -- its content and its form, together with its behaviour. Furthermore, as in all complex systems, it has emergent properties [33, 34].

So we make the conjecture that an individual makes use of a PIMS, a personal information management system, as part of the Personal Work System PWS of which she is the dominant component. I accept that this is not the only possible definition, but I do believe it to have value.

4.4. What is the personal work system MySystem?

MySystem is the conjectured personal work system of which I am a part. I use it (and I live it). It embodies me, the way that I get things done, and any information system that I devise to help me to get my work done.

MySystem is an enquiring system which learns. It includes a memory extension system in the sense originally identified by Vannevar Bush [21]. This memory extension system, more or less coincident with the information system MySystem, externalises aspects of my knowledge and of my data. Bush named it memex.

Some people's HerSystems are highly internally structured. In particular, Chandrasekaran [23] holds that they may make more or less explicit use of the personal ***ontology*** of the person whose system it is:

> "In philosophy, ontology is the study of the kinds of things that exist… [An] ontology is a representation vocabulary, often specialized to some domain or subject matter. More precisely, it is not the vocabulary as such that qualifies as ontology, but the conceptualizations that the terms in the vocabulary are intended to capture… The representation vocabulary provides a set of terms with which to describe the facts in some domain, while the body of knowledge using that vocabulary is a collection of facts about a domain." [23].

A filing system (paper or on a computer) is an embodiment of such a personal ontology. The expression of the personal ontology may be less rich than the ontological viewpoint of its owner; thus a student's filing system may distinguish only Home and School folders, but as Elin Jacob [45] says the student's mental classification and categorisations are likely to be very much richer. Eliciting those might considerably increase the value of stored data. Jacob's paper very clearly distinguishes classification and categorisation. See also the work of Katifori and his associates on personal ontology [47].

5. Useable and useful systems

I am concerned more accurately to identify what the individual information system that Jane Doe uses is, and how she can be helped to learn to evolve a better information system that more completely supports her personal work system. The disciplinary lens used by existing research on personal information management is dominated by that of cognitive science and its close cousin, human computer interface research. Thus much existing research has concentrated on tools and on the ***usability*** of those tools.

My concern is more for the ***usefulness*** of those tools and for their ***use***.

Landauer [48] discusses usefulness, usability and productivity, and we can follow him in suggesting that ***use*** is a function of perceived ***usefulness*** and ***usability***. In this formulation there is more than an echo of Davis and his Technology Adoption Model [28], more recently reinterpreted by Venkatesh [67].

6. Future research: my PhD research question

My two-part research question is:

1. How do knowledge workers manage their personal information and knowledge?

2. How can knowledge workers be helped to improve their personal knowledge management (PKM) by means of a useful and applicable teaching, learning and evaluation framework?

This question ***does not emerge as a research gap in the existing literature*** of my own (information systems) literature, or any other literature that I have been able to investigate. There is of course a great deal of academic literature which is relevant, but all of it in disciplines other than my own. And as we have already seen, the absence of IS literature concerning individual or personal information systems has attracted the interest of Richard Baskerville.

The origin of my question is in fact the result of reflection, of reflexivity; I now seek to justify this epistemologically and pragmatically.

7. The abductive logic of enquiry

If we accept the simple distinctions with which Wendy Stainton-Rogers [64] frames her discussion of logics of enquiry, we can distinguish at least induction, deduction and abduction. She makes a strong case for considering abduction. My initial approach is abductive and it is pragmatic: I follow Charles Sanders Peirce as interpreted by Yu in [72]. I summarise this as:

- The logics of abduction and deduction contribute to our conceptual understanding of a phenomenon, while the logic of induction adds quantitative details to our conceptual knowledge.
- ***Neither induction nor deduction can help us to unveil the internal structure of meaning***. As exploratory data analysis performs its function as a model builder for confirmatory data analysis, ***abduction plays a role of explorer of viable paths to further inquiry.***
- Hypotheses (or at least, initial questions) should be ***generated by means of critical thinking applied to pattern recognition. The objective of abduction is to determine which hypothesis or proposition to test***, not which one to adopt or assert.
- ***Classification plays a major role in making hypotheses; that is the characters of phenomenon are placed into certain categories.***
- ***Researchers must be well-equipped with proper categories in order to sort out the invariant features and patterns of phenomena.***

Peirce defined abduction as "the process of forming an explanatory hypothesis" [55], p.55. Stainton-Rogers describes how Peirce formally defines abduction through ***syllogism:***

> **Result -- the surprising fact, C, is observed.**
>
> **Rule -- but if A were true, C would be a matter of course (i.e. not in the least surprising).**
>
> **Case -- hence, there is reason to suspect that A is true.**

One among perhaps many ways of investigating personal (that is, individual) information management is by up-close observation and participation in the personal information management experiences of a sample, however statistically unrepresentative, of individuals who have information to manage. Different individuals will reach different "solutions" or working compromises. Some will build more effective personal information management systems than others. Note my use of the term ***personal information management systems***, which to the best of my knowledge has only ever been used previously by the library scientist Deborah Barreau – see for example [15]. Yet whenever a computer user sets out to manage some information by making a list and structuring it, she in her use of that list to drive her subsequent actions has constituted a personal information management ***system*** (whose primary components are the computerised list, the technology she employs to maintain it and ***she herself as an active agent or actor***). If we make a shopping list in Excel, we are using technology. If we go just a little further and start to use Excel functions to derive information from raw data, then in our use of that technology, we establish an information system. We might, for example, establish this week's shopping list on the basis of last week's and the previous week's. Applying intelligence and simple programming arguably elevates the use of Excel to (simple) system construction. Viewing that use of technology as an information system highlights a crucial distinction, that between information ***technology*** and information ***systems***. This distinction is fundamental to the existence and self-awareness of the information systems discipline. See for example [54] which holds, simplistically but usefully, that "IS is IT in use".

8. Research gap: Individual information systems as a research arena

8.1. How research questions arise or emerge

Alvesson and Sandberg [10] accept that what they call "research gap spotting" is the orthodox way in which research questions are generated. But they argue strongly that what makes a theory interesting and influential is that it challenges our assumptions in some way. In this article, Alvesson & Sandberg propose what they call "problematisation" as a methodology for identifying and challenging assumptions underlying existing literature and, based on that, formulating research questions that are likely to lead to more influential theories. In developing a typology of what types of assumptions can be problematized they propose a set of methodological principles for how this can be done. In doing this they refer to the "large and overlapping body of literature on reflexivity dealing with key aspects of research… Since our emphasis is on how to work with reflexivity when formulating research questions, we only marginally address other issues of reflexivity in research, such as invoking awareness of the researcher him/herself, the role of rhetoric, and ongoing constructions of reality in the research process."

In fact in an earlier book, Alvesson and Sköldberg [11] are much more explicit in their insistence upon the abductive logic of enquiry and on the role of reflection or reflexivity in research methodology.

8.2. How my research question has emerged

It is a surprising fact that comparatively little of the existing PIM literature treats personal information-management ***systems***. However, we note as counter-examples the work of Bergman and his associates, e.g. [17, 18]. They lay emphasis on the value and necessity for the user to associate subjectively important value to their stored information items.

It is also a surprising fact that almost no academic has discussed how people build personal information management ***systems***, nor how they can be helped to do it better – which will always involve learning and might involve teaching and / or mentoring.

I am of course aware of the work undertaken by, for example, Sauermann and his colleagues on the system Gnowsis for maintaining personal information: [58], [57], [56], [59], [60]. However, the semantic web constructs embodied in that system have not yet entered the personal information management mainstream.

My contention is that a personal information management system exists when someone uses IT in a more or less systematic way to store and manage data which they then use as they act purposefully; based on the information they obtain from that data as interpreted by their knowledge, explicit and tacit.

My problem is to enquire into how people learn to build individual information systems and how they can be helped to design a better system by means of observing them and by actively helping them. This could be done using ethnography or it could be done using action research. To anticipate, the (putative, tentative) 'solution' which I have identified is as follows:

1. To observe myself as I manage the information I do – this is a research approach which is sometimes called auto-ethnography and which others have identified as systematic self-observation. This approach is clearly subjective and limited, and thus incapable in itself of leading to generalisable conclusions. It is not, however, devoid of insight.
2. By reference to the considerable literatures on personal information management (but also on information systems, information technology, computer science, learning, cognitive science and the like), to construct learning materials which have the potential to assist people as they learn to create and (more usually) to improve their personal information management systems.
3. To use those learning materials firstly myself, then as an element in active intervention with research volunteers – people who are willing to allow me to mentor them. This is action research. The context will be volunteers whom I invite to take an interest and others who are attracted by and perhaps also federated by a community built around an online forum. Action research is by nature cyclical.

In the process, I as researcher will collect many more facts, some of which may also be surprising. These will suggest hypotheses which, beyond the scope of this current research, may be the subject of further empirical investigation by logics of enquiry other than abductive. In the processes of carrying out my research and aiding the learning of others, other contributions – prototype learning resources in the form of working documents – will be generated and, to some extent, refined. My "conclusions" will be tentative, insufficiently rigorous for most journals but of ***some relevance or usefulness in practice.*** That latter probability motivates me.

9. Reflections on reflexivity

In my use of the term, I am in no way claiming scientific validity for "conclusions" drawn solely from reflexivity. Many sociologists would agree; thus Norman Denzin [29] describes triangulation, the use of multiple methods which if they converge indicate the trustworthiness of the individual finding.

Instead I am suggesting reflexivity as being in practice a common starting point for conceptualization and modelling. Rigour may subsequently emerge as the concepts are put under more scientific scrutiny and as they receive peer review in the wider scientific community.

Van de Ven [66] quotes Adler and Jermier [5] as understanding that the idea of being reflexive remains unpopular with many social scientists. Adler and Jermier go on to challenge the very possibility of value neutrality. Instead scholars should reflect on their underlying epistemological assumptions and develop an awareness of their standpoints, even consciously choosing them. Reflexivity is presented as a close cousin of reflection as espoused by critical thinkers; Andrew Van de Ven cites [11] as holding that reflexivity "is characterised by different types of recursive turns each providing different insights and perspectives".

Earlier in his same book van de Ven sees reflection arising when an anomaly disconfirms our (working) theories as one way that new knowledge is created. This logic of discovery or creativity was identified by Charles Peirce as the ***abduction*** logic of enquiry:
"This form of reasoning begins when some surprising anomaly or unexpected phenomenon is encountered. This anomaly would not be surprising if a new hypothesis or conjecture was proposed… I argue that researchers and practitioners create or discover theories through a process of abduction." [66]

10. Synthesis and interim conclusions

10.1. Insights from existing theory

The original action researcher, Kurt Lewin, stated that "there is nothing so practical as a good theory" [50]. Good theory has explanatory power and suggests extrapolation into new applications. As an example of such theory we advance Ross Ashby's Law of Requisite Variety: "Variety absorbs variety, defines the minimum number of states necessary for a controller to control a system of a given number of states" (albeit in a discrete state controller) [13]. Ourselves reflecting on that law, we rediscovered Conant and Ashby [25]. Here Ross Ashby and Roger Conant produced their Good Regulator theorem stating that "every good regulator of a system must be a model of that system". The design of a complex regulator includes the making of a model of the system to be regulated. The theorem shows that any regulator that is maximally both successful and simple must be isomorphic with the system being regulated. ***Making a model is thus necessary.***

Drawing together the law of requisite variety and Conant's theory, we suggest that a personal work system PWS (viewed broadly as including the person who uses and manages it as well as any computer-based elements)

has to be sufficiently rich in its variety and close in its internal models to the processes and actions which its user undertakes if it is to be effective. It must be (reasonably) ***isomorphic*** with the process. Furthermore, when the PWS and its constituent PIMS are being designed they must themselves be modelled and those models must be as simple and accurate as they can be. We aim for simplicity by a ***separation of concerns*** (following (Rzevski 1981), who is himself following (Dijkstra 1974), reproduced as (Dijkstra 1982)).

For this reason, it will often be appropriate and necessary to create more than one complementary model. Specifically, ***it is necessary to model at least the work system, then the data structures and information outputs required within the processes and activities identified by the work system analysis*** and ***to ensure that the information system is capable of producing those outputs because its data structures are adapted and adequate to the creation of those outputs.***

10.2. My ongoing research question and an initial indication of how to investigate it

- **Q(i):** How do knowledge workers manage their personal information and knowledge and
- **Q(ii):** how can they be helped to improve their personal knowledge management (PKM) by a teaching, learning and evaluation framework?
- One approach: provide people with self-help tools to evaluate and improve their own PIM / PKM and ***observe*** how much more effective they become
- Another approach: ***actively intervene*** with people to assess their learning styles, existing knowledge and to help them learn to improve

Russell Ackoff believes action research to be very well adapted to dealing with what he calls "messes" [2]. Messes are complex, multi-dimensional, intractable, dynamic problems that can only be partially addressed and partially resolved. They are "Systems of problems" requiring planning rather than individual problem-solving. He commends an interactivist approach:

1. Design an idealised future for the system being planned for
2. Design the implementation of a decision as an experiment that tests its effectiveness and that of the process by which it was reached

Do issues of this complexity arise at the individual level? That is an issue of scale – and huge complexity arises at any level, including what used to be called fundamental particles. But more generally, Ackoff's way of thinking is attractive and useful. I intend to follow it.

Appendix: Selected Definitions

Notion	*Description*
axiom / assertion	An axiom is an established principle, that is, principle which is accepted as having been demonstrated and is not therefore in question, at any rate in this study. Axioms can instead be assumed as true for the purposes of experimental design. They correspond to Peirce's ***assertions*** (Yu, 1994); Peirce contrasts them with ***propositions***.
categorisation	Tag - a non-exclusive characterisation; cf. Classification
classification	Single, exclusive, classification - contrast with Categorisation.
data	Fundamental and unbiased qualitative or quantitative element upon which reasoning or realization of treatments are based.
individual information system IIS	Baskerville, the originator of the term, does not define it but illustrates it by its architecture – a set of component sub-systems, such as entertainment systems, email, instant messaging services, web purchasing, home finance and office productivity suite; network resources such as printers and computing devices – desktop, notebook and smartphone.
information	Data set structured and organized to give shape to a message resulting from a given context and so perfectly subjective.
information system	UKAIS, the United Kingdom Academy for Information Systems, states: "Information systems are the means by which people and organisations, utilising technologies, gather, process, store, use and disseminate information. The domain involves the study of theories and practices related to the social and technological phenomena, which determine the development, use and effects of information systems in organisations and society."
knowledge	Knowledge is new information acquired by an intelligent process, study or practice.
mashup	Web mashups are Web applications generated by combining content, presentation, or application functionality from disparate Web sources. They aim to combine these sources to create useful new applications or services.

mess	Messes are complex, multi-dimensional, intractable, dynamic problems that can only be partially addressed and partially resolved. They are "Systems of problems" requiring planning rather than individual problem-solving. [2]
methodology	A collection of problem-solving methods governed by a set of principles and a common philosophy for solving targeted problems (Checkland, 1981).
personal information management system PIMS	A personal information management system PIMS is posited as an information system which stores data used by an individual in such a way that it can yield information which she requires so as to be able to control her own activities. Its components will include processing elements (what DesAutels calls aggregators)
personal work system	The system within which an individual knowledge worker maintains a personal information management system
PIMS as part of PWS	An individual makes use of a PIMS, a personal information management system, as part of the Personal Work System PWS of which she is the dominant component. A PIMS, personal information management system is a system which can support a user in managing her personal information.
problem	This may either be obvious, that is, evident; or may need to be re-formulated and analysed in terms of underlying problems, leading to Questions.
question	Problem stated in a form that can be investigated epistemologically, ontologically or empirically.
requirement	A statement of what functionality is required in a tool.
requisite variety	Ross Ashby's Law of Requisite Variety [13]: "Variety absorbs variety, defines the minimum number of states necessary for a controller to control a system of a given number of states" (albeit in a discrete state controller). This can be summarised as "only variety can destroy variety".
system, simple	A set of interacting or interdependent components which together form an integrated whole.
system, open or closed	"A closed system is one where interactions occur only among the system components and not with the environment. An open system is one that receives input from the environment and/or releases output to the environment. The basic characteristic of an open system is the dynamic interaction of its components, while the basis of a cybernetic model is the feedback cycle. Open systems can tend toward higher levels of organization (negative entropy), while closed systems can only maintain or decrease in organization." [68]
technique	A technique is commonly understood to be a procedure or a set of specific steps for accomplishing a desired outcome. The term technique is defined for our purposes as a set of precisely described procedures for achieving a standard task.
theory	Accepted set of axioms having predictive capacity. A theory may be espoused or a theory-in-use; the distinction comes from Chris Argyris and Donald Schön; see for example [12]
tool	A software artefact, a program, used to implement or support a method; the working definition is a computer software package to support one or more techniques.
user-generated information system UGIS	"A user-generated information system is defined as a set of component services, integrated by the user into a novel configuration such that the resulting information service is (1) qualitatively different from its components and (2) offers unique value to the user over and above the value of its inputs"[30] A UGIS may be used to manage a user's personal information system; that is not however necessarily the case.
work system	Alter [8] defines a Work System as "a system in which people and/or machines perform a business process using resources (e.g., information, technology, raw materials) to create products/services for internal or external customers". See also, personal work system

References

[1] Ackoff, R.L. 1999. On learning and the systems that facilitate it. *Reflections: The SoL Journal*. 1, 1 (1999), 14–24.

[2] Ackoff, R.L. 1997. Systems, messes and interactive planning. *The Societal Engagement of Social Science*. 3, (1997), 417–438.

[3] Ackoff, R.L. 1987. *The art of problem solving: accompanied by Ackoff's fables*. Wiley.
[4] Ackoff, R.L. 1979. The future of operational research is past. *Journal of the operational research society*. 30, 2 (1979), 93–104.
[5] Adler, P. et Jermier, J. 2005. Developing a field with more soul: Standpoint theory and public policy research for management scholars. *Academy of Management Journal*. 48, 6 (2005), 941–944.
[6] Allen, D. 2003. *Getting things done: The art of stress-free productivity*. Penguin Books.
[7] Alter, S. 2008. Defining information systems as work systems: implications for the IS field. *European Journal of Information Systems*. 17, 5 (2008), 448–469.
[8] Alter, S. 2002. The work system method for understanding information systems and information system research. *Communications of the Association for Information Systems (Volume 9, 2002)*. 90, 104 (2002), 104.
[9] Alter, S. 2006. *The Work System Method: Connecting People, Processes, and IT for Business Results*. Work System Press.
[10] Alvesson, M. et Sandberg, J. 2011. Generating research questions through problematization. *The Academy of Management Review (AMR)*. 36, 2 (2011), 247–271.
[11] Alvesson, M. et Sköldberg, K. 2009. *Reflexive methodology: New vistas for qualitative research*. Sage Publications Ltd.
[12] Argyris, C. et Schön, D.A. 1974. *Theory in practice: Increasing professional effectiveness.*
[13] Ashby, W.R. 1956. *An introduction to cybernetics*. Chapman & Hall London.
[14] Barreau, D.K. 1995. Context as a factor in personal information management systems. *Journal of the American Society for Information Science*. 46, 5 (1995), 327–339.
[15] Barreau, D.K. et Nardi, B.A. 1995. Finding and reminding: file organization from the desktop. *ACM SIGCHI Bulletin*. 27, 3 (1995), 43.
[16] Baskerville, R.L. 2011. Individual information systems as a research arena. *European Journal of Information Systems*. 20, 3 (mars. 2011), 251-254.
[17] Bergman, O. et al. 2003. The user-subjective approach to personal information management systems design: Evidence and implementations. *Journal of the American Society for Information Science and Technology*. 59, 2 (2003), 235–246.
[18] Bergman, O. et al. 2008. The User-Subjective Approach: A New Direction for PIM Systems Design. *Third International CHI Workshop on Personal Information Management (PIM'08), Florence, Italy. Retrieved* (2008), 08.
[19] Berthon, P. et al. 2010. Created creates creator. (Orlando, FL, 2010).
[20] Bostrom, R.P. et Heinen, J.S. 1977. MIS problems and failures: a socio-technical perspective. Part I: The causes. *MIS quarterly*. (1977), 17–32.
[21] Bush, V. 1945. As we may think. *Atlantic Monthly*.
[22] Caspi, E. et al. 2004. Vannevar Bush: « As We May Think » -- CS294-6 Reading The Classics 9/21/04.
[23] Chandrasekaran, B. et al. 1999. What are ontologies, and why do we need them? *IEEE Intelligent Systems and their applications*. 14, 1 (1999), 20–26.
[24] Ciborra, C. et Jelassi, T. 1994. *Strategic information systems: a European perspective*.
[25] Conant, R.C. et Ashby, W.R. 1970. Every good regulator of a system must be a model of that system. *International journal of systems science*. 1, 2 (1970), 89–97.
[26] Cross, N. 2007. Forty years of design research. *Design Studies*. 28, 1 (janv. 2007), 1-4.
[27] Davies, S. et al. 2005. Building the Memex Sixty Years Later: Trends and Directions in Personal Knowledge Bases. (2005).
[28] Davis, F.D. 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*. 13, 3 (1989), 319–340.
[29] Denzin, N.K. 1970. Strategies of multiple triangulation. *The research act in sociology: a theoretical introduction to sociological method*. (1970), 297–313.
[30] DesAutels, P. 2011. UGIS: Understanding the nature of user-generated information systems. *Business Horizons*. 54, 3 (2011), 185-192.
[31] Descubes, I. et Gregory, M. 2011. Personal knowledge management: PIMS/IIS/UGIS - A research in progress. (Prague, CZ, sept. 2011).
[32] Fingar, P. 2009. *Dot.Cloud*. Meghan-Kiffer Press.
[33] Georgiou, I. 2003. The idea of emergent property. *Journal of the Operational Research Society*. 54, 3 (2003), 239–247.
[34] Georgiou, I. 2007. *Thinking through systems thinking*. Routledge London.

[35] Gregory, M. 2010. Collaboration and end-user information management tools. (Lima, Peru, août. 2010).
[36] Gregory, M. 2011. Towards a better understanding of how knowledge workers use computer-based information and knowledge representation tools: Probation Report supporting transfer to Ph.D. Available from the author.
[37] Gregory, M. et Descubes, I. 2011. Structured reflection in teaching and research. (Oxford, England, avr. 2011).
[38] Gregory, M. et Norbis, M. 2009. Auditing Personal Information Management. (St. Anne's College, Oxford, avr. 2009).
[39] Gregory, M. et Norbis, M. 2009. Evaluating Situational Applications Builders. (Orlando, FA., juill. 2009).
[40] Gregory, M. et Norbis, M. 2008. The business of personal knowledge. (Cambridge University, United Kingdom, janv. 2008).
[41] Gregory, M. et Norbis, M. 2008. Towards a Systematic Evaluation of Personal and Small Group Information and Knowledge Management. (Orlando, FA, juill. 2008).
[42] Gregory, M. et al. 2010. Data, Information and Knowledge: a candid and pragmatic discussion. *Proceedings of the 4th International Conference on Advanced and Systematic Research, Zagreb, Croatia, Nov. 11th.-13th, 2010*. (2010).
[43] Hassan, N.R. 2011. Is information systems a discipline? Foucauldian and Toulminian insights. *European Journal of Information Systems*. 20, 4 (2011), 456–476.
[44] Hevner, A. 2010. *Design Research in Information Systems: Theory and Practice*. Springer.
[45] Heylighen, F. 1992. Principles of Systems and Cybernetics: an evolutionary perspective. *Cybernetics and Systems*. 92, (1992), 3–10.
[46] Jacob, E.K. 2004. Classification and categorization: A difference that makes a difference. *Library Trends*. 52, 3 (2004), 515–540.
[47] Jones, W.P. 2007. *Keeping found things found: The study and practice of personal information management*. Morgan Kaufmann Pub.
[48] Katifori, A. et al. 2008. Personal ontology creation and visualization for a personal interaction management system. *Workshop on Personal Information Management, in CHI* (2008).
[49] Landauer, T.K. 1996. *The trouble with computers: usefulness, usability, and productivity*. MIT Press.
[50] Lansdale, M.W. 1988. The psychology of personal information management. *Applied Ergonomics*. 19, 1 (1988), 55–66.
[51] Lewin, K. 1951. Field theory in social science: Selected theoretical papers (edited by Dorwin Cartwright.). *Harpers*. (1951).
[52] Mumford, E. et Weir, M. 1979. *Computer systems in work design-the ETHICS method*. Ass. Business Press.
[53] Novak, J.D. 2009. *Learning, Creating, and Using Knowledge: Concept Maps as Facilitative Tools in Schools and Corporations*. Routledge.
[54] Paquette, G. et al. 2006. La modélisation des connaissances en milieu organisationnel. Centre de recherche LICEF, Québec, Canada.
[55] Paul, R.J. 2010. Motivation for Writing the Paper What an Information System Is, and Why Is It Important to Know This: Why I Give Lectures and Seminars. *Journal of Computing and Information Technology*. 18, 2 (2010).
[56] Peirce, C.S. et al. 1998. *The essential Peirce: selected philosophical writings. Vol. 2, 1893-1913*. Indiana University Press.
[57] Sauermann, L. 2005. The gnowsis semantic desktop for information integration. *Proceedings of the 3rd Conference Professional Knowledge Management* (2005).
[58] Sauermann, L. 2005. The semantic desktop-a basis for personal knowledge management. *Proceedings of the I-KNOW* (2005), 294–301.
[59] Sauermann, L. et Schwarz, S. 2004. Introducing the gnowsis semantic desktop. *Proceedings of the International Semantic Web Conference* (2004).
[60] Sauermann, L. et al. 2005. Overview and outlook on the semantic desktop. *Proceedings of the 1st Workshop on The Semantic Desktop at the ISWC 2005 Conference* (2005), 1–19.
[61] Sauermann, L. et al. 2008. Cool URIs for the semantic web. *Working draft, W3C*. (2008).
[62] Schön, D.A. 1987. *Educating the reflective practitioner*. Jossey-Bass San Francisco.
[63] Simon, H.A. 1996. *The sciences of the artificial*. The MIT Press.
[64] Simon, H.A. et al. 1987. Decision making and problem solving. *Interfaces*. 17, 5 (1987), 11–31.

[65] Stainton-Rogers, W. 2006. Logics of Enquiry. *Doing postgraduate research*. (2006), 73–91.
[66] Toffler, A. 1981. *The third wave*. Bantam Books New York.
[67] Van de Ven, A.H. 2007. *Engaged scholarship: A guide for organizational and social research*. Oxford University Press, USA.
[68] Venkatesh, V. 2000. Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information systems research*. 11, 4 (2000), 342–365.
[69] Walonick, D.S. 1993. General systems theory. *Statpac. http://www. survey-softwaresolutions. com/walonick/systems-theory. htm (accessed on November 24, 2007)*. (1993).
[70] Wiederhold, G. 1992. Intelligent integration of diverse information. *IEEE Computer Magazine*. 25, 3 (1992), 38-49.
[71] Wiederhold, G. 2002. Mediators in the architecture of future information systems. *Computer*. 25, 3 (2002), 38–49.
[72] Wiener, N. 1973. *Cybernetics or control and communication in the animal and the machine*... MIT press.
[73] Yu, C.H. 1994. Abduction? Deduction? Induction? Is there a Logic of Exploratory Data Analysis? *annual meeting of the American Educational Research Association, New Orleans, LA, April* (1994).
[74] Yu, J. et al. 2008. Understanding mashup development. *IEEE Internet Computing*. (2008), 44–52.