4-11-2008

Factors Inhibiting Information Process Integration

Nicholas Berente
Case Western Reserve University, nxb41@case.edu

Betty Vandenbosch
Case Western Reserve University

芽|Sprouts Working Papers on Information Systems ISSN 1535-6078

Factors Inhibiting Information Process Integration

Nicholas Berente
Case Western Reserve University, USA

Betty Vandenbosch
Case Western Reserve University, USA

Abstract
Although researchers have considered process integration in some detail, describing it using expressions such as tight coordination among activities, standardization and tight coupling, operating as a whole, etc., we lack an operational measure. Aubert, Vandenbosch and Mignerat (2003) proposed a formal definition of process integration as the sum of efforts expended by the receiving activities of a process to achieve access, transparency, granularity and timeliness of goods and data, relative to the total value added by the process. In other words, the fewer steps and handoffs and the smaller the physical distance in a process, the greater its integration. To test their proposal, we undertook 42 on-site interviews to understand the degree of integration of ten information processes in four industries. We found that the four properties are collectively exhaustive, but fail the test of mutual exclusivity. In order to differentiate among them, it is necessary to uncover instances of information transformation (granularity and transparency) before looking for needless information transfer (accessibility and timeliness). The degree of integration of the ten processes ranged from 9 percent to 81 percent. Accessibility was the most common reason for a lack of process integration and re-keying known data was the major activity undertaken to make information more accessible. A great deal of the re-keying was for documentation purposes. More research is necessary to understand the purpose and value of documentation vis-à-vis the real work accomplished in information processes.

Keywords: Process integration, business process reengineering, BPR, business process improvement

Permanent URL: http://sprouts.aisnet.org/4-3

Reference: Berente, N., Vandenbosch, B. (2004). "Factors Inhibiting Information Process Integration," Case Western Reserve University, USA . *Sprouts: Working Papers on Information Systems*, 4(3). http://sprouts.aisnet.org/4-3

Factors Inhibiting Information Process Integration

It has long been clear to management researchers and practitioners that business processes work in concert with information technology, paving the way for the business process reengineering (BPR) revolution of the 1990s (Hammer, 1990; Davenport and Short, 1990). Before BPR, those who wished to improve business processes largely focused on "Total Quality Management" (TQM) ideals. During the BPR revolution, the goal was the radical change of processes themselves. Subsequent "Second wave BPR" strategies combining radical and incremental change now focus much more on connectivity, knowledge sharing, and taking "greater advantage of the Internet" (El Sawy, 2003). Nevertheless, after almost two decades of literature, exactly what constitutes business process improvement has yet to be defined. We recognize it, but have a difficult time explaining it. Quality, efficiency, and integration are all relevant measures of processes.

Process quality can be defined in terms of efficacy--whether the process output is the intended output; and effectiveness--whether the process is doing the right thing (Checkland 1981). Process efficiency is defined as the extent to which resources are minimized and waste is eliminated (Harrington 1991). Process integration has been discussed and advocated at length and in great detail by practitioners. In fact, integration of business processes is often the justification for many ERP implementations. Nevertheless, of the three components of process improvement, integration is the most nebulous.

When asked what integration really means, top-level executives reply with wide-ranging views: … *significant automation … access to files on computers and automation of supply functions… elimination of paperwork … integration is inter-enterprise process reengineering* (Low, 2002). Interestingly, these expressions do not relate to a clear concept nor do they provide a formal definition. They are oriented more toward examples and the means to achieve integration. The research community has also considered process integration in some detail. They describe it using expressions such as seamless, tight coordination or coupling among activities, standardization, and operating as a whole (Gustin, Daugherty, and Stank, 1995, Barki and Pinsonneault, 2002; Markus, 2000). In order for a process to be integrated, Sabbath (1995) believes that it must be "linked organizationally and coordinated with information flows." Sikora and Shaw (1998) describe process integration as coordination between stages and activities. Nevertheless, we lack an operational definition or measure. Therefore, although one may be able to discern that a process is integrated, it is not easy to assess the extent to which that is the case, and whether the cost of increasing process integration would be justified for the organization.

The remainder of this paper describes our investigation of process integration. We begin by reviewing a tentative formal definition. Then we discuss the challenge of applying that definition in real world settings. Next we describe empirical work we undertook to validate the definition. Finally we discuss implications for research and management.

A Formal Definition of Process Integration

A process is "*a lateral or horizontal organizational form, that encapsulates the interdependence of tasks, roles, people, departments and functions required to provide a customer with a product or service*" (Earl 1994, 13). It consists of flows and activities. An activity "*takes an input, adds value to it and provides output to an internal or external customer*" (Harrington, 1991, 6). A measure of process integration should be usable whether a process is carried out within or across organizations.

Process improvement can be accomplished through synthesis and decomposition. Synthesis refers to the combination of sub-processes to eliminate redundancy and inconsistency. Decomposition embodies simplification and delegation. (Basu and Blanning 2003). Decomposition of work leads to more information flows as actors engage in some form of documentation and learning as they pass information among themselves. Information systems often facilitate these information flows among actors. An information view of process integration is important and relevant, as most of the business process improvement research focuses on information and information systems (Broadbent and Weill, 1999; Bhatt, 2000); and an estimated 90% of process exchanges are said to be of data (Kock, McQueen, and Corner, 1997).

In developing a model of process integration, Aubert, Vandenbosch and Mignerat (2003) presented theory from IT, logistics, and other fields. The resulting definition posits that the level of process integration is the sum of efforts expended by the receiving activities of a process to achieve access, transparency, granularity and timeliness of goods and data, relative to the total value added by the process.

$$PI = (VA - \sum_{j=1}^{n} C(a_j) + C(tr_j) + C(g_j) + C(ti_j)) / VA$$

where	*VA: Value added by the process,* *$C(x_j)$: Cost of providing property x for activity j,* *a_j : Accessibility for activity j,*	*tr_j: Transparency for activity j,* *g_j: Granularity for activity j,* *ti_j: Timeliness for activity j*

Hence, the lower the cost of achieving access, transparency, timeliness and granularity of goods and data relative to the value added by the process, the higher the level of process integration. In other words, the fewer and better the transfers in a process, the greater its integration.

Accessibility. Culnan (1984) defined accessibility as having three dimensions: reliability, convenience and ease of use. The user of the information has to be sure that the access method to use the information is dependable and that the information is available when it is supposed to be available. In addition, the access method must be convenient in comparison to access methods for other data, and finally, the data must be easy to manipulate (Strong, Yang and Wang, 1997).

Transparency refers to the ease with which information that is passed from one task in a process to another can be understood. Lee, Strong, Kahn, and Wang's (2002) use of the terms understandability, consistency and completeness all refer to our notion of transparency. Of course, the extreme of transparency is standardization. For example, UPC codes are perfectly transparent. Everyone who uses them knows what they mean and how to interpret them.

Timeliness refers to the currency of the information passed from one task to another, along with the instantaneity of the information for the task to be completed. Instantaneity does not mean that information is necessarily processed and transferred instantly. It means that it is provided at the instant required for processing, i.e. there is no delay. When assessing timeliness, one has to investigate if each activity could be initiated sooner if information was provided sooner.

Granularity is concerned with level of detail. Information passed from one task in a process to another must balance conciseness and completeness. In a completely integrated process there is enough information for the people to perform each activity without overloading them with excessive detail.

The inclusion of value added by the process enables us to compare the degree of integration of simple and complex processes. The cost of providing accessibility, transparency, timeliness and granularity of the goods and data needed to build a table is much less than that needed to build a car. However, a table is much less valuable than a car, so it is conceivable that the degree of process integration might be the same. When comparing two tables that are built using the identical process but of materials of different value, the value added by the process will be identical, so the degree of process integration will be the same. Two processes that add the same amount of value may have very different levels of integration depending on information flows. Exactly the same value is added when you go to a teller as when you go to an ATM machine, but the latter is a much more integrated process, in addition to being more secure and less error-prone (quality), and requiring fewer bank employee resources (efficiency).

Application of Process Integration Definition

Although the formal definition of process integration is an objective standard on which to base theory, its application to real processes is problematic. The value added by a process is often very difficult, or even impossible to calculate accurately as there is no market for the outputs of most processes. One solution is to estimate the value of a process based on total costs associated with it. Using total cost as a surrogate for value can lead to a situation in which additional integration reduces total costs, in effect reducing total value estimates, and the process integration measurement might not change to reflect that increase in integration. In addition, some costs may vary by geography (e.g., United States vs. India) or time (days vs. evenings) without affecting the value of the process, thus skewing the results in a process comparison. With a cost focus, by simply assigning a different employee with a different salary to a task, one would change the level of integration of a process. To be useful, the measure of degree of integration must be independent of the person performing the task. As such, we chose to use resource time as a surrogate for value and cost.

$$PIt = 1 - \sum_{j=1}^{n} T(a_j) + T(tr_j) + T(g_j) + T(ti_j) / TT$$

where:	TT: Total time taken by the process, $T(x_j)$: Time spent to provide property x for activity j, a_j : Accessibility for activity j,	tr_j: Transparency for activity j, g_j: Granularity for activity j, ti_j: Timeliness for activity j

Although the use of time solves the valuation problem, it is also an imperfect measure. For example the amount of time is no better an estimate of value than cost, and the ratio of integration time to total time in an integrated process may be the same as that of its previous condition – if integration reduces total time proportionally. Nevertheless, time is easily measured and avoids the problems associated varying costs of resources.

It is easy to assume that the total time expended in the execution of a process can be considered to represent the extent to which an organization is willing to invest in it. Of course, as an organization improves the integration of a process and reduces the time necessary, the time it will be willing to expend also decreases leading to a conundrum. Even though the output may be identical, as processes become more integrated, people will be willing to spend less to achieve the output. The results from a time analysis do, however, offer a tool for determining where to focus when integrating a process, and they enable

relatively accurate comparisons of similar processes at a particular point in time. Also, for a longitudinal analysis of progress associated with process integration efforts, using the original total time as a constant denominator enables the analyst to take previous integration success into consideration.

To test the usefulness of the definition, we have applied it in a variety of business settings. In doing so, we addressed the following questions:

- *Are the properties of process integration collectively exhaustive?*
- *Are the properties of process integration mutually exclusive?*
- *What are the main inhibitors of process integration?*
- *Where can managers look to improve process integration?*

Research Methods

Ten processes from five different organizations were analyzed using a *field study* approach (Stone 1978). Although similar to a case study, the field study allows for a more systematic means of obtaining information, albeit a less thorough one. Given the early state of understanding and the preliminary nature of the process integration definition, a highly detailed study would have been premature. Instead we chose interviews and limited observation to inform our research. The discursive time data which we collected is not intended to be quantitatively rigorous. Rather, it illustrates the relative nature of the properties associated with activities, documents, resources, and other process variables. We use the analysis of the qualitative data presented from the interviews with the discursive time estimates to gain insight into the true nature of process integration.

We worked with a convenience sample, choosing business processes from four industries. In some cases comparable processes within an organization were also measured. Forty-two process participants in ten different processes from five different organizations were interviewed (Table 1).

Organization	**Department**	**Process**	**Interviews**[1]
Bank	Help Desk	Problem Management Process	7
Home Builder	Design & Construction	Scheduling Process	5
Manufacturer	Valve Engineering	Engineering Change Process	8
Manufacturer	Actuator Engineering	Engineering Change Process	4
Bank	IT Development Group	Waterfall Project Management Process	4
Bank	IT Development Group	RUP Project Management Process	4
Hospital	General Surgery Nursing Unit	Patient Admission Process	8
Hospital	General Surgery Nursing Unit	Patient Discharge Process	7
Hospital	Open Heart Nursing Unit	Patient Admission Process	4
Hospital	Open Heart Nursing Unit	Patient Discharge Process	4

Table 1. Sample processes

[1] Fourteen interviewees were interviewed for more than one process

The objective of the interviews was to accurately create a process map, to develop a rough estimate of the proportions of the integration properties and their relative impact on the process, and to gain qualitative insight into the nature of processes in general. Interviewees were asked to verbally map out their role in the process in question. Probes loosely followed an interview guide, searching for instances in which non-integrated activity was taking place (according to the accessibility, transparency, granularity, and timeliness attributes). For example, a probe for granularity might be "Is there enough detail in the information you receive to handle all situations?" A probe for timeliness might be "Is there ever any delay in this information?" Time ranges and percentages associated with the likelihood of an event were also probed during the interviews. Activities were occasionally observed in real time, and interviewees were often asked to demonstrate how they would interact with a given input or output. Several people were interviewed for each role in each process, when applicable, to ensure completeness and to corroborate time estimates.

First, process maps were developed for each of the processes. Then we coded the interviews and developed a list of all the specific ways that a process was not integrated. Next, these were assigned to the four properties. Finally, spreadsheets with integration time estimates and their proportions were developed. (A sample process map and spreadsheet are included in Appendix 1.)

Findings

Table 2 lists the specific ways that unnecessary time was expended in dealing with information inputs and outputs for the business processes we investigated.

Timeliness	Waiting for person (input) Waiting for technology (input)
Granularity	Reformatting for appearances (output) Getting more information (input) Summarizing for management (output)
Accessibility	Keying in known data (output) Keying in search criteria (output) Navigating computer interface (input / output) Documenting work the first time (output) Documenting work redundantly (output) Finding / obtaining information (input) Circumventing the system (input / output) Transferring data from one document to another (output) Checking for correctness (input) Manually performing automatable process (input / output)
Transparency	Requiring clarification (input) Clarifying for others (output)

Table 2. Details of process integration properties

In certain instances, we found it difficult to objectively make a categorization. For example, when addressing the work request form in the Waterfall project management process, one project manager indicated that "*level of detail determines the understandability*." In this case the actor did not understand an input (transparency), because there was not enough information provided (granularity). Since the information was not provided, the actor

may have to search for it (accessibility). During this search, the actor may be required to wait for some information (timeliness). Similarly, when a hospital secretary cannot decipher the doctor's handwriting (transparency) she may have to track down the doctor to obtain the required information (accessibility). If the doctor is in surgery, the secretary must wait on hold while a nurse walks in and out of surgery to request the information (timeliness).

Because of these overlaps, we developed priorities for categorization. An examination of the four properties reveals that they can be split into two groups: activities that transform information, and those that transfer it. Granularity and transparency imply a transformation of the information. They can involve translation, summarization, itemization, etc. All of these activities involve some changes in the information for use within the process. Accessibility and timeliness do not imply any modification of the information content. They involve pulling, sharing, re-keying, or passing information among different actors involved in a process.

Since granularity and transparency involve transformation, they could (but do not necessarily) add value to the business process. Because of the potential for added value, we first determine whether a specific process integration issue can apply to the transformational properties, before categorizing them into accessibility and timeliness. In those situations such as the one described above, we categorized based on level of understanding. If the actor understands the information clearly, but requires more information, this involves granularity. If, however, there is some problem understanding the information that is in front of the actor, then we categorized it under transparency. The situation above where our project manager said that she could not understand a document because there was not enough information was categorized as a granularity issue.

Table 3 summarizes the way that the process integration properties affect each process. Percentages indicate the proportion of process integration shortcomings explained by that property[2]. The project management and scheduling processes are based primarily on ideas from the interviews rather than time estimates, as time estimates varied so widely that they were not realistically measurable in this preliminary study. For example, to develop the project log and risk list in the RUP project management process, it could take the project manager anywhere from 8 hours to 20 hours using the preferred Clearquest software, depending on the complexity of the project and other variables. Beyond this, only an estimated 20-30% of project managers actively use Clearquest. Of those that use Clearquest for the project log, many use Excel for the risk list. The use of different systems has varying integration implications.

	Accessibility	***Transparency***	***Timeliness***	***Granularity***	***Total PI_t***
Problem Mgt	Mid (29%)	Low (4%)	Mid (40%)	Mid (26%)	71%
Scheduling	High	0	Mid	Mid	n/a
Valve EC	High (98%)	Low (2%)	0	0	81%
Actuator EC	High (86%)	Low (.5%)	0	Low (14%)	36%
RUP	High	Low	Low	Mid	n/a
Waterfall	Mid	0	0	Mid	n/a
GS Admit	High (71%)	Low (7%)	0	Mid (22%)	38%
GS Discharge	High (54%)	0	Low (17%)	Mid (29%)	41%
OH Admit	Mid (47%)	Mid (39%)	0	Low (14%)	9%
OH Discharge	High (58%)	0	Mid (25%)	Low (17%)	38%

Table 3. Processes by integration properties

[2] Details of each process are available from the authors.

Keying in known data is by far the most common accessibility instance – making up the majority recorded accessibility time and over 25% of the total instances (Table 4).

"Known data" is data or information that has been previously documented or entered into a computer system by someone in any process, and therefore exists in some form elsewhere. The act of "keying in" known data infers input into a computer (its most common manifestation), but also included verbal communication, written documentation, etc. Examples of "keying in known data" include:

- In the engineering change process, the "affects jobs" field in the ECN form of the PDM system is the same exact data in the "where used" field of the enterprise resource planning (ERP) system. Engineers are expected to look up this data in the ERP system, then manually key it into the ECN form.
- In the construction scheduling process of the home builder, superintendents each keep their own schedules with accurate dates for their projects. In Wednesday meetings schedule dates are communicated as administrators update their own schedules accordingly.
- On the admission form for both nursing units, the nurse must interview the patient to obtain emergency contact, allergy, and other historical information that was already captured by the main hospital admission department and again in the surgical unit.

Beyond "keying in known data," no single issue appeared to have greater significance than any other.

Timeliness was rarely ever considered to contribute to process integration shortcomings. This could be explained by the observation that all of the people interviewed were busy with multiple tasks. Therefore, they rarely experienced idle time waiting for an input. Instead, they perform other work. This does not imply that timeliness is not problematic, just that our methods were unable to capture it.

> Lab results must often be reviewed before a patient can be discharged. A nurse will occasionally check for lab results throughout the morning, also has many other activities to remain occupied. Therefore the delay in lab results actually does delay the process, but has no effect on the process integration, because the nurse is not idle waiting for the information.

Also, many priority situations simply circumvent the process so the process never actually holds up real work.

> The bulk of critical urgency I&II problems are resolved by system monitoring, and are therefore handled without invoking the problem management process. Many other customers with critical issues skip the help desk and call a situation manager directly. Still others call the appropriate support engineer directly, circumventing the entire problem management process. Only small portion of urgency I&II issues find their way through the entirety of the problem management process.

Work practices have also accommodated the expected times, and many inputs are addressed in batch mode.

- The production engineer receives a print-out every morning of the approved engineering changes from the day before. She then routes the information to the proper place in the manufacturing process and updates the ERP system with all new information every morning. New engineering changes throughout the day will be inputted in ERP the following morning, and other corporate processes have incorporated this work practice into their own practices.
- The role of a problem analyst is to document, close, and communicate resolved problems (or activity in certain chronic or longer-term issues) in reports and meetings throughout the week. If a resolution reaches the problem analyst five minutes after a meeting, there

> is a lag of days or even a week, until the appropriate report or meeting is scheduled. Due to this lag, information is not communicated real-time to management.

Timeliness is important only when the delay of information causes the actor extra work. For example, every half hour, beyond the first half hour that transport is late in picking up a patient for discharge, is estimated to cost a nurse ten minutes in dealing with family and patient issues. Similarly, when an individual is truly idle while waiting for an input, such as when the problem manager waits spends up to 20 minutes waiting for his computer to generate "WIR" reports after a meeting, timeliness is relevant.

Transparency was not a major concern, because most process communication is routine, and actors have experience in understanding the inputs required to do their respective jobs. The one instance in which transparency problems were fairly high, was the challenge hospital secretaries and nurses had reading doctors' handwriting, which could result in hours of work per day (across multiple discharge processes).

It appears that the bulk of process integration shortcomings occur in the preparation of information for subsequent steps, or documentation. Hence, after we coded the issues, we grouped them according to whether they stemmed from an input, contributed to an output, either, or both. There were a total of 9 issues that apply solely to outputs, 5 to inputs, and 4 that can apply to either. The portion of PI_t that applied solely to outputs accounted for 69% of PI_t whereas categories that apply solely to inputs accounted for 26%. The outputs were usually documentation. Even though the documentation that was created was often not required by the process we were analyzing, the act of documentation was still considered to be part of that process.

Documentation that is required in order for downstream actors to perform their work would be considered added value to the process. This is true when the actual content of the documentation provides the information for downstream activities. For example,

> While approving the ECN form in an engineering change process, an engineer will often read only the "description of change," and if this is adequate, he may not view the drawing before approving the ECN. Without an adequate description, he will often call the initiating engineer to clarify the change, or further inspect the drawings to determine if he will approve.

Content documentation should not be confused with documentation that is required by a rule or the organization's structure to be completed before an activity can occur. Such documentation is not in place for its content, but rather for its procedural validation. Another type of procedural validation is documentation that occurs to inform an auditing or management process, but adds no value to the process itself. The RUP project management process offers an example:

> A group outside of the project management process, known as "Process Compliance" is one of the only groups that gain information from the "Project Development Plan." Although the project manager is told to consider process compliance to be his lowest of many priorities, the findings of Process Compliance affect his performance-based compensation and therefore a project manager does regard the document as important.

Some documentation is simply stored "just in case" – or for posterity. This documentation may never be reviewed by another actor in any process, but is still stored to record the content in some sort of archive. This archive can be searched and information can be retrieved if it is ever needed. Often the information stored in such documents is critical for insurance, legal, or liability issues. The hospital general surgery unit illustrates.

> Before a patient is discharged, the doctor fills out discharge orders and completes the green chart. The nurse documents discharge training, final labs, and then completes the blue chart. The secretary takes all of the patient information from the green and blue charts and condenses them into the patient's archive folder. This folder will be picked up by the hospital archival staff and will be stored in the hospital archives until the patient is readmitted or information is required by an outside hospital.

Many activities center on documentation and add no value to the process being evaluated, but contribute to other intersecting processes. Yet these activities are usually considered part of the document generating process, rather than the document consuming process (where they probably should be attributed).

The role of documentation seems to vary significantly depending on the nature of work. In our interviews, we labeled engineers, nurses, and construction superintendents as technical/professional actors, and managers and administrative support people as overhead. Examples abound in which technical/professional actors skip documentation that is not critical to their jobs:

- Engineers make changes for parts in production and immediately provide prints to manufacturing, then follow up with an official change process. By the time the official paperwork reaches the production personnel, the change has already been in place for a day or two.
- Engineers often skip filling out the "affects jobs" field of the ECN form without penalty.
- All but two nurses in the general surgery unit skip filling out the redundant discharge training form on the computer. They have already filled out the paper form in a file, and the electronic copy is only used for quality control. Management has attempted both penalties and incentives, yet busy nurses do not fill out the form.
- Project superintendents at a construction site keep a certain amount of contractor scheduling knowledge in their heads and do not document it in their schedules.

Overhead workers tend to take their documentation very seriously:

- The "Project Development Plan" is considered to be a critical document for the project management process. The document typically has over 40 pages. According to one project manager, 80% of the document is "unneeded overhead … lots of canned stuff no one reads. Relevant information is buried in the document and you have to cross the Great Wall of China to find the relevant information." Yet they are monitored by this document and fill it out dutifully.
- One problem manager creates reports for a weekly meeting which are made available to all parties through the company intranet. Since his experience is that managers do not download nor read the reports, he sends the reports to each meeting participant in an email before the meeting, thus increasing the likelihood that they will bring the reports to the meeting and follow along.

To explore these observations, we broke down the frequency of property instances by type of work (Table 4).

In overhead activities such as project management or problem management, it is difficult to tell the real work from the non-integrated work. This is because it is all not integrated in relation to the project or problem. In these cases the entire process exists largely to document existing work being carried on elsewhere. The roles of managers, secretaries, and administrative personnel are essentially a result of process disaggregation and the resulting information flow required to monitor the process.

	Professional	%	Overhead	%	Total	%
Transparency	**2**	**5%**	**8**	**10%**	**10**	**8%**
Clarifying for others	0	0%	3	4%	3	2%
Requiring clarification	2	5%	5	6%	7	6%
Granularity	**5**	**12%**	**22**	**27%**	**27**	**23%**
Get more information	4	10%	3	4%	7	6%
Organizing information	0	0%	8	10%	8	7%
Reformatting for appearances	1	2%	3	4%	4	3%
Summarizing for management	0	0%	8	10%	8	7%
Accessibility	**31**	**76%**	**44**	**54%**	**75**	**61%**
Checking for correctness	2	5%	1	1%	3	2%
Circumventing the system	1	2%	0	0%	1	1%
Documenting work redundantly	1	2%	0		1	1%
Documenting work the first time	2	5%	2	2%	4	3%
Finding / obtaining information	7	17%	7	9%	14	11%
Keying in known data	13	32%	16	20%	29	24%
Keying in search data	2	5%	0		2	2%
Manually performing automatable activity	0	0%	4	5%	4	3%
Navigating computer interface	1	2%	2	2%	3	2%
Tranferring data from one document to another	2	5%	12	15%	14	11%
Timeliness	**3**	**7%**	**7**	**9%**	**10**	**8%**
Waiting for person	3	7%	4	5%	7	6%
Waiting for technology	0	0%	3	4%	3	2%
Total Instances	**41**		**81**		**122**	

Table 4. Frequency of property instances by type of work

Discussion

Our findings provide insight into each of the four research questions.

Are the four properties of process integration collectively exhaustive?
As Table 2 indicates, all issues associated with unnecessary time spent working with information in a process appear to fit neatly into the definition of process integration. One concern may be that use of the construct as a lens may have affected the framing of the interview, and therefore the interviewee's responses and our findings. This is unlikely however, as the terms used to describe instances accurately reflect the integration shortcoming described by the actor.

Are the four properties of process integration mutually exclusive?
We have shown that our four properties occasionally overlap, and therefore are not mutually exclusive. In order to allow for consistent categorization, we assess whether an issue requires information transformation before information transfer.

What are the main inhibitors of process integration?

Processes suffer the various process integration shortcomings in vastly different configurations, and often do not suffer the same shortcomings. The only exception to this is the finding that "keying in known data" is prevalent in all processes. Timeliness and transparency have little negative effect.

The processes we studied all have a technical aspect and an overhead aspect. The closer to real work, the less important non-integrated documentation becomes. According to Table 4, for professional work, accessibility is the key issue, primarily taking the form of *keying in known data*. Clearly, implementing technology to remove the need to key in known data would have a dramatic impact. Since the professionals themselves often circumvent non-integrated information activities, overhead roles such as secretaries, problem managers and project managers support them. The work of the overhead roles is driven primarily by the need to document.

For overhead work, accessibility was still a factor, but includes many instances of *transferring data from one document to another* and *finding and obtaining information.* Granularity in the form of *summarizing the data for management* and *organizing information* was also a frequent issue.

Where can managers look to improve process integration?

Our data indicate that by gaining an understanding of documentation has the potential to improve the integration of processes. Keying in data, documenting work (the first time and redundantly), transferring data, summarizing, and organizing all prepare information for downstream activities in the process being evaluated or in other processes

Business process improvements, such as those targeted in a BPR effort, can be thought of as improvements in some combination of process quality, efficiency, and integration. As processes become disaggregated across actors and activities, the information flows between actors and activities naturally increase. Through our preliminary research, we have determined that our definition of process integration, as a function of accessibility, transparency, timeliness and granularity, is an effective tool for exploring processes. The properties in the definition, while collectively exhaustive are not mutually exclusive; the idea of transforming or transferring information must be used to ensure that analysis is consistent across processes. As a lens for viewing a process, simply using transfer/transform would not arm the process analyst with enough detail to thoroughly address any given activity. The entire list of 18 coded properties would be thorough, but unwieldy. We believe the accessibility, transparency, timeliness and granularity definition to be a parsimonious tool for viewing an information flow in order to determine its level of integration.

By applying the tool, we better understand the nature of process information flows as they apply to different work practices. In what we designate as a professional work practice, information flows are fairly efficient, since professional/technical workers do not prioritize information work unless it supports the "real work" in which they are engaged. Overhead work, on the other hand, tends to be largely information-focused. Managers and administrators often focus on documentation as the output of their processes, because the real work is being done by others. Therefore issues associated with documentation, such as formatting, summarizing, and transferring data tend to apply more to overhead workers.

The nature of documentation is important to any serious integration effort. Documentation can be categorized into content documentation when the content is used in downstream real work; procedural validation documentation when a document is used for the subsequent steps in the process or intersecting processes to determine the level of completion or compliance of an activity; and documentation for posterity, when a document is archived

with the possibility of never being accessed in the future. Because documentation sometimes adds value to processes, the work associated with documentation should ideally be attributed proportionally across all of the benefiting processes in any measurement of those processes. The image that is evoked is a matrix of intersecting processes; activities in any given process may add value to a number of processes in the matrix. Such a concept has been studied in vertical integration literature in industrial economics (Maddigan, 1981; Davies, 1996). To implement such an input/output model as a measurement tool, a researcher would need to find all uses of a given output from each activity, then measure the integration costs associated with producing that output, spreading these costs proportionally across the relevant processes (weighing them on some subjective value such 'impact on process').

Accompanying the notion of an intersecting process matrix is one of a process level of abstraction. Using Earl's (1994) definition of a process, the entire matrix, firm or supply chain is essentially a single process. This process is made of sub-processes, which are in turn made up of more sub-processes, until these processes become small enough to be considered activities. The arbitrary nature of the process designation has resulted in further non-descriptive terminology, such as "enterprise process" and "business process" (as opposed to the non-business process). When measuring processes, it may be necessary to define the level of abstraction of the process being analyzed, as different levels of abstraction may have different integration issues.

Conclusion

In this research we have focused on the information flows inherent in a disaggregated process. We have found that the nature of process integration issues vary among organizations, types of processes, and types of work. We have a better understanding of the definition we used to do this research, and we have both increased and decreased the level of abstraction of this definition to aid in its application. With this insight, we can now embark on more rigorous research.

With further process integration research, we may uncover a greater richness of process integration variables, categories of work, and their interaction. Application of the definition to a greater number and wider range of processes, with an eye toward quantitative rigor would enable us to determine trends in types of work practices and associated integration variables, find additional integration variables and better understand the relationship between real work and documentation.

Rather than focusing exclusively on the process integration aspect of process improvement, it will also be necessary to further formally and empirically define process quality, efficiency, and integration and seek a better understanding of their relationships. As we have established, these properties are not mutually exclusive, but are they collectively exhaustive? It is imperative that we work toward building a strong theoretical foundation on which to further build the process improvement literature.

References

Aubert, Benoit; Vandenbosch, Betty; Mignerat, Muriel; "Towards the Measurement of Process Integration," 2003

Barki, H. and A. Pinsonneault, "Explaining ERP Implementation Effort and Benefits With Organizational Integration", *Cahier du GReSI*, February 2002, 27 pages

Basu, Amit; Blanning, Robert, "Synthesis and Decomposition of Process in Organizations," *Information Systems Research*, December 2003, Vol. 14, No. 4, p. 337-355.

Broadbent, M. and P. Weill, "The implications of information technology infrastructure for business process redesign", *MIS Quarterly*, (23:2), 1999, 159-181.

Checkland, P. *Systems Thinking, Systems Practice*, New York: John Wiley, 1981.

Culnan, M., "The dimensions of accessibility to online information: Implications for implementing office information systems", *ACM Transactions on Information Systems*, (2:2), 1984.

Davies, S.W. and C. Morris, *A New Index of Vertical Integration - Some Estimates for Uk Manufacturing.* International Journal of Industrial Organization, 1995. 13(2): p. 151-177

Earl, M.J., "The new and old of business process redesign," *Journal of Strategic Information Systems* (3:1), 1994, 5-22.

El Sawy, Omar, Redesigning Enterprise Processes for E-Business, McGraw Hill Irwin, 2001

Gustin, C., Daugherty, P., Stank, T., "The Effects of Information Availability on Logistics Integration", *Journal of Business Logistics*, (16:1), 1-21

Hammer, M., "Reengineering Work: Don't Automate, Obliterate", *Harvard Business Review*, July-August 1990, 104-112

Harrington, H. J., *Business Process Improvement*, New York, MGraw-Hill, 1991.

Kock, N.F., R.J. McQueen and J.L. Corner, "The nature of data, information and knowledge exchanges in business processes: Implications for process improvement and organizational learning". *The Learning Organization* (4:2), 1997, 70-80.

Lee, Y.W., Strong, D.M..Kahn, B.K and Wang, R.Y.., "AIMQ: A methodology for information quality assessment", *Information & Management*, (40), 2002, 133-146.

Maddigan, R.J., *The Measurement of Vertical Integration.* Review of Economics and Statistics, 1981. 63(3): p. 328-335

Markus, M. L., "Paradigm Shifts - E-Business and Business / Systems Integration", *Communications of the Association for Information Systems*, (4), November 2000, 45 pages Sabbath, Robert, "Volatile Demand Calls for Quick Response: The Integrated Supply Chain", Logistics Information Management, (8:2), 1995, p. 49

Sikora, R., Shaw, M., "A Multi-Agent Framework for the Coordination and Integration of Information Systems", *Management Science*, (44:11), 1998, S65-S78

Stone, E., *Research Methods in Organizational Behavior*, Goodyear, Santa Monica, CA, 1978

Strong, D.M., W.L Yang and R.Y. Wang, "Data quality in context", *Communications of the ACM*, (40:5), 1997.

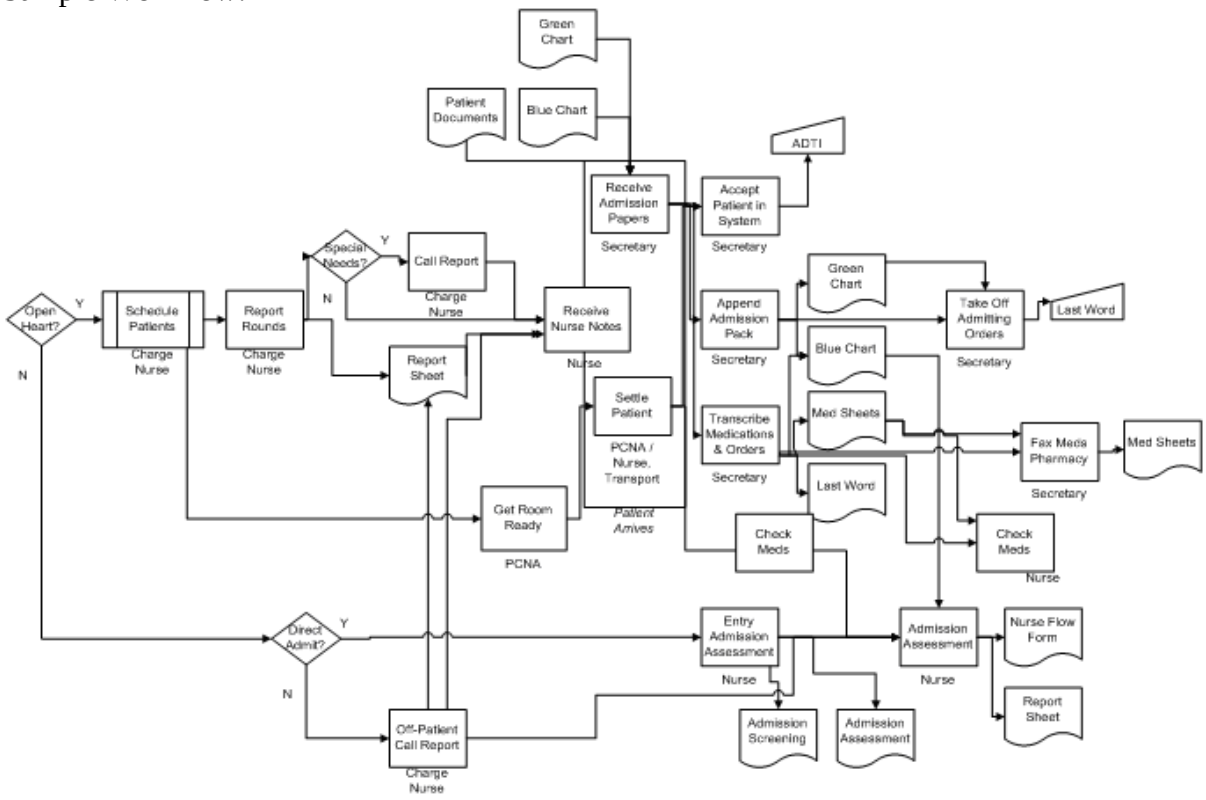
Appendix 1

Total Times

	Time (min)		Time (min)
Valve	16.83	**GS Admission**	73.00
Accessibility	3.17	Accessibility	32.50
Transparency	0.05	Transparency	3.00
Timeliness	0.00	Timeliness	0.00
Granularity	0.00	Granularity	10.00
Actuator	16.83	**GS Discharge**	59.40
Accessibility	9.18	Accessibility	18.90
Transparency	0.05	Transparency	0.00
Timeliness	0.00	Timeliness	6.00
Granularity	1.50	Granularity	10.00
Problem	270.80	**OH Admission**	84.70
Accessibility	24.57	Accessibility	36.10
Transparency	3.00	Transparency	30.00
Timeliness	20.78	Timeliness	0.00
Granularity	30.17	Granularity	10.70
		OH Discharge	95.00
		Accessibility	34.00
		Transparency	0.00
		Timeliness	15.00
		Granularity	10.00

Appendix 2

Sample Workflow:



Sample Results Spreadsheet

Process Integration (preliminary) *time in minutes*		Call Report	Receive Nurse Notes	Accept Patient	Append Admission Pack	Transcribe Meds & Orders	Update Share Boards	Entry Admission Assess	Admission Assess-ment	Check Meds	Total
Role		Asst Mgt	Nurse	Secretary	Secretary	Secretary	Secretary	Secretary	Nurse	Nurse	
	accessibility	1.0	0.0	0.0	0.0	30.0	0.0	0.6	4.0	0.5	**36.1**
	transparency	0.0	0.0	0.0	0.0	30.0	0.0	0.0	0.0	0.0	**30.0**
	timeliness	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	granularity	0.0	0.7	0.0	10.0	0.0	0.0	0.0	0.0	0.0	**10.7**
Value Add	total time	2.0	1.7	0.5	10.0	60.0	2.0	1.5	5.0	2.0	**84.7**
	integration time	1.0	0.7	0.0	10.0	60.0	0.0	0.6	4.0	0.5	**76.7**
	process integration	**0.50**	**0.60**	**1.00**	**0.00**	**0.00**	**1.00**	**0.63**	**0.20**	**0.75**	**0.09**

芽|Sprouts

Working Papers on Information Systems | ISSN 1535-6078

Office:
Sprouts
University of Amsterdam
Roetersstraat 11, Room E 2.74
1018 WB Amsterdam, Netherlands
Email: admin@sprouts.aisnet.org

芽|Sprouts