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Infomania: Why we can't afford to ignore it any longer

by Nathan Zeldes, David Sward, and Sigal Louchheim

Abstract

The combination of e–mail overload and interruptions is widely recognized as a major disrupter of knowledge worker productivity and quality of life, yet few organizations take serious action against it. This paper makes the case that this action should be a high priority, by analyzing the severe impact of the problem in both qualitative and quantitative terms. We attempt to provide sufficient supporting data from the scientific literature and from corporate surveys to enable change agents to make the case and convince their organizations to authorize such action.

Introduction

Mid–size and large organizations employing knowledge workers are greatly impacted by the Infomania phenomenon, also referred to as Information Overload or Attention Deficit Trait (ADT) [1]. Infomania is the mental state of continuous stress and distraction caused by the combination of queued messaging overload and incessant interruptions.

In this work, we show that this phenomenon places knowledge workers and managers worldwide in a chronic state of mental overload. It exacts a massive toll on employee productivity and causes significant personal harm, while organizations ultimately pay the price with extensive financial loss. We're making the case that the impact is so great that eliminating this problem should be a high priority, meriting serious and radical corrective measures. Solving this problem would have a positive and immediate impact on organizational results, while restoring computer–based communications technology to its rightful role as promoter of personal and organizational effectiveness.

Furthermore, as this problem affects the entire high–tech industry, organizations taking early action will realize a significant competitive advantage.

People afflicted by Infomania are well aware they are in trouble, yet they nurture a feeling that they should stay the course and not fight back [2]. They rationalize that the modern world revolves around communication, so they must always be connected or lose vital information. Many believe that there is no better way. This can't help but remind us of A.A. Milne's "Winnie the Pooh":

Here is Edward Bear, coming downstairs now, bump, bump, bump, on the back of his head, behind Christopher Robin. It is, as far as he knows, the only way of coming downstairs, but sometimes he feels that there really is another way, if only he could stop bumping for a moment and think of it.

Our goal in this paper is to provide sufficient data to convince organizations that a better way exists and that they should invest aggressively in finding and implementing it. Armed with this data, change agents should be better able to make the case and convince managers to authorize such action.

Problem overview

Today's rapid flow and exchange of information, and the consequent tasks they impose, are overwhelming for knowledge workers and their managers. The barrage of communication exacts a toll on their productivity, as well as on their personal well–being. The problem encompasses two distinct yet interlinked causative phenomena:

a. **E–mail overload.** A typical Intel knowledge worker receives 50–100 work–related e–mail messages each day [3]. The continual accumulation of messages is a major driver of employees' work experience. This volume represents a sizable task load, starting with the need to read and dispose of messages and ending with execution of uninvited work generated by those messages. This e–mail barrage taxes employees' resources and reduces time they can devote to their primary work. It also places them in a frustrating, unending rat race.

The problem isn't the abundance of accessible information. It's the *queued* streams of *pushed* information; that is, the accumulation of messages governed by the expectation that the worker process them all [4].

b. **Distractions/interruptions.** On average, knowledge workers can expect three minutes of uninterrupted work on any task [5] before being interrupted. Sources of interruption include e–mail, instant messages, phone calls, text messages, co–workers, and other distractions [6]. The majority of these distractions are attended to immediately.

The result is that people average 11 minutes on any one "working sphere" (project) before switching to another project altogether [7]. This extreme fragmentation of work results in a severe cumulative time loss, with some estimates as high as 25 percent of the work day [8]. In addition, the inability to concentrate on an intellectual activity requiring more than a few minutes has a debilitating effect on employees' ability to achieve optimal results.

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The combination of these phenomena has led to a state where employees are so stressed and overwhelmed that their ability to function is seriously impaired, and their quality of life and job satisfaction plummet.

While virtually every worker we talked with has an intuitive grasp of the truth of these statements, an impressive body of both applied and basic research in academia and the industry proves them right. This research is referenced throughout this paper.

Information collected from Intel shows the problem is prevalent across the company, but it is by no means unique to Intel. Our communications with people in dozens of organizations worldwide clearly show the severe impact on knowledge workers and managers in practically every company and organization in the industrialized world. This includes high– and low–tech companies both large and small, governmental organizations, educational institutions, religious, military, and non–profit organizations.

Over the years, Infomania has been the subject of extensive academic research [9], and published results are sobering indeed.

Problem impact areas

While most people we interviewed admit this problem is driving them to distraction, few appreciate the extent of the damage. The impact of Infomania extends far beyond actual time expended on e–mail processing. In this section, we characterize and classify the damage.

1. Direct loss of productive time

*To quote one exasperated VP: "30 percent of this company is doing e–mail **instead** of working!"*

While e–mail is a legitimate – and vital – part of today's workplace, much of it simply isn't. Intel employees spend an average of some three hours per day processing e–mail. About 30 percent of messages (one million per day) are unnecessary [10]. The unnecessary fraction consumes about 20 minutes every day. That's fully paid time not devoted to useful work, spent creating, forwarding, opening, reading, and processing messages whose real value is less than the time consumed.

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Work–interrupting distractions cause a direct loss of time due to "cognitive reorientation costs" or "switching costs" compared to uninterrupted work [11]. This is time required to change context from one task to another and back.

Actual time consumed by the distraction can be minimal and still impose a serious loss: an irrelevant pop–up lingering for a few seconds or a brief phone call can require minutes to recover lost concentration.

The old adage that time is money has changed. We find now that time is a more precious commodity than money. Overwhelmed workers are steadily squandering a significant fraction of theirs on the meaningless make–work of Infomania.

2. Reduced mental capacity

"This is your brain. This is your brain on Infomania." All we're missing is a warning from the Surgeon General.

Endless distractions and the stress of information overload combine to perceptibly degrade the mental acuity of knowledge workers [12]. People are less capable of thinking, generating creative ideas, and effectively solving problems. A research study commissioned by Hewlett–Packard reported that IQ scores of information workers tested while they are subjected to distraction and overload are reduced by 10 points [13]. Ponder that, if you can find a free moment!

The psychiatrist who coined the informal term Attention Deficit Trait (ADT) to describe this phenomenon is Dr. Edward Hallowell. He asserts that the cognitive impact of Infomania causes people to work well below their full potential. They produce less output, think superficially, and generate fewer new ideas – despite working an increasing number of hours [14]. There is also evidence showing an increase in error rates, including errors in management decision–making [15].

Distractions can cause a loss of "situational awareness" [16], requiring cognitive reorientation to restore task situational awareness after the interrupting event. This can also induce errors [17], [18], rework, forgotten steps, and lowered overall output [19], [20].

It is critical to understand this huge impact: because of Infomania, employees are **not creating new ideas** to the extent they could. New, significant inventions remain un–invented. Better solutions to major problems that may be hobbling an organization's performance toward its goals are left undiscovered. The engineer who could have the "Aha!" insight leading to the next major product innovation is trying to find 30 minutes to think about it, and failing. The supervisor who could double a fabrication line's efficiency can't because they are nearly brain dead from staying up until one AM working on e–mail. Across the industry, knowledge workers and managers are thinking less, inventing less, producing less, succeeding less.

3. Disappearance of quality "Thinking Time"

"In the information society, nobody thinks. We expected to banish paper, but we actually banished thought" – Michael Crichton

The creative thinking process requires long stretches of uninterrupted time, to study books, articles and online resources, and to process information, sorting it mentally and generating insight. These activities take time as well as mental concentration, which builds up slowly and can easily be lost.

Field research demonstrates that restoring daily segments of contiguous "Quiet Time" can have a major effect of increasing productivity in development teams [21], [22]. Additional research shows a correlation between a fragmented work mode and reduced creativity [23].

In the past, such thinking time was core to the work paradigm. Newton got hit by that apple because he was sitting under a tree. Sitting and contemplating the world (what we now call "doing nothing") was an expected part of a scientist's routine. More recently, say ten years ago, employees could still expect to do some thinking – if no other way, after 5 PM, during the weekend, or by hiding in a conference room.

Today, the only time we can think is when the flight attendant orders us to close our notebooks prior to landing. At any other time – 24x7 – we're accessible to beeping, alerting, attention–grabbing devices and software tools. We are expected to respond to them instantly. One perspective is that technology channels our thinking to multiple, mostly trivial problems instead of focusing on a few important ones where we can create real value.

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Let's look at this quantitatively. On average, a major interruption occurs every 11 minutes [24], the time to return to an interrupted task is 25 minutes [25], many incoming e–mail messages are reacted to within seconds of arrival [26] (implying constant e–mail monitoring to the detriment of concentration on the task at hand), and recovery from e–mail distraction takes 64 seconds [27]. It is thus fair, yet sad, to say that many knowledge workers have almost no uninterrupted work time – time that is essential to enabling creativity, innovation or serious problem solving [28].

This reduced ability to reflect on problems often and at length complements the reduction in mental capacity described in the previous section. Together, they hobble knowledge workers' ability to generate creative ideas and innovative solutions that are at the core of their value to their employers.

4. Breakdown of organizational processes

> *"Apollo, this is Houston, do you read?" – – – – [silence] – – – –*
> *"Dang... they must be doing e–mail again. Oh well, let's try again tomorrow."*

A little–recognized outcome of Infomania is the breakdown of many of the vital processes powering an enterprise, notably:

4.1 Effective communications. With good reason, e–mail has become a vital communication channel, but its value has been compromised by overload. Fifteen years ago, this was a tool that guaranteed next–day–response, today it is a game of chance: will my urgent message be answered today? Tomorrow? Next week? Ever? Place your bets! [29], [30]

Computer–mediated communication researchers call it "online silence," the failure to respond to an e–mail in a timely fashion. Lack of response breeds ambiguity, since it is unknown whether the message was willfully ignored, not yet opened, filtered away by some rule, left for later response, or simply lingers unnoticed under the avalanche. Ambiguity can be worse than delay.

The outcome is a broken chain as projects are put on hold awaiting decisions or information [31]. Trust within the team erodes, so teams already struggling to overcome limitations imposed by their global dispersion are particularly hamstrung by these realities [32].

4.2 Meeting effectiveness. People dealing with e–mail in meetings is now the norm. It is not uncommon to see *all* attendees, including the chairperson, typing at their keyboards with a glazed look in their eyes – even in face–to–face meetings. This occurs while some hapless coworker is presenting and doubtlessly cursing their inability to do their own e–mail.

The most important aspect of effective meetings is joining the creative energy and critical thinking of several brains into a powerful problem–solving engine. That energy becomes utterly lost. Large companies hold hundreds of thousands of meetings every month – a huge investment with significantly reduced return caused by this phenomenon [33].

4.3 Manager/subordinate interaction. A key role of senior managers is to mentor, guide and support their subordinates. Reality is that getting half an hour with your big boss is next to impossible. Managers waste countless hours trying to cope with e–mail yet often will not respond to a subordinate's message for days. The fact that a subordinate is unable to get a manager's coaching and advice when needed is an alarming sign of how extensively unsolicited distractions have derailed even the most basic management processes.

Even when employee and manager get together in classic "one–on–one" meetings, to quote an employee, "Of the hour we have, half is lost to my manager taking cellular calls or rejecting them."

4.4 Task and work planning. A major use of e–mail is to broker assignments. The sender requests something: fill a Web survey, attend a meeting, compile and share materials, write a report, view a file, take a class, etc. The shorter tasks – ones taking under 10 minutes – are often executed when the message is read. This type of diversion can accumulate rapidly given current traffic levels. Others get incorporated in the person's activity plan for coming days.

The bottom line is that employees devote a significant portion of work hours to executing work dictated by others, independent of their own priorities and without agreeing in advance to reprioritize. Prior to e–mail, people planned their day based on their own objectives. If anyone wanted their time, they needed to negotiate with the employee

and/or their manager, often being refused if workloads and priorities dictated it. By succumbing to Infomania, entire worker populations have gone from **plan–driven** to **interrupt–driven**.

5. Reduced quality of life

> *"[these days] I can't even go to a movie at night like I used to" – a middle manager.*

Infomania affects employees' lives – and their loved ones' – both quantitatively and qualitatively. Quantitatively, because employees have less of a "life" when they process incoming messages around the clock [34], [35]. Long evening and weekend sessions at the Inbox have become the norm, appropriating time that used to belong to family, friends, and relaxation.

Qualitatively, because when employees are run ragged by the endless pressure of a losing race, their ability to relax and devote time to their life, hobbies, and families is reduced [36]. Long hours might be justified if they felt the pride and joy of a job well done, but even this is denied them as they slip ever backward in their race against the continuing flood of communication [37], [38].

Anecdotes abound. An engineer told us he does "quality time" in the living room with his children, concurrently doing e–mail with his notebook at hand. Another buys children's books in e–book format, so he can read them to his son at bedtime while processing e–mail. A manager was tempted one day to call in sick – falsely – not to rest, but to stay home and try to empty the ever–looming Inbox.

Even those who are genuinely ill do e–mail from their sickbed, fearful of the accumulation they'll face later. And vacation is no longer a way to "get away from it all". Increasingly, people take laptops on vacation, not for leisure but to process work–related e–mail [39].

Stress is a key issue in the workplace, bearing several negative outcomes, with Infomania being a significant contributor [40]. An unexpected research finding comes from a survey of U.K. employees where *temporary* employees report better well–being, general health, more positive attitude towards work and better work behavior (*e.g.*, less absenteeism) than their permanent counterparts. Researchers link this to the finding that many permanent workers reported high levels of work overload, relatively high levels of irritation, anxiety and depression and a strong interference of work with life at home [41].

Judiciously applied work–from–home options can significantly enhance both productivity and work/life balance – if handled correctly. These options become another inherently worthwhile idea compromised by the advent of Infomania.

Business value assessment of the damage

To prove the need for a solution to the Infomania problem, we conducted a quantitative business value analysis of the damage sustained by an organization, using published methods [42].

The bottom line: Infomania causes a damage of about US$1 billion per annum for a knowledge–intensive company of 50,000 employees. As usual with such calculations, this value is conservative, representing only more direct aspects of the problem. Additional, harder to measure damages exist but are not included.

The US$1 billion figure derives from a set of models based on extensive research conducted with knowledge workers. This includes over 1,000 hours of published field observation carefully examined to ensure its applicability to a company in the high tech industry.

Numerous variables can be considered when determining the impact of information overload, including:

- Lost work time or reduced employee efficiency.
- Reduced intellectual property (IP) generation.
- Cost of errors, or quality issues.
- Job dissatisfaction, leading to burnout and/or undesired turnover.

Our analysis focuses on employee efficiency, the metric examined in most of the research done to date. Assessing damage from other variables is more difficult. We are certain they would contribute significant additional losses.

See Appendix 2 for details of this business value analysis and other considerations.

Call for action

The impact described and quantified in this work clearly warrants a serious solution effort. No large organization can tolerate a phenomenon that reduces employee productivity, makes lives miserable, and potentially costs hundreds of millions of dollars each year.

Development of programs to address and solve the problem will not be simple. This is especially true given its deeply entrenched nature and numerous misperceptions of impacted knowledge workers. For example, they inevitably claim they can "multi–task" without negative impact on their performance, despite extensive data to the contrary.

A solution will require changes at the heart of expected behaviors and cultural paradigms in the organization, and possible modification of mission–critical technologies. Any program to achieve results will likely run initially for a year or more. It will involve professionals in the relevant disciplines from within the organization and beyond. Input from other corporations and support from research and consulting communities will be invaluable to avoid pitfalls and optimize solution elements.

The authors issue a call to affected organizations to embark on a search for solutions. This is already taking place at Intel and a few other corporations. There has been some success in gaining interest and cooperation from industry, academia and consulting communities. With resolve and perseverance, it is possible for these communities to join forces in creating viable solutions to be shared and implemented in organizations worldwide.

It is our hope that this will create a completely different reality of work and life – a reality where people can create outstanding business results while enjoying a pleasant work environment and improved quality of life.

Appendix 1: Intel e-mail usage survey results

The following data validates the extent of e-mail overload at Intel:

An e-mail usage survey to Intel knowledge workers in 1999 showed:
- Three million messages sent throughout Intel per day (based on server logs).
- An average of 200 messages wait in an employee's inbox.
- Thirty percent of e-mail is perceived as unnecessary.

- On average, each employee expends 2.5 hours per day managing e-mail.

A worldwide survey in March 2006 to all Intel IT employees showed:
- An average of 350 messages is received by each employee per week.
- On average, each employee expends 20 hours per week managing e-mail.
- This includes two hours per week processing 30 percent of incoming messages viewed as unnecessary.
- Forty percent responded that e-mail has a negative impact on their stress level.
- Thirty-one percent responded that e-mail has a negative impact on their quality of life.

- This analysis is based on 2,299 responses received.

A survey in June 2006 to a portion of Intel's Sales and Marketing Group showed:
- An average of 400 messages is received by each employee per week.
- On average, each employee expends 20 hours per week managing e-mail.
- This includes three hours per week processing 20 percent of incoming messages viewed as unnecessary.
- Fifty-four percent responded that e-mail has a negative impact on their stress level.
- Forty-three percent responded that e-mail has a negative impact on their quality of life.

- This analysis is based on 95 responses received.
Interviews with Intel executive-level managers confirmed that they receive up to 300 messages per day.

Appendix 2: Business value analysis

After reviewing both basic and applied research it is clear that the impact of Infomania in terms of reduced worker efficiency is enormous. The following example is based on publicly available data and uses US$50 per hour as the fully loaded cost of an employee to determine the impact on a company of 50,000 employees. Adjustments to the loaded cost of an employee per year are not made based on global regions or job types in this example.

Assumptions

The following assumptions were made in estimating the impact of the problem:

- As not all information-related interruptions are considered negative, a reduced daily frequency of interruptions is used. Research shows that interruptions can have a positive impact on employee performance for simple routine work tasks [43]. It has also been shown that if a task is interrupted and the interruption contains information related to the task at hand, then the interruption is less detrimental than those not related to the task.

Using data that estimates hourly interruptions related to the current task to be approximately 50 percent [44], the average number of interruptions has been reduced by 50 percent. The average number of major interruptions reported in the majority of the work reviewed is six to eight per hour. This analysis uses three information related interrupts per hour as the basis to ensure the negative impact is not overestimated.

- The impact estimate is based on a sequence of employee work, not a general estimate across an eight–hour work day. Again, this is done to avoid overestimating the negative impact. Since work unfolds as a sequence of tasks and interruptions, the maximum number of work segments that can occur in a day needs to be estimated to determine the upper limit on tasks that can be interrupted during the work day.

Reviewing published work to develop the task sequence [45], we used a baseline of eight minutes when not interrupted and 12 minutes when interrupted. Average task completion times vary across studies, so these numbers reflect an objective estimate arrived at through field observations. Using this data, the maximum tasks that can occur in an hour is six (see Figure 1). The magnitude of the difference (*i.e.*, increase in time to complete an interrupted task) is consistent with the range documented in lab experiments. However, a number of studies are highly controlled and measure short duration tasks [46], making data from field observations a better estimate.

- A six–hour work day is used to determine the impact per employee for tasks that are interrupted. Six hours is used as we assume employees attempt to isolate themselves some of the time to get work done, are in meetings during the day, etc.
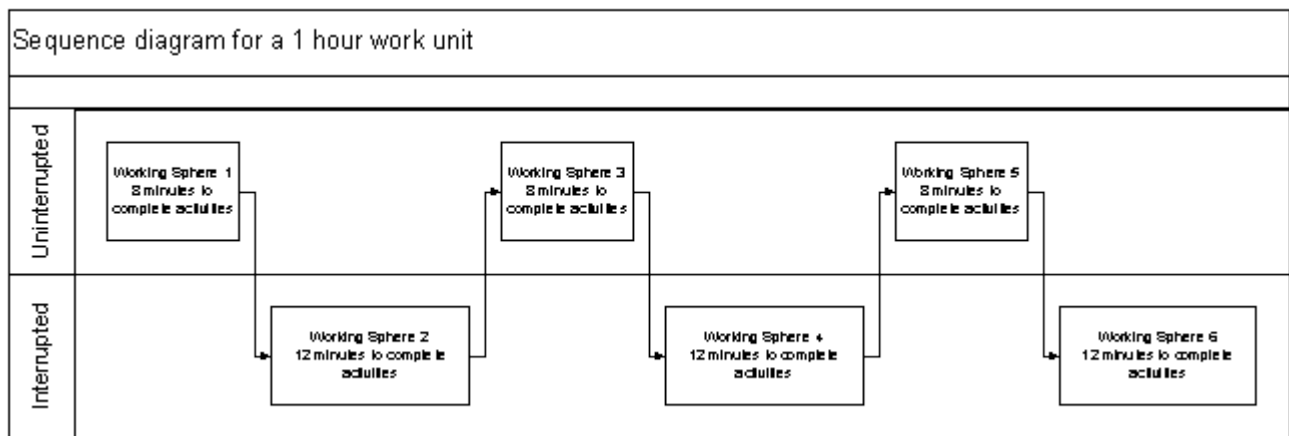
Figure 1: Work sequence diagram.

- The impacted employee base is the Total Worker Population (TWP), or 50,000.
- The available public research is based largely on knowledge workers. Additional data is required to determine how Infomania impacts other types of workers, such as manufacturing, call center, or other types of highly structured work settings. In addition, the nature of some jobs is the constant flow of information; applying data used in this example to job functions of this type would require close examination.
- Several issues determine how employees cope with information overload, and how these events arrive and queue. We assume these other factors (*e.g.*, tasks complexity, skill level, source of interruption, time of interruption, cognitive demand, etc.) are randomly distributed over the data collected in field observations and lab research.
- It has been observed that 30 percent of interrupted work events are not completed in the same day [47]. The cognitive reorientation cost to recreate "task situational awareness" for these work events would be much higher; this is *not* used as a factor in this analysis.
- Interruptions and information overload are related yet differ in how and when they occur. We calculated interruptions and unnecessary e–mail using separate data points. This approach also allows for easy updates as new information becomes available.

Calculations

Calculation 1 summarizes the data points used to determine the impact of interruptions and e–mail overload. These two items together represent our best estimate of the Infomania impact.

1. Total time lost due to interruptions and processing unnecessary e–mail is 392 hours per employee per year. This assumes a 49–week year. Six hours per week is the result of interruptions determined using the process outlined above, and two hours per week was reported in the e–mail survey done in Intel IT (see Appendix 1). The 392 hours is the result of 294 hours lost from interruptions and 98 hours lost due to unnecessary e–mail. The impact is roughly 20 percent, or eight hours per week.
2. The size of the impacted employee base is the TWP, in this case, 50,000.
3. The fully loaded hourly cost of an employee used here, US$50, is not broken down by region and job type. These two items should be considered when using this model to generate an impact estimate for a specific company.
4. Yearly impact equals the (Total Worker Population) X (loaded cost of an employee per hour) X (392 hrs per yr).

Using the data outlined above we arrive at the following:

Calculation 1: Yearly impact = 50,000 X US$50 X 392 hours = US$980,000,000 per year

Data from a specific organization requires taking into account various job segments and global regions to properly estimate the impact. Determining the impact requires that each TWP and loaded hourly cost of employees in that segment be defined and added up for the estimate. Close partnership with Finance and Human Resources is required to determine the correct information since there are many methods used to track and report this data.

For example, assume we have two impacted employee segments. Segment 1 has 10,000 employees and segment 2 has 15,000 employees; the loaded hourly cost for employees in segment 1 is US$40 and for segment 2 is US$65.

Calculation 2: Segment yearly impact = Segment population X Loaded hourly cost X 392 hours. Yearly impact for both segments = 10,000 X US$40 X 392 + 15,000 X US$65 X 392 = US$156,800,000 + US$382,200,000 = US$539,000,000 per year

The approach outlined above can be used with different estimates of the impact for the Infomania problem. For example, an extensive analysis based on an 18–month study by the research firm Basex [48], places the cost of the interruptions problem at 503 hours lost per worker per year [49] vs. the 294 hours used in this paper. Using the Basex estimate for interruptions instead of the more conservative one used in Calculation 1 generates an impact of US$1,257,500,000 per year [50].

Appendix 3: Comments on problem causes

In this paper we do not propose a thorough root cause analysis. We can, however, share a few high–level insights into the complexity of the underlying mechanisms of Infomania:

Infomania is a prime example of the classic "too much of a good thing." Overall, increased communication is beneficial, as is the desire to increase its flow and access. Deploying continuously faster, easier to use communication technologies does have merit but left unchecked, it creates a paradox. Rapid communications (first order effect) mean more distractions and overload (second order effect) which reduces people's ability to react. This paradox causes people to adopt various strategies to communicate less (third order effect) [51]. The outcome

is that people are less responsive to many messages than they were a decade ago, when communications were much slower.

Infomania is complex and multi–dimensional. Understanding the impact will require a multi–disciplined investigation into technology, psychology, organizational culture and management practices. Solutions will need to be equally diverse – and powerful enough to address this deep–rooted phenomenon.

Technology and organizational culture have failed to properly co–evolve. Rapid advances in technology enable new work modes, but there is insufficient study, if any, upfront to predict opportunities and risks. This intelligence would allow implementation of parallel changes in the paradigms defining work ethics, management expectations and employee behavior.

Instead, corporations deploy technology without that intelligence, and the culture adapts to the new technology in a haphazard and clearly sub–optimal manner.

Infomania is an emergent phenomenon resulting from this uncoordinated evolution. This chart represents the chasm:

Technological reality (what is possible)	**Cultural paradigm** (what is done)
Unlimited *accessibility* of everyone to everyone by many communication channels	Everyone is expected (by managers, peers, and self) to be *available* to everyone 24x7
Sending messages is easy to do and perceived as practically free of cost (monetary or other)	We sanction the unlimited sending of unsolicited messages ("freedom of speech")
Free, asynchronous access to everyone's attention queues	Interruption–driven, un–negotiated task management replacing plan driven methodology
Queued messaging is available for most communication modes (e–mail, voice mail) [52]	Expectation that message queues be emptied (including unsolicited messages)
Work from home technology is "as good as being in the office"	No clear understanding, much less a policy, of where to place the work/life barrier
Computers allow multi–tasking and rapid switching from task to task	Implicit expectation that all people are good at multi-tasking and can switch rapidly [53]

About the authors

Nathan Zeldes, an Intel IT Principal Engineer, is a veteran player in the e–mail overload field. Following external publication of his work on this problem, over 100 organizations worldwide have contacted him. This resulted in exchange of information, consulting engagements and cross–fertilization of ideas. Nathan's personal Web site is at http://www.nzeldes.com . He writes about Infomania on the IT@Intel blog at http://blogs.intel.com/it/.

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Dr. Sigal Louchheim is an internationally recognized expert in the area of *interestingness*, the discovery of what is interesting (new, actionable, etc.) in large masses of data. Sigal has published in international conferences and is an active member of the international interestingness community.

Notes

1. ADT is not a formal medical term and should not be confused with Attention Deficit Disorder (ADD). Dr. Edward Hallowell coined ADT in 2005 to describe the mental state that Hewlett–Packard called Infomania.

2. Observed by N. Zeldes during numerous user interviews and management discussions across Intel.

3. See Appendix 1.

4. An interesting conjecture is that posts accessed through an RSS feed reader will not impose the kind of stress associated with e–mail overload as there is an expectation that they will not all be read. This still requires validation.

5. Gonzalez and Mark (2004) found that information workers average about three minutes on a task and slightly more than two minutes using any electronic tool or paper document before switching.

6. Gonzalez and Mark (2004) and others observed that workers interrupt themselves as often as they are interrupted externally. They are unable to concentrate on a prolonged task even when briefly given the luxury of no external distractions.

7. Gonzalez and Mark (2004) and Mark, *et al.* (2005) found that information workers spend on average 11 minutes on any "working sphere" (*i.e.*, higher–level project) before switching or being interrupted by a task related to another project. Only 77 percent of interrupted work spheres were resumed the same day, and those averaged 25 minutes before being resumed. During this time, on average they worked on 2.26 other work spheres.

8. In a knowledge worker survey by Basex (2005), time lost to unimportant interruptions and recovery time from all interruptions (important or otherwise) totaled 2.1 hours of lost productivity per day.

9. Bawden (2001) noted that academians produced over 245 papers on the subject between 1972 and 2000, with many more works published since then.

10. See Appendix 1.

11. Rubinstein, *et al.* (2001) estimate the time cost of switching at 20–40 percent.

12. Just, *et al.* (2001) showed that this may be reflected in the findings of brain imaging research work, which proves that performing two tasks concurrently results in each of them being processed less efficiently than when done sequentially. Also described at http://www.npr.org/programs/morning/features/2001/aug/multitasking/080601multitasking.html.

13. Hewlett–Packard (2005).

14. Hallowell (2005b) interview.

15. Chan (2001) observed a decline in manager decision quality with the onset of information overload. Chewning and Harrell (1990) observed the same.

16. M.R. Endsley, 2000. "Theoretical Underpinnings of Situational Awareness: A Critical Review," In: M.R. Endsley and D.J. Garland (editors), 2000. *Situation Awareness: Analysis and Measurement*. Mahwah, N.J.: Lawrence Erlbaum Associates.

17. Rudolph (2002, 2003) found that the extent of interruptions experienced by medical students and physicians participating in simulated learning exercises correlated negatively with task effectiveness, measured as treatment errors in simulated patient outcomes.

18. Speier, *et al.* (2003) found in controlled experiments that for complex tasks, decision makers who did not experience interruptions made significantly more accurate decisions than those who experienced interruptions. In some types of tasks, interruptions also adversely affected the time to reach the decision.

19. Cutrell, *et al.* (2001) found in controlled experiments that the receipt of IM notifications while performing computer tasks resulted consistently in a slowing down of the work (after attending to the notification).

20. Gillie and Broadbent (1989) found that interruptions can cause a decrease in how quickly people perform post interruption tasks. Eyrolle and Cellier (2000) found that interrupted tasks take longer to complete and have an increased error rate.

21. Perlow (1999) found that implementing "quiet time" – an agreement among coworkers not to interrupt one another during designated hours – led to the majority of developers reporting improved productivity, with significant impact on their project's time–to–completion. This was conducted as a quasi–field experiment with an industry software development team.

22. An experiment in Intel's Arizona site to ban meetings on Fridays showed that the resultant blocks of contiguous uninterrupted thinking time significantly raised productivity.

23. Amabile, *et al.* (2002) observed reduced creative activity in knowledge workers on days when their work was fragmented by distractions and interruptions.

24. See note [7].

25. Mark, *et al.* (2005).

26. Jackson, *et al.* (2001) conducted a study of incoming e–mail messages and observed that 70 percent, were reacted to within six seconds of arrival (this is faster than letting the phone ring three times); 85 percent were reacted to within two minutes.

27. Jackson, *et al.* (2001) documented an average of 64 seconds for the average employee to recover from an e–mail interrupt and return to their work at the same work rate.

28. Rennecker and Godwin (2005) observed one of the main directives of information systems to be increasing the flow of information to accelerate work, and removing barriers and delays detrimental to getting work done (first–order effect). However, this creates an interesting paradox: as the ability to exchange information accelerates, the probability of interruptions also increases (second–order effect). This creates a situation where workers respond to modify how they work (third–order effect) to deal with the second–order effect — creating, in essence, a vicious circle.

29. Kalman and Rafaeli (2005) show most messages get answered within one day, but a message that has not received a response within one day has only a 16 percent chance of being answered at all.

30. Tyler and Tang (2003) give an interesting study of the behavior patterns governing this variability.

31. PalmOne (2004) conducted a survey of large corporations in Europe where 61 percent of respondents say business decisions are delayed due to lack of e–mail response.

32. Cramton (2001) identified online silence as one of the biggest challenges facing geographically dispersed teams, since the silence was often misinterpreted, leading to misunderstandings adversely affecting team processes.

33. Microsoft (2005) conducted a survey of 38,000 workers worldwide and found ineffective meetings are ranked highest as the most common productivity pitfall. Respondents spend on average 5.6 hours a week in meetings, and 69 percent consider meetings to be unproductive.

34. Hewlett–Packard (2005) cites research showing 62 percent of adults are addicted to checking messages outside of office hours and while on holiday.

35. Intel (2004) conducted a worldwide survey of 2,982 employees where more than half of the respondents agreed with the statement "Technology makes me feel like I'm always on call for work".

36. Reuters (1996) conducted a survey of 1,300 managers worldwide finding two out of three respondents associated information overload with loss of job satisfaction and tension with colleagues. Forty–two percent attributed ill health to this stress. Sixty–one percent cancel social activities as a result of information overload. Sixty percent are frequently too tired for leisure activities.

37. Microsoft (2005) conducted a survey of 38,000 workers worldwide finding 60 percent do not have work–life balance, and being unproductive contributes to this feeling.

38. It is sad to observe the worker who rejoices in having temporarily reduced their Inbox to less than one screenful, following hours of effort. It feels good but is a pathetically empty victory.

39. Intel commissioned Harris Interactive (2005) to conduct a survey revealing 34 percent of adult computer users in the U.S. have taken a laptop computer with them on vacation. Fifty–one percent say they plan to in the future. Forty–three percent of those who took a computer used it to send or check work-related e–mail.

40. See Appendix 1.

41. Guest and Clinton (2006). Survey results mirrored those from others conducted in several other European countries.

42. Sward, 2006. *Measuring the Business Value of Information Technology: Practical Strategies for IT and Business Managers*.

43. Q.R. Jett and J. George, 2003. "Work interrupted: A closer look at the role of interruptions in organizational life," *Academy of Management Review*, volume 28, number 3, pp. 494–507. Mark, *et al.* (2005) have information that interruptions related to the current working sphere are not as detrimental as those not related to the current working sphere.

44. Mark, *et al.* (2005).

45. Mark, *et al.* (2005).

46. Rubinstein, *et al.* (2001).

47. Mark, *et al.* (2005).

48. Basex, Inc. (2005).

49. Basex also determined that this detrimental impact is increasing at a rate of five percent per year.

50. This calculation uses 503 hours per year for interruptions and 98 hours per year for e–mail (from the Intel e–mail survey). This assumes no overlap between the interruption impact from Basex and the e–mail impact from Intel.

51. Rennecker and Godwin (2005) give an excellent summary of the organizational impacts of these effects.

52. The exception at this time is instant messaging, where a missed message is usually not retained in a queue.

53. While many people feel they can effectively multi–task, *e.g.*, participate in a meeting and process e–mail and IMs at the same time, this self–perceived ability is highly overrated. For example, most people assert that they can drive safely while talking on a hands free cell phone. However, multiple studies show a direct link between the likelihood of a car accident and the use of cell phones. More research shows that the brain has limited abilities to multi–task effectively. See Just (1996); Strayer and Johnston (2001); and Strayer, *et al.* (2003) who found that with respect to driving safety, cell phone drivers exhibited greater impairment than intoxicated drivers.

References

T. Amabile, C.N. Hadley, and S.J. Kramer, 2002. "Creativity Under the Gun," Special Issue on The Innovative Enterprise: Turning Ideas into Profits, *Harvard Business Review*, volume 80, number 8 (August), pp. 52–61.

Basex, Inc., 2005. "The cost of not paying attention: How interruptions impact knowledge worker productivity," at http://bsx.stores.yahoo.net/coofnotpaat.html.

D. Bawden, 2001. "Information overload," *Library and Information Briefings*, volume 92 (January).

S.Y. Chan, 2001. "The Effect of Information Load and Presentation Format on Managerial Decision Quality," *Business Research Centre Working Papers*, Hong Kong Baptist University, Hong Kong.

E. Chewning and A.M. Harrell, 1990. "The effect of information load on decision makers' cue utilization levels and decision quality in a financial distress decision task," *Accounting, Organizations and Society*, volume 15, issue 6, pp. 527–542.

C.D. Cramton, 2001. "The mutual knowledge problem and its consequences for dispersed collaboration," *Organization Science*, volume 12, number 3, pp. 346–371.

E. Cutrell, M. Czerwinski, and E. Horvitz, 2001. "Notification, disruption, and memory: Effects of messaging interruptions on memory and performance," In: M. Hirose (editor). *Human–Computer Interaction – INTERACT 2001 Conference Proceedings*. Amsterdam: IOS Press, pp. 263–269, and at http://interruptions.net/literature/Cutrell-Interact01-Messaging.pdf.

M.R. Endsley, 2000. "Theoretical Underpinnings of Situational Awareness: A Critical Review," In: M.R. Endsley and D.J. Garland (editors). *Situation Awareness Analysis and Measurement*. Mahwah, N.J.: Lawrence Erlbaum Associates, pp. 1–25.

M.R. Endsley, 1995. "Measurement of Situation Awareness in Dynamic Systems," *Human Factors*, volume 37, number 1, pp. 65–84.

H. Eyrolle and J.–M. Cellier, 2000. "The effects of interruptions in work activity: Field and laboratory results," *Applied Ergonomics*, volume 31, number 5, pp. 537–543, and at http://www.interruptions.net/literature/Eyrolle-AE00.pdf.

T. Gillie and D. Broadbent, 1989. "What makes interruptions disruptive? A study of length, similarity and complexity," *Psychological Research*, volume 50, number 4, pp. 243–250.

V. Gonzalez and G. Mark, 2004. "Constant, Constant, Multi–tasking Craziness: Managing Multiple Working Spheres," *Proceedings of ACM CHI'04*, pp. 113–120, and at http://interruptions.net/literature/Gonzalez-CHI04-p113-gonzalez.pdf.

D. Guest and M. Clinton, 2006. "Temporary Employment Contracts, Workers' Well–Being and Behaviour: Evidence from the UK," Department of Management, King's College, London, at http://www.kcl.ac.uk/content/1/c6/01/15/65/paper38.pdf.

E.M. Hallowell, 2005a. "Overloaded Circuits: Why Smart People Underperform," *Harvard Business Review* (January), pp. 54–62.

E.M. Hallowell, 2005b. "Interview with CNet News," at http://news.com.com/Why+cant+you+pay+attention+anymore/2008-1022_3-5637632.html.

Harris Interactive survey, 2005. Commissioned by Intel, Intel Press Release (20 July).

Hewlett–Packard, 2005. "Info–Mania — Is it reducing your IQ?" at http://h50043.www5.hp.com/hpservices/ap_features/july05/4016.htm.

Intel, 2004. "Worldwide Work Behavior Study," administered by Intel's Information Services and Technology Group, surveyed 2,982 Intel employees worldwide.

T.W. Jackson, R.J. Dawson, and D. Wilson, 2001. "The Cost of E-mail Interruption,", *Journal of Systems and Information Technology*, volume 5, number 1, pp. 81–92, and at http://iii.lboro.ac.uk/pdf/JOSIT%202001.pdf.

Q.R. Jett and J. George, 2003. "Work interrupted: A closer look at the role of interruptions in organizational life," *Academy of Management Review*, volume 28, number 3, pp. 494–507.

M.A. Just, 2006. "Study Provides Conclusive Evidence: Cell Phones Distract Drivers," *Carnegie Mellon News* (9 January), at http://www.cmu.edu/cmnews/010906/010906_cell.html.

M.A. Just, P.A. Carpenter, T.A. Keller, L. Emery, H. Zajac, and K.R. Thulborn, 2001. "Interdependence of Nonoverlapping Cortical Systems in Dual Cognitive Tasks," *NeuroImage*, volume 14, pp. 417–426, and at http://www.ccbi.cmu.edu/reprints/Just_NeuroImage2001-multitask.pdf.

Y.M. Kalman and S. Rafaeli, 2005. "Email Chronemics: Unobtrusive Profiling of Response Times," In: Ralph H. Sprague (editor). *Proceedings of the 38th International Conference on System Sciences, HICSS 38*, p. 108, and at http://csdl2.computer.org/comp/proceedings/hicss/2005/2268/04/22680108b.pdf.

G. Mark, V.M. Gonzalez, and J. Harris, 2005. "No task left behind? Examining the nature of fragmented work," In: *Human Factors in Computing Systems: Proceedings of CHI'05*. New York: ACM Press, pp. 321–330, and at http://interruptions.net/literature/Mark-CHI05-p321-mark.pdf.

Microsoft, 2005. "Microsoft Office Personal Productivity Challenge survey," at http://www.microsoft.com/presspass/press/2005/mar05/03-15ThreeProductiveDaysPR.mspx.

PalmOne, 2004. "Combating seven deadly e–mail sins," at http://www.cnn.com/2004/BUSINESS/09/15/email.sins/.

L. Perlow, 1999. "The time famine: Toward a sociology of work time," *Administrative Science Quarterly*, volume 44, number 1, pp. 57–81, and at http://interruptions.net/literature/Perlow-ASQ99.pdf.

J. Rennecker and L. Godwin, 2005. "Delays and interruptions: A self–perpetuating paradox of communication technology use," *Information and Organization*, volume 15, number 3, pp. 247–266, and at http://interruptions.net/literature/Rennecker-I&O05.pdf.

Reuters, 1996. "Dying for information? A report on the effects of information overload in the UK and worldwide," Reuters, United Kingdom, at http://www.cni.org/regconfs/1997/ukoln-content/repor~13.html.

J.S. Rubinstein, D.E. Meyer, and J.E. Evans, 2001. "Executive Control of Cognitive Processes in Task Switching," *Journal of Experimental Psychology*, volume 27, number 4, pp. 763–797. See also interview in http://archives.cnn.com/2001/CAREER/trends/08/05/multitasking.study/.

J. Rudolph, 2003. "Into the big muddy and out again: Error persistence and crisis management in the operating room," Unpublished doctoral dissertation, Boston College, Chestnut Hill, Mass., at http://escholarship.bc.edu/dissertations/AAI3103269/.

J. Rudolph, 2002. "Disaster dynamics: Understanding the role of quantity in organizational collapse," *Administrative Science Quarterly*, volume 47, pp. 1–30.

C. Speier, I. Vessey, and J.S. Valacich, 2003. "The Effects of Interruptions, Task Complexity, and Information Presentation on Computer-Supported Decision–Making Performance," *Decision Sciences*, volume 34, number 4 (November), p. 771, and at http://interruptions.net/literature/Speier-DS03.pdf.

D.L. Strayer and W.A. Johnston, 2001. "Driven to distraction: Dual–task studies of simulated driving and conversing on a cellular phone," *Psychological Science*, volume 12, pp. 462–466.

D.L. Strayer, F.A. Drews, and D.J. Crouch, 2003. "Fatal distraction? A comparison of the cell–phone driver and the drunk driver," In: D.V. McGehee, J.D. Lee, and M. Rizzo (editors). *Driving Assessment 2003: International Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design*. Iowa City: Public Policy Center, University of Iowa, and at http://www.psych.utah.edu/AppliedCognitionLab/DrivingAssessment2003.pdf.

D. Sward, 2006. *Measuring the Business Value of Information Technology: Practical Strategies for IT and Business Managers*. Santa Clara, Calif.: Intel Press.

J.R. Tyler and J.C. Tang, 2003. "When Can I Expect an Email Response? A Study of Rhythms in Email Usage," at http://www.hpl.hp.com/research/idl/papers/rhythms/.

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