

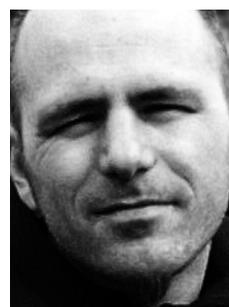
Semantic Retail: Towards a Cross-Context Information Architecture[†]

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ABSTRACT: Information architecture (IA) is an emerging discipline within the knowledge organization field that merges concepts and approaches from several different disciplines (librarianship and information science, classification theory, logic and philosophy, user experience, web design, psychology and ergonomics, industrial design): its goal is the structural design of shared information environments. We outline a unified model of information architecture for both digital and physical spaces, providing a conceptual framework for the design of cognitive and informational continuity between environments that allows users not to shift constantly between diverse, often colliding patterns (Bates 2002; Grossman 2006; Marchionini 2004; Rosati 2007). We identified key concepts which act as cross-fields heuristics and which provide the foundations for our framework: in this paper we will illustrate these heuristics as they apply to the design process of a new kind of retail space that we call "semantic retail". This is a new kind of physical space where knowledge organization principles are applied not only to proper informational content, but also to goods, services and paths (wayfinding).

1. Foreword

Information architecture (IA) is an emerging discipline and community of practice focused on bringing principles of librarianship, design and architecture to the digital landscape (Rosenfeld & Morville 2006). If initially the discipline itself was mostly confined to the World Wide Web, in recent years phenomena like ubiquitous computing, the rising of an Internet of things and the issues related to infoglut and information overload have clearly showed that a proper organization of information has become integral not only to libraries or websites, but to the physical environment: everything is permeated with information today (Morville 2006). So, information architecture is not just for the Web: information architecture has a much larger impact on many offline activities, affects our lives in many different ways, and its contribution becomes crucial where complexity, unfamiliarity and information overload stand in the way of the user. Moreover, we believe this evolution of information architecture is but a strategic part of the general evolution of design, from the design of objects to that of processes (Sterling 2005): by enabling coherent bridge-experiences (Grossman 2006), knowledge organization can provide better and more satisfying Human Information Interaction (HII, Marchionini 2004) in both worlds, online and offline.

The goal of this paper is to outline a unified model of information architecture able to traverse the different contexts we encounter daily, from digital to physical spaces, providing a conceptual framework for the design of cognitive and informational continuity between environments that allows users not to shift constantly between diverse, often colliding patterns (Bates 2002; Grossman 2006; Marchionini 2004; Rosati 2007). Within this model we propose to apply organizational and interactional models typically used on the Web to the design of physical objects and spaces, and vice-versa. The goal is that of:

- Improving the retail-space user experience (UX) by applying design processes typical of the Web environment and library models: this is what we call *synchronicity* and will be discussed in §2;
- Improving the choice process and the physical layout of products and goods in the shop by applying ergonomics and library methods and rules: this is what we call *choice* and will be discussed in §3;
- Reducing the paradox of choice, nurturing personal information seeking strategies and favouring correlation among products and goods (Bates

1989) by applying faceted classification and social tagging techniques: this is what we call *circularity* and will be discussed in §4 *Correlation*.

- A short remark (§ 5) is finally devoted to the concept of *coherence* of a classification system: what does it mean that a classification has to be coherent? What with?
- To illustrate how this model works, we will describe a possible new layout for a generic *semantic supermarket* in §6. In §7 we offer some preliminary conclusions and considerations, and in §8 a complete bibliographical reference.

2. Synchronicity

*I've often imagined gazes
surviving the act of seeing
as if they were poles,
measured distances, lances
in battle.*

*Then I think of a room
just abandoned
where similar traces remain
for a time, suspended and intersecting
in the balance of their design
intact and overlapping, like
pick-up-sticks.*

(Magrelli 1991)

Our goals deeply influence our strategies when searching. Cognitive and cultural models have a strong impact on behaviour: different individuals search differently because they follow different goals and possess different cognitive models. Furthermore, even single individuals might modify their patterns according to context, time, and goals. To work effectively, then, a classification system has to be able to adapt to these ever changing information seeking strategies, effectively moving from Information Retrieval (IR), where users are external entities, to Human Information Interaction (HII), where users are an integral part of the process (Marchionini 2004, Bates 2002, Fisher et al. 2005).

Schwartz (2004, 19, 221) remarks that “apparently, people are shopping more now but enjoying it less. [...] A recent series of studies, titled ‘When Choice is demotivating’, provide the evidence [that ... h]aving too many choices produces psychological distress. Especially when combined with regret, concern about status, adaptation, social comparison, and perhaps most important, the desire to have the best of everything - to maximize”. As people in the

European Union spend a large amount of their time shopping (from 13% to 17% of their 6-8 work hours per day) (Eurostat 2006, 6), this is by no means marginal.

- Preserving our interaction history with items and environments (Magrelli’s “poles” and “lances in a battle”), for example using RFID (Radio Frequency Identification), would allow for a totally new brick-and-mortar retail model capable of providing better services and better experiences to customers. And most of these services would be information-related, information-based, and time-saving, in a word, synchronical;
- re-finding and retracing of past tasks and past paths (shopping tasks, for example);
- path and task personalization;
- shopping time optimization;
- creation of *ad hoc* shopping suggestions and custom correlations among products.

As Sterling (2005, 45) says, a *synchronic society* is a society that synchronizes many stories through space and time. In a synchronic society every single note-worthy - by human beings or machines it does not matter - item generates a story. A synchronic society produces billions of paths as well, which can be investigated, tracked, and interpreted. These stories and paths do not form a dusty ink and paper archive, but a vast data pool which can be manipulated in real time. Being able to use it to its full extent is a fundamental opportunity and the real challenge awaiting tomorrow’s design. By observing and tracking the user’s paths and choices inside the physical environment, we can adapt to their different navigational models (that is, we can tune the physical layout of information, goods, and shelves, and provide the correct pieces of information) even in real-time, and then leave these patterns available for reuse. By exploiting these data and network technologies we can apply to physical spaces the hypertext logic and social context peculiar to the Web.

3. Choice

Current markets are moving towards a long tail model: strong differentiation and personalization, attention to an increasing number of niche markets, selling few items to many instead of many items to few (Anderson 2006). But choosing among an ever-growing number of possible brands, models, sizes, colours, textures for any single item we have to

choose or buy can be a stressful experience: this is what is known as the paradox of choice (Schwarz 2004). This information overload is not (only) an issue of *quantity*, but rather an issue of *quality*: it directly relates to how information is organized, visualized and made accessible.

To conciliate these opposite needs, berrypicking (Bates, 1989) and a long tail economy on one side, information overload and paradox of choice on the other, we resort to ergonomics and Hick’s Law (Raskin 2000, 93; *Hick’s Law* 2007). Hick’s Law provides the mathematical model which explains the paradox of choice and suggests some countermeasures as well. In short, given n equally probable choices, the average reaction time required to choose among them is approximately proportional to the logarithm to base 2 of the number of choices, plus one. That is: $Time = a + b \log_2 (n + 1)$, where a e b depend on context conditions, such as presentation and the user’s degree of familiarity with the subject. For example, if choices are poorly presented both a and b increase, while familiarity only decreases b .

What’s worth noticing is that the correlation between reaction time and possible choices is expressed logarithmically, that is, it’s non-linear. Every time we choose, we do not consider every available option (linear time), but rather we cluster options in categories, dismissing progressively a part of them (roughly half of the options every time). For a and b constant, if the number of options grows so does reaction time. Vice-versa, given an equal number of choices, a e b influence reaction time. This is why necessary caution has to be used for instance when applying Hick’s Law to items in a menu: if a list is unordered, or ordered meaninglessly from the user’s point of view, no clustering takes place and the user will probably browse through each item every time. That means that reaction time becomes linear and the formula loses any utility. Ordered list (for example, alphabetically ordered lists) on the other hand, allow for such scanning: the user goes to the pertinent letter (i.e. M) and starts reading only the relevant subset (i.e. all animals whose name begins with M). This time the Law applies and reaction time is non-linear. Hence, choosing once from a significantly ordered 8-item-menu is quicker than choosing twice from two 4-item-menus: wide structures (less levels) are to be preferred over deep structures (more levels). Mathematically: $a + b \log_2 8 = a + 3b$ in the first case, and $2(a + b \log_2 4) = 2a + 4b$ in the second case. Furthermore, and of a certain relevance to our goals, Hick’s Law clearly shows that reaction

time depends not only on the number of choices, but also on the way these choices are presented to users.

Let's consider an average electronic do-it-yourself scale in an average supermarket, as it usually offers a rather useful example of paradox of choice. In the vast majority of cases, the scale is fitted with roughly 30-60 buttons, ordered numerically and displaying a small picture of the associated vegetable. Every button corresponds to a product via its number, and this number is also usually printed on the tags and labels on the racks. Unfortunately, this system presents the users with a less-than-convenient model:

- when picking up grocery, the customer needs to memorize the number, move to the scale, put the goods on the plate, and press the correct button. There is a mnemonic effort involved;
- the association between code and product is never fixed: it obviously varies seasonally or with product availability, and it is strictly supermarket-dependant. Memorizing codes for common products provides little help then.

To solve this issue, some supermarkets adopt solutions that improve performance (Figure 1): their scales do not list all available products at once, but require choosing from a first-level menu that just lists for example *Fresh fruit*, *Vegetables*, *Dried fruit*. These are the top items of a tree hierarchy, so, after choosing *Fruit*, the display changes to *Apples*, *Apricots*, *Kiwis*, *Peaches*, *Pineapples*, etc. This works much better, but why? Splitting a 60-item menu in a three-item main menu and a number of subordinate menus should increase the cognitive burden on the customer, and fuel the paradox of choice: but it doesn't,

because Hick's Law, according to which choosing once from an 8-item menu requires less effort than choosing twice from two 4-item menus, does not apply here. This is because numbers and products have no fixed known association and the numbers on the display offer no help to customers even if ordered from smallest to largest. Even the icons depicting items tend to get blurred and scarcely recognizable because of the general visual clutter and the high number of products. In other words, these buttons are a typical example of a list of options casually or meaninglessly ordered: since users cannot operate clustering, reaction time grows linearly and not logarithmically. Hence, an organize and cluster principle could be applied to reduce choosing time and related cognitive burden in two different directions:

- by listing menu items using meaningful, self-evident rules, so that users can cluster items, according to Hick's Law;
- by clustering and organizing in levels, when no ordering is possible, Hick's Law does not apply and a wide structure offers no advantage over a deep structure.

Not surprisingly, solution #1 corresponds to the Principle of *helpful sequence* as outlined by Ranganathan (Ranganathan 1967, Denton 2005). When that helpful sequence cannot be discerned or is plain absent, solution #2 helps reintroduce it by tokenizing the whole list in shorter, helpful lists.

The paradox of choice can also be countered using contextualization and customization. That is what the long tail model prescribes: it's not about having fewer choices, but about showing choices at the right

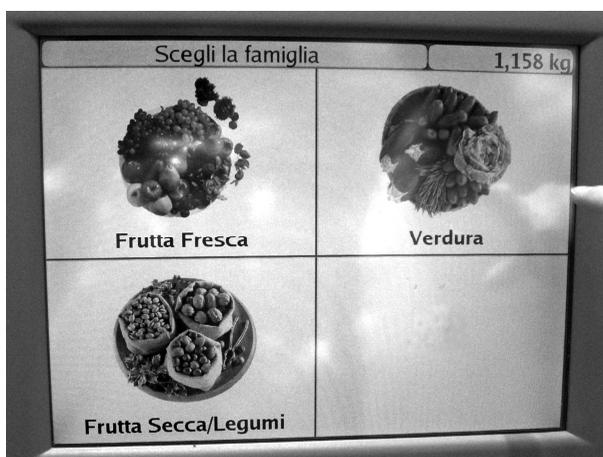


Figure 1. Reducing the paradox of choice. First categories, then items.

moment in the right way, where right means appropriate, in context. Amazon's flexible suggestions interface is once again a good example of this behaviour (who bought x also bought y, if you are interested in z maybe you could be interested also in w). This strategy successfully relies on the natural human attitude to sample and select that Marcia Bates (2002) pinpoints as the basic model of information seeking, a model that in a time-span of possibly millions of years moved from food foraging to be exapted to information foraging. We could describe this procedure as *focus and magnify* (Figure 2): first you focus a niche, an item, and then you magnify and look for similar items from there. The results are analogous to those obtained when organizing and clustering: choice is reduced using logical separations.

In physical shops, this could very well mean that items and products could be related in such ways as to allow for adjustments, re-focusing or magnifying the user's seeking behaviour, and this could be obtained by applying faceted classification techniques, and showing for each facet of an item / product the related items / products belonging to the same

facet(s). An alternative solution could very well be to use a freely faceted classification scheme, or tagging (Austin 1976, Gnoli 2005), or a traditional hierarchical-enumerative scheme with cross reference links.

4. Correlation

You read the Bible? There's a passage I got memorized. Ezekiel 25:17 [...] I been sayin' that shit for years. And if you ever heard it, it meant your ass.

(Tarantino 1994)

Quentin Tarantino's movie *Pulp Fiction* is a wonderful example of non-linear storytelling. The narrative moves in circles and the beginning and the end of the movie are tied together in a Möbius band, with chronologically contiguous events moved away from one another and then reconnected with a twist and some minimal, subtle changes. The story moves freely back and forth in time and space, and the movie can also be considered a tightly integrated se-

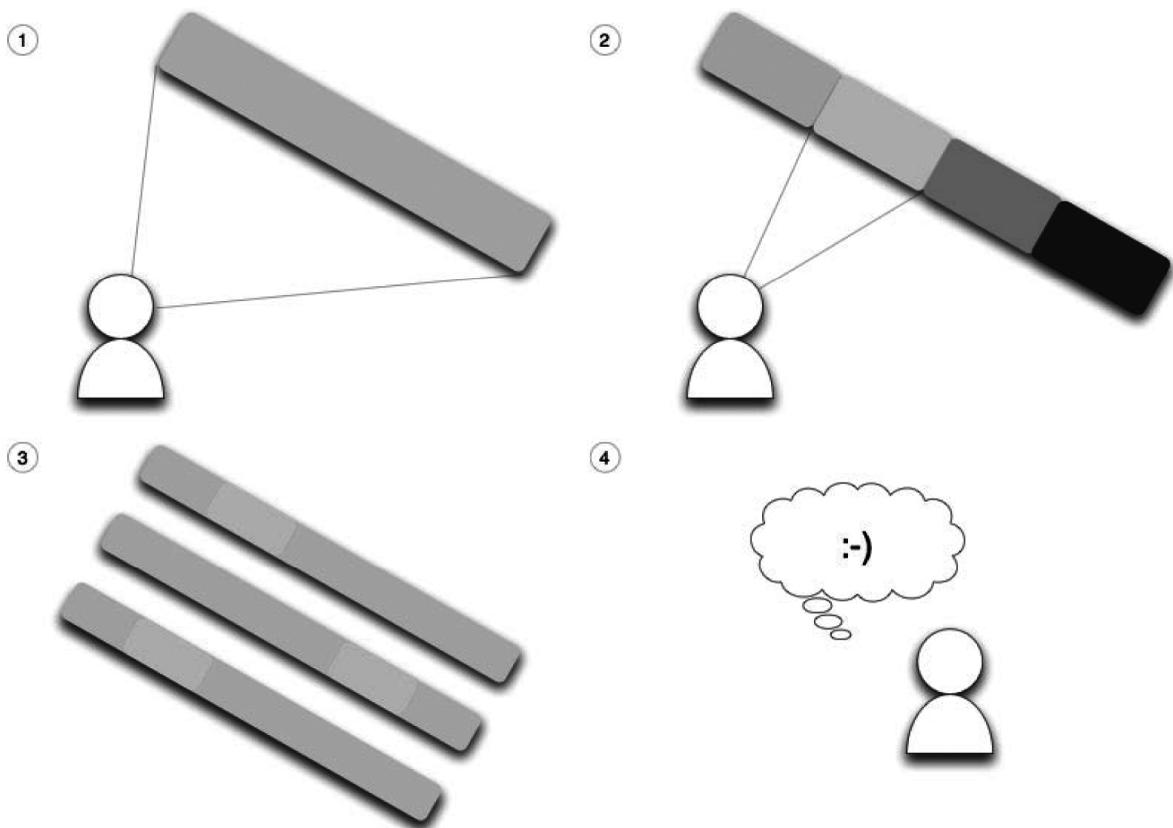


Figure 2. *Focus and magnify strategy to reduce the paradox of choice.*

ries of interconnected episodes. Citations of other movies are plenty as well. We call this model of correlations, these logic and semantic ties which link elements belonging to the same or to different physical and digital collections, *is information circularity*, something we think plays a very important role in fuelling a positive feedback loop which favours berry-picking and information scent when searching.

Usually, product layout in a shop is firmly tied to racks, shelves and aisles and is market-driven, with little attention devoted to a global vision in terms of user needs and user navigation: the very idea of way-finding (Lynch 1960) which is strategic for a successful mapping between the physical environment and our cognitive perception of it (Resmini 2007) seems to be somewhat relegated to large architectural spaces such as airports, stations, malls, and usually only for macro-navigation and for taking us from one place to another. Considering both the way we (search) and the average amount of time dedicated to shopping by both men and women in the EU (Eurostat 2006 - see §2), this seems at least ill considered. RFID, touchscreen technology, mobile phones, and PDAs are actively increasing the amount of data we (or our enhanced selves) produce, receive, process and transmit: these data could be used to improve the relational dimension of information architecture in physical spaces, allowing for re-

lated-items links among products or families of products and alternative ways of navigation which free themselves of the shelf structure such as theme paths, coupling paths (i.e. “if you bought a we suggest b and c, that you may find there”), and recommended or best selling products, to reduce the burden of choice when facing a large array of brands or variants (Figure 3).

Moreover, since users are an integral part of the HII process (Marchionini 2004, 3), the next logical step would be to apply the social, collaborative patterns of the current Web to these environments and objects (Sterling 2005), using previous data to propose alternative classification models, such as faceted classification; social classification of products (top views, other users also bought, reviews); personalization; collaborative tagging of goods to improve findability.

5. Coherence

Borges’ *Chinese Encyclopaedia* (Borges 1960) is often quoted as a good example of incoherence in a classification scheme: good classification uses one single fundamentum divisionis a time, and limits or avoids entirely using heterogeneous principles. But when dealing with large domains or complex data

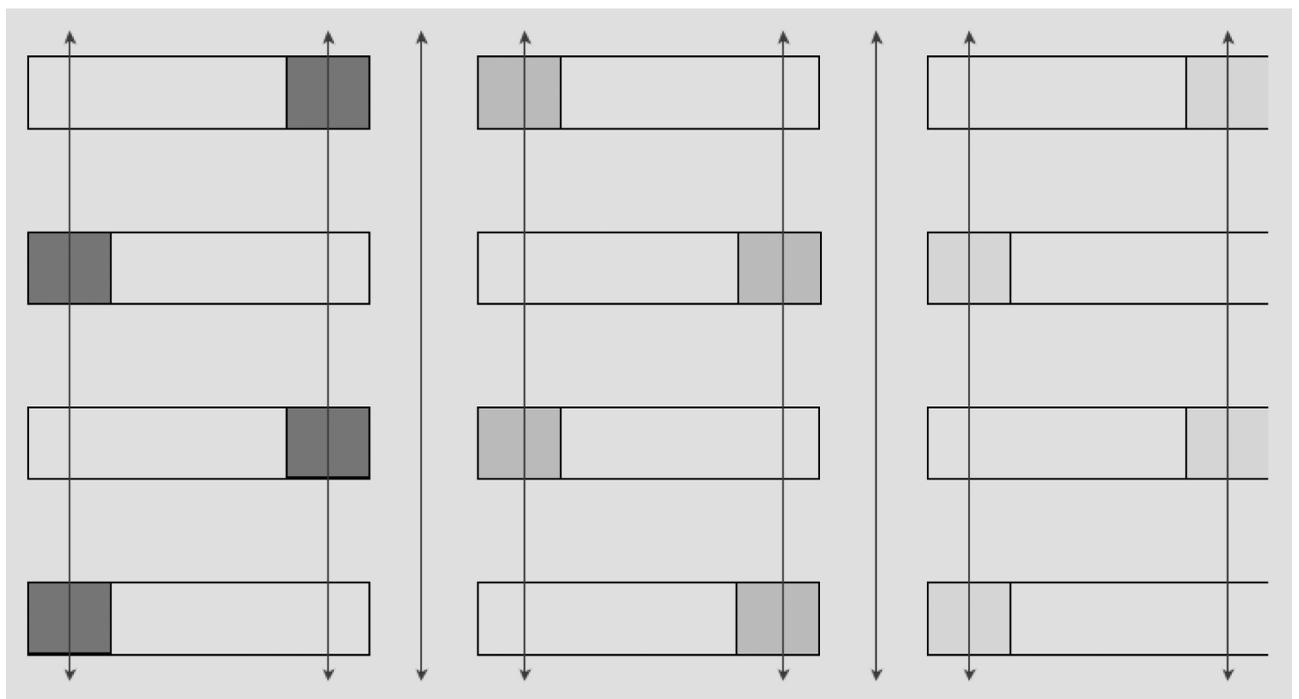


Figure 3. Product correlations create new paths, orthogonal to the aisle concept

sets, the rigorous use of one single sectioning principle is often impossible. If the primary goal of any classification scheme is to provide scientific organization for a given knowledge domain, it undoubtedly also has to address practical cataloguing issues and information management practicalities: it needs to adapt, it needs to be useful and fit for a purpose. This basic dichotomy is largely irresolvable (Gnoli 2004), mostly because every classification criterion is really just a different mental model which prioritizes certain aspects over the others, a reflection of a particular vision of the world, a culture or a way of thinking that is specific to any classifier (Bowker & Star 1999, 53-68). In this respect, similitude and distinction are the outcome of preliminary choices (Foucault, 1994), as much as we decide of the scientificity of a theory on the basis of another set of currently accepted theories (Kuhn 1962, Lakatos 1978, Feyerabend 1993) or, in Escher's woodcuts, every perceived image, fish or bird, up or down, hollow or full, is the result of a choice.

To explain the Dyirbal language and its intrinsic classification, Lakoff (1987, 92) argues that elements in categories are often correlated using analogic models such as metaphor and metonymy rather than logical Aristotelian links. Consequently, they are imbued with the language's culture and vision: Dyirbal is incoherent, or the Encyclopaedia is incoherent, only if seen on the background of our culture. When in context, they both make perfect sense. Moreover, this metaphor-metonymy model can also explain why elements in a category may or may not be representative of that class or act as prototypes.

Let's consider Bertolucci's design of a new taxonomy for Determined Production, the largest producer of Peanuts and Snoopy gadgets on the market (Bertolucci 2003). Their primary goal was that this new classification had to establish an ordered framework of products to entice employees and stimulate new ideas: in this respect then, the catalogue had a dynamic, innovative twist to it. As it turned out, Bertolucci designed an apparently incoherent classification scheme which worked well. The main categories were: Babies, Bed and Bath, Books, Christmas, Decorations, Dolls, Electronics, Fashion, Figurines, Garden, Housewares, Kitchen, Music, Office, Plush.

It's obvious that they follow different *fundamenta divisionis*: item type (book, doll), item target (children), item use (kitchen, bath, office), but this is obviously incoherence only if read out of context. If logically a plush is some kind of doll (or an item related to dolls anyway), the former is a high-selling

item in the company's catalogue, while dolls are a minor sector with potentiality for growth: the separation prevents plushes from eating up dolls and clearly shows that the latter have some niche value to them which needs to be brought out. This is clearly visible if we browse the list: main categories are also alphabetically ordered, so that important (company-wise) items come first. The term *Babies*, for example, had little use at the time but was seen as a strategic sector to be developed, and hence promoted to first-level status.

6. Towards a cross-context information architecture approach

Now, let's try to put together all of the principles we have discussed to this point. Each of them is a Lego brick by which we are building our "semantic" model of retail. So we can use "synchronicity" (§ 2) in order to harvest data by people paths and behaviours, and - in turn - to employ such data for design or redesign the classification system of a physical space. As well, we can use the strategies explored in "choice" (§ 3) to reduce the choice paradox itself in long-tail markets. "Correlation" supports a berrypicking exploration of goods and services - supporting the choose process not only upstream but even downstream. "Coherence" issues teach us to build pragmatically correct classification systems - not just theoretically right ones.

By means of these bricks it is possible to create a HII continuity between different channels, media or environments. To this extent, information architecture is the glue which holds together the digital and the physical world, the Web, information, software, and hardware and makes them a cohesive whole. Racks and shelves in a supermarket are not that different from folders in a computer disk when it comes to findability: when their number grows too much, finding and re-finding items becomes difficult. Since store layouts and product placement are not designed from a user-centered point of view, Hick's Law is once again of little or no use to customers.

In its report, the Institute for the Future (2000) illustrates a seminal way to rethink retail spaces and the role played out by their components: we think this vision can be further strengthened and improved by applying the information architecture principles and model we outlined in the previous paragraphs. We also suggest that, in a general-purpose store like our supermarket, a mixed classification scheme works best: a hierarchical scheme on the first level,

and a faceted scheme on the second level. Facets satisfy more than one cognitive model at the same time, enabling users to access elements in a collection from different points of view. Moreover, they allow for easy correlation, favouring berrypicking and information circularity. It's worth pointing out that in physical space this approach easily allows experimenting with product layouts, for example by having rack sections for Meals, Times of the day or Regional recipes. Niche or specialized retails, selling a more homogeneous range of products, might be able to use just one general faceted scheme, since a prerequisite for its applicability is that the items to be classified share similar characteristics.

We also need to graph physical space, and to do that we use guidelines originally written for web pages (Rosenfeld 2004). This effectively maps the auto-feeding, flexible, and adaptive approach derived from data collection and analysis to the physical design of what becomes a new kind of supermarket. Correspondences can be briefly sketched out:

Web page	Retail (e.g. supermarket)
Main navigation	Departments and aisles
Site map	Map of the supermarket. "You are here" marks
Alphabetic order	Alphabetic display of products with their physical location
Shortcuts	Returning users, i.e. for discounted shopping, healthy shopping, or special regimes shopping
What's new	Sales and promotions
Local or special navigation	Theme paths: pasta; Italian wines; Thai cuisine; etc.

Table 1. *Web space – retail space correspondences map*

Every space and function can then be identified by a unique combination of chromatic hints and alphanumeric codes:

- icons (possibly using geometrical shapes) for departments;
- letters for aisles;
- numbers for racks (or parts of racks), so that every product can be identified by its combination letter + number code;
- colours for shortcuts and navigational themes (using either rack, shelf, ceiling or floor signage or a combination of these);

- personal paths, only available to customers with an appropriate card or reader registering their shopping patterns.

In this new IA-informed store the general layout might move away from the common linear, sequential layout (a number of straight racks placed back to back), for example to a new radial structure, where a core, a main hall, acts as the entry and exit point and is used as a multi-purpose landmark. It is the main wayfinding hub, so it needs to be easily accessible from every entrance and from every area, to avoid users getting lost and to allow quick smooth adaptations of seeking strategies from the customers. This is *home*, and it acts as a one-stop shop which allows fast navigation towards all departments, racks and shelves, cashiers, check-out points: it accommodates all starting points for signage, that marking personalized navigation and that for theme paths, maps, interactive indexes, accessible displays, and help desks.

Discount sales and promotions should have a place in the main hall as well, so that all options are immediately visible and available. Not only this way we can simultaneously satisfy the different cognitive models and search strategies that emerge from personal information seeking behaviours, but we should be able to better favour the passive gathering of information / products (push) in accord with the Law of Least Effort (Bates 2002). Again, tracing returning customers' behaviour via technologies like RFID suggestions and related items could easily be introduced, much like what Amazon does on the Web.

Furthermore, we can figure out the following correspondences between digital and physical environments:

		Web site	Retail shop
Findability 1	General classification model	Taxonomy implemented as navigation and navigation aids	Taxonomy implemented as department, shelves and goods layout. Study of paths.
	Controlled vocabularies	Thesauri, metadata	Product index (with links, variants and synonyms), RFID- or SIM-enabled metadata
	Direct search	Search engine using vocabularies	Interactive displays, PDAs, help desks

		Web site	Retail shop
Findability 2	Shortcuts	Quick links, social navigation, personalization (history, wish list)	Colour-coded paths, integration with the web site
	Information circularity	Contextual navigation	Related products highlighted via displays, data transmission to PDAs, etc
	Navigational aids	Location markers	Colour and alphanumerical codes used to map spaces
Home	Home	Homepage	Main hall, start and finish zone, gathering zone

Table 2. A traversal information architecture model

It must be noted that in this new spaces aisles become lighter artifacts. Much like in IKEA shops, showcasing and physically acquiring products, especially for certain kinds of goods, might become two separate activities: the shelves themselves might just as easily be simple displays, with no more than a few items available for direct evaluation. Samples, whose code customers can read into a mobile device to acquire all necessary information. Later, after they have been confirmed, the real items could be checked-out from a larger warehouse area closer to the parking lots (Institute for the Future 2000).

7. Conclusions

The different scenarios of entrepreneurial life and the relationships between a commercial venue and its employees, its data, its market, and its customers are one complex system. Failing to address this complexity in its entirety, failing to see that the sum is much more than its parts and acting on single issues as if they were completely unrelated, does not work

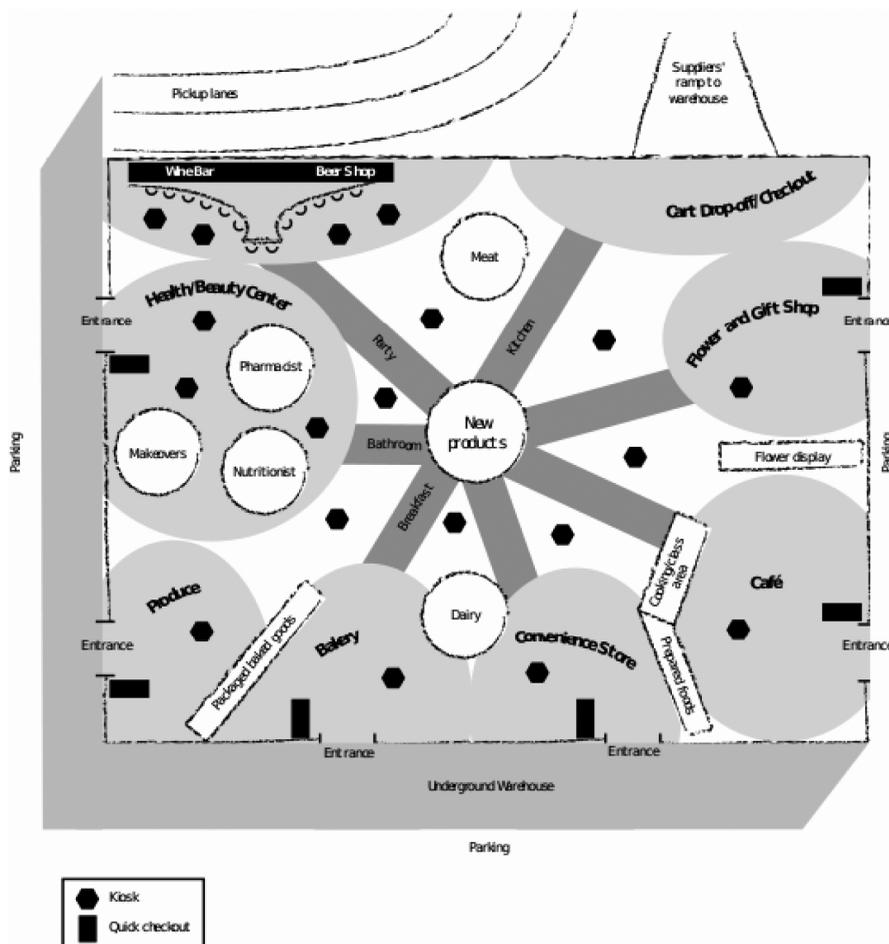


Figure 4. New retail concepts for brick-and-mortar spaces: a radial shopping point (Institute for the Future 2000).

in a synchronic world (Sterling 2005). As much as we have coordinate commercial branding and imaging, we think we should have coordinate information architecture and coordinate human-information interaction. These should inform and structure any commercial Internet and Intranet presence as well, their documents and their physical spaces as an integrated, tightly related whole which spans across environments, as this would greatly help carrying out common tasks, such as shopping, and vastly improve the general user experience.

For this, we need a traversal integrated information architecture model that moves away from industrial design, where we shape physical or digital objects, into the new territories of process design, where we shape the very processes in which objects, information, context and users talk to each other and constantly produce new meanings: this model we believe can be built on synchronicity, choice, circularity, coherence, and a novel approach which takes the Web and web-space to the physical world.

This cross-context information architecture model places design at the very heart of the cognitive shift which is reshaping user experience: it moves the focus from artifacts to processes, from interfaces to human-information interaction, from objects to users, and from a static, isolated view of products and information – Sterling’s gizmos and gizmologic society (Sterling 2005) – to a dynamic, fluid view of space-time data-rich items, *spimes*, in a synchronic society where end-users are wranglers who play, as much as the designers, an important and active role.

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