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# From Physical to Digital Environments (and Back): Seven Laws of Findability


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# From Physical to Digital Environments (and Back)

Towards a cross-context information architecture*

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## Foreword

Information architecture is not just for the Web: information architecture has a larger impact on many offline activities and affects our daily experience in many different ways. Its contribution becomes crucial where complexity, unfamiliarity and information overload stand in the way of the user.

The goal of this paper is to outline a unified model of information architecture able to orthogonally traverse the diverse 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 different, often colliding patterns (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.

We believe this evolution of information architecture is 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), information architecture can provide better and more satisfying Human Information Interaction (HII) in both worlds, online and offline.

## Coherence

## Foucault, Borges and the Chinese Encyclopaedia

Borges' Chinese Encyclopaedia (1960)[1] 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. Classifying Lego bricks as *yellow, red, hollow, wheels* would be highly incorrect: *solid (red, yellow), hollow, wheels* would be a much more sensible approach.

But when dealing with large domains or complex data 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 empirical information management practicalities: it needs to adapt, it needs to be useful and fit for a purpose. This basic dichotomy is largely irresolvable, 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 cataloguer (Bowker, Star 1999, 53-68).

On these grounds Foucault does not simply dismiss the Chinese Encyclopaedia as an incoherent work of art (Foucault 1994, xv), but rather sees through its non-Western flavours and asks himself what makes it possible, what holds it together (Kurowski 2003). When we classify consciously, when we say that a dog and a cat are more far apart than two greyhound dogs, even if they are both trained, even if they are both embalmed, where does the basis of our judgement lie? What is this coherence, if it is not pre-determined by logical chaining or some tangible content?

In Escher's woodcuts, every perspective, up or down, every perceived image, fish or bird, is the result of decisions, either individual or collective: whether that is the floor or the ceiling, what is hollow and what is filled, as a whole. 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 (Khun 1962, Lakatos 1978, Feyerabend 1993).

## Lakoff and Borges

Using the Dyirbal language and its intrinsic classification as his personal anatomical theatre[2], Lakoff argues that elements in categories are often correlated using analogic models such as metaphor and metonymy rather than logical

* Though this paper is the result of a collaborative effort, L. Rosati wrote paragraphs 1-4.2; A. Resmini paragraphs 4.3-7.

[1] "These ambiguities, redundancies and deficiencies remind us of those which doctor Franz Kuhn attributes to a certain Chinese encyclopedia entitled The Celestial Emporium of Benevolent Knowledge. In its remote pages it is written that the animals are divided into: a. belonging to the Emperor, b. embalmed, c. trained, d. pigs, e. sirens, f. fabulous, g. stray dogs, h. included in this classification, i. trembling like crazy, j. innumerable, k. drawn with a very fine camelhair brush, l. et cetera, m. just broke the vase, n. from a distance look like flies".

[2] Lakoff 1987, 92-93 "An excellent example is the classification of things in the world that occurs in traditional Dyirbal, an aboriginal language of Australia. The classification is built into the language (...). Whenever a Dyirbal speaker uses a noun in a sentence, the noun must be preceded by a variant of one of four words: bayi, balan, balam, bala. These words classify all objects in the Dyirbal universe (...). Here is a brief version of the Dyirbal classification of objects in the universe as described by R.M.W. Dixon (1982): Bayi: men, kangaroos, possums, bats, most snakes, most fishes, some birds, most insects, the moon, storms, rainbows, boomerangs, some spears, etc; Balan: women,

Aristotelian links[3]. 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 class or category may or may not be *central* to that class or act as *prototypes*. In brief:

- elements of a class do not share similar properties;
- within the same class some elements, called prototypes, are more *central* and they represent the whole set much better than others: class inclusiveness / exclusiveness mainly relies on them;
- central elements are related to peripheral members by chaining and analogic mechanisms, such as similitude, metaphor, metonymy;
- there is or there might be a class *other*, which comprises whatever elements do not belong to any other class. Such residual class possesses no prototypes nor it uses chaining.

## Borges and Information Architecture

If more than one classification scheme exists for a given set, how do we choose one over the other? How do we evaluate the internal coherence of a given classification scheme? The answer is that a classification scheme cannot be evaluated abstractly, *a priori*. As miscellaneous categories (*other*) do exist in our minds, even if their use in a navigation system may be problematic, choice and coherence need to be assessed in respect to an empirical paradigm: context, goals, users, the cultural climate from which the classification stems and within which it thrives. Hence, there is no absolute right or wrong, but only fitness for an appointed goal.

Identifying and using prototypes is then of the utmost importance. Whatever the scheme, it's very possible that there will be no ordered, clean border among categories, but they will certainly exist between central elements, *prototypes*: by using these to represent categories, a classification scheme can help users understand the model and choose better.

Moreover, prototype theory suggests that the traditional top-down and bottom-up model could be further integrated in an *up-and-down* model where the classification process starts in the middle, from the basic-level categories, grouping them in super-categories and splitting them in subordinate, more specific classes: as prototypicity works within a hierarchy also, middle-classes are usually more representative of the whole tree (Maurer, 2006). Conversely then, it is probably useful that any navigation aids move users to basic-level categories as soon as possible[4].

## Case Study: Classifying Snoopy

Bertolucci (2003) details her experience of building a new taxonomy for Determined Production, the largest producer of Peanuts and Snoopy gadgets on the market. 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 swell. 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 *fondamenta divisionis*: item type (*book, doll*), item target (*children*), item use (*kitchen, bath, office*), but this is incoherence only if read out of context. If logically a plush is some kind of doll (or related to dolls), 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 these latter have some niche value to them which needs to be brought out. Main categories are also alphabetically ordered along the principle of most convenience, so that important (company-wise) items come first. *Babies*, for example, had little use at the time but was seen as a strategic sector to be developed.

### Flexibility

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. But even a single individual might modify her patterns according to context, time, and goals. To work effectively, then, a classification system has to be able to adapt to this 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).

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anything connected with water or fire, bandicoots, dogs, platypus, echidna, some snakes, some fishes, most birds, fireflies, scorpions, crickets, the stars, shields, some spears, some trees, etc; Balam: all edible fruit and the plants that bear them, tubers, ferns, honey, cigarettes, wine, cake; Bala: parts of the body, meat, bees, wind, yamsticks, some spears, most trees, grass, mud, stones, noises, language, etc”. See also Maurer (2006).

[3] According to Aristotelian theory, a category or class is an abstract container: every object in a set is either in or out. Belonging to a certain class is entirely dependent on having or not having certain properties, which should be shared by all members and identify the class. This theory implies clean borders, independency from the cataloguer, and equipotency among members.

[4] It is entirely probable that popular tags in folksonomies identify basic-level categories.

## Case Study: Flexible Retail

A synchronic society can synchronize many stories through space and time (Sterling 2005). Preserving our interaction history with items and environments, for example using RFID – Radio Frequency Identification, would allow for a totally new brick-and-mortar retail model capable of helping customers with:

- re-finding and retracing past tasks and past paths (shopping tasks, for example);
- path and task personalization;
- time optimization;
- *ad hoc* shopping suggestions and custom correlations among products.

We then use guidelines originally written for web pages (Rosenfeld 2004) to effectively map this auto-feeding, flexible, and adaptive approach to the physical design of a new kind of supermarket. Correspondences can be briefly sketched out:

Table 1. Web page – retail space correspondences map

| 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<br>– discounted shopping<br>– healthy shopping<br>– special regimes shopping |
| What's new | Sales and promotions |
| Local or special navigation | Theme paths: pasta; Italian wines; Thai cuisine; etc. |

Every space and function is identified with a unique chromatic, alphanumeric code:

- 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.

Sales, promotions, and themed navigation should have a place in the main hall, so that all options are immediately visible and available and we can simultaneously satisfy the different cognitive models and search strategies that emerge from personal information seeking behaviours. Furthermore, we should be able to better favour the passive gathering of information / products (*push*) in accord with the Law of Least Effort (Bates 2002).

As we will see in #5, using customers' behaviour and RFID we could easily add suggestions and related items to the picture, much like Amazon does on the Web.

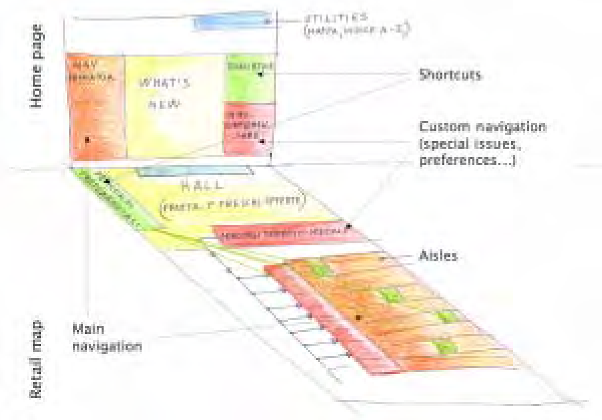


Figure 1. Applying digital space patterns to physical environments

## Choice

## The Long Tail and the Paradox of Choice

Current markets are moving towards the 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.

## Hick's Law

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 need to resort to Hick's Law (Raskin 2000, 93; *Hick's Law* 2007). Hick's Law, by providing the mathematical model which explains the paradox of choice, suggests some countermeasures as well.

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: Time = $a + b \log_2 (n + 1)$.

$a$ e $b$ depend on context conditions, such as presentation and the user's degree of familiarity with the subject: if choices are poorly presented, both $a$ and $b$ increase, while familiarity only decreases $b$.

What's worth noting is that the correlation between reaction time and possible choices is expressed logarithmically, that is, non-linearly. 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 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. 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.

## Organize and cluster

The average electronic do-it-yourself scale in your average supermarket offers a rather useful example of paradox of choice. In the vast majority of cases, it comes fitted with roughly 30-60 buttons, ordered numerically. Every number corresponds to a product, and this number is also usually printed on the tags and labels on the racks. 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 not fixed: it obviously varies seasonally or with product availability, and it is strictly supermarket-dependant. Memorizing codes for common products provides little help then.

Figure 2. Reducing the paradox of choice: first-level menu (categories), second-level menu (elements)

To solve this issue, some supermarkets adopt solutions that improve performance: 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, since 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 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, the *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 norms, 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.

## Contextualize and Customize

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 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*: 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.

### Correlation

## Information Circularity: Pulp Fiction

> *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, Pulp Fiction).* [5]

*Pulp fiction* is a wonderful example of non-linear storytelling. The storyline 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 other and then reconnected with a twist and some subtle changes. The narrative moves freely back and forth in time and space and the movie ends up looking like a tightly integrated series of different episodes which continuously reference one another and other movies. These correlations, these logic and semantic ties which link elements belonging to the same collection or elements belonging to different physical or digital collections, these constitute what we call information circularity, something we think plays a very important role in fuelling a positive feedback loop which favours berrypicking and information scent when searching.

## Shop Circularity, or To the Shelves and Beyond

Usually, product layout in a shop is firmly tied to racks, shelves and aisles and market-driven, with little attention devoted to a global vision in terms of user needs and user navigation: the very idea of wayfinding (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.

Meanwhile, RFID, touchscreen technology, mobile phones, PDAs, are actively increasing the amount of data our enhanced selves constantly produce, receive, process and transmit. These data could be used to improve the relational dimension of information architecture in physical spaces, allowing related-items links among products or families of products and alternative ways of navigation which free themselves of the shelf such as:

- theme paths (#3);
- coupling paths (i.e. “if you bought *a* we suggest *b* and *c*, that you may find there”);
- recommended or best selling products, to reduce the burden of choice when facing a large array of brands / variants.

And 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 Web to these environments and objects (Sterling 2005), using:

- alternative classification models, such as faceted classification;
- social classification (top views, other users also bought, reviews);
- personalization based on navigation;
- collaborative tagging.

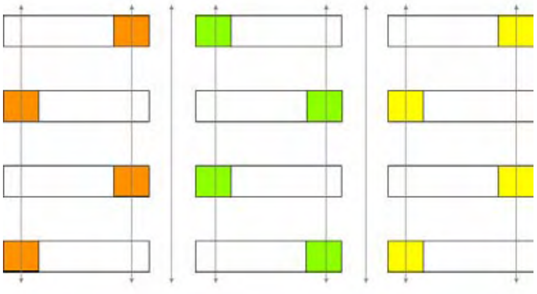

Figure 3. Product correlations create new paths, orthogonal to the aisle concept

5 Jules, played by Samuel L. Jackson, speaking to Pumpkin in the final scene of the movie.

## Bringing it all Back Home: Towards a Cross-context Information Architecture Approach

By means of a unified information architecture model it is possible to create an 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.

# Retail Design

If we move back to the retail space we discussed in #3, we can figure out the following correspondences between digital and physical environments:

Table 2. A traversal information architecture model

| | | *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 |
| *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 |

# Integrating Faceted and Hierarchical Classification

In a general-purpose store (like our supermarket), we suggest that a mixed classification scheme works best: a hierarchical scheme on the first level, and a faceted scheme on the second level. Niche or specialized retails, selling a more homogeneous range of products, might be able to just use a faceted scheme, since a pre-requisite for its applicability is that the items to be classified share similar characteristics.[6]

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.*

# Home: a Retail Space Built for Customers

Racks and shelves in a supermarket are not that different from folders in a computer disk: whey 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.

The Institute for the Future in its report *The Future of Retail: Revitalizing Bricks-and-Mortar Stores* (2000) shows a way to rethink retail spaces and the role played out by their components, which we think can be further strengthened by applying the information architecture principles we outlined.

In this new IA-informed store the general layout might move away from the common linear, sequential structure (a number of racks back to back) to a *radial structure*, with a main hall at its core that acts as the entry and exit point and is used as a multi-purpose landmark. This *home* acts as a *one-stop shop*, and allows fast navigation towards all departments, racks and shelves, cashiers, check-out points: it accommodate all signage marking personalized navigation and theme paths, maps, interactive indexes, accessible displays, help desks. 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 one's seeking behaviour.

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[6] To apply facets to physical products it is necessary to use faceted classification theory in its original librarian formulation, i.e. comprehensive of specific notation and citation order (Vickery 1960).

In this new spaces aisles become lighter artifacts. Much like in IKEA shops, showcasing and physically acquiring products become two separate activities. The shelves themselves are just for showcasing and data feeds, with no more than a few items to evaluate and whose code customers can *read* into a mobile device to acquire all necessary information. Later, if confirmed, they can be checked-out from a larger warehouse area closer to the parking lots.

Figure 4. New retail concept for brick-and-mortar spaces: a radial shopping point

## Conclusions

The different scenarios of enterprise life and the relationships between a company and its employees, its data, and its market 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 in a synchronic world. As much as we have coordinate corporate branding and imaging, we think we should have coordinate information architecture, or coordinate human-information interaction, to inform and structure the company Internet and Intranet presence, its documents and its physical spaces as an integrated, tightly related whole which spans across environments.

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: we have to design for a cognitive shift which effectively reshapes user experience and moves from artifacts to processes; from interfaces to human-information interaction; from objects to users; from a static, isolated view of products and information – Sterling's *gizmos* and *gizmologic society* (2005) – to a dynamic, fluid view of space-time data-rich items *(spimes)* in a synchronic society; from end-users to wranglers, who play, as much as the designers, an important active role in the building of objects / information and have with them a continuous change-inducing interchange; from today to tomorrow.

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