Front Matter at the end
(please see bookmarks)

This file contains an article with the revised text of a paper presented
at the Politecnico of Milan on November 16, 2021

It also contains the editorial by Danila Iacovelli,
who describes briefly the round table within which the paper was presented

It further contains an article by Paolo Paolini
with the revised text of the paper he presented at the same round table,
in which he discusses the central argument of my paper

TRANSFORMATIVE TRANSITIONS: LEARNING FROM A DISTANT PAST

GIORGIO BUCCELLATI (*)

1. A historical perspective on epistemological channels[1]

Digitality affects our way of knowing at a much deeper level than generally recognized. Hence the transition we are witnessing is not towards a revised dimension of established modes of relating to reality, but towards a radical transformation of the same. This is on a scale that can only be properly compared only to two other transformative transitions in the development of humankind, from its earliest origins: the introduction of language and the introduction of writing. Looking even briefly at these two moments, however far back in the past they may be, will provide a fundamental insight into our present condition. We will do so by first considering the background against which these transitions have to be understood.

1.1 Para-perception

From its inception, some two million years ago, a fundamental trait of humankind has been to gain distance from nature by fragmenting it and recomposing it into new wholes. In their utter simplicity, even the earliest tools made by homo erectus show a repetitive control in the application of a coherent sequentiality which underlies their production. What is more, they show a complementarity of models that govern the application of these models: they are

(*) Founding Director and Research Professor, The Cotsen Institute of Archaeology, UCLA; Professor Emeritus, Departments of History and Near Eastern Languages and Cultures, UCLA; Director, IIMAS – The International Institute for Mesopotamian Area Studies.

[1] All references will be found in my website d-discourse.net, where I also provide a more extensive presentation of the topic.

like templates that can be changed, and this is the spring that triggers experimentation leading in turn to continuous progress – in contrast with the animal world. We may explain all of this by assuming that there was, next to the perception of the data, a parallel perception, or para-perception, of these models or templates: experimentation could take place because para-perception made it possible to modify the templates and then to apply them to the raw material at hand.

The production process rests on the control of the fragmented sequentiality that organizes the steps to be followed. On the other hand, it can be assumed that the tool as a finished product was also perceived in its wholeness by the users, and appreciated as such, not only for its functionality, but also for its aesthetic qualities. We have no evidence for this: it could come, for instance, in the form of items which do not lend themselves to being used as tools but show the application of the same technique. Such evidence comes with the first major transformation in the ways and means to relate to nature: the introduction of language and logical thought.

1.2 Language and logical thought

How and when language started is a debated question: I adhere to the point of view that sees it as a sudden change and places its beginnings relatively late in time, between 100,000 and 60,000 years ago. For our purposes this is not the major issue. What rather matters is the recognition that language ought to be seen not simply as phonation, but as the application of a syntax that organizes sound, something which goes intrinsically along with categorization and analysis, i. e., with logical thought. It is in this regard that language marks a radical change in the relationship to nature: items acquire an identity of their own through the concepts and words used to represent them, and they can be kept in mind very explicitly even with the absence of the item in question. This aspect of referentiality is the factor that triggers the fundamental change: a speaker could refer to anything that was not within sight in such a way that the hearer could understand perfectly what was intended. Even more importantly, connections could be made among items that were not contiguous in space or time: the waxing and waning of the moon, for example, gave a clear indication of time sequentiality, and the various phases could be seen as distinct conceptual categories and named accordingly (as evidenced by some markings on stone and bone that have been so interpreted).

What this entailed, then, was a much higher level of fragmentation of reality. Concepts and words could give new life to phenomena and reorganize them in sequences that were not available in nature (such as the many shapes of the moon, which could never be perceived together visually, but could now be distinguished logically and verbally). But "soon" after these beginnings (i. e., after a few tens of thousand of years) we have evidence that the attention became focused again on the wholeness that stood behind the fragmentation. Paleolithic cave art gives the clearest indication of an aesthetic appreciation for animals seen in the wild and represented with a stunning sensitivity for the overall impact of the single image. And where multiple images are represented, they, too, cohere in a single compositional whole. There is a clear aesthetic appreciation of the beauty of these animals, one that still speaks to us today with an immediacy all its own.

1.3 Writing

Cave art gives us a graphic representation of nature, but its intrinsic realism reduces the degree of referentiality: it does not require any interpretive mediation as it happens with abstract codes which are "ciphered", and must accordingly be "deciphered". Such ciphered or coded referentiality appears with writing: reference to an animal is made not through a naturalistic drawing, but through a sign that stands for the animal in question. More importantly, actions and abstract concepts can also be so coded and referenced to. This raises the referential frame to a radically higher level: the element that triggers the referential sphere (cuneiform signs on a clay tablet, in the case of Mesopotamia) exists independently of the face to face contact between speaker and hearer, it has a consistency that matches precisely and autonomously the consistency of what is referred to. The process of analysis (fragmentation) is thereby enhanced immeasurably: things and abstract concepts can be inspected physically on the small surface of a tablet, even when one deals with "big data". For example, 60,000 animals belonging to a given royal administration could never be seen physically together, but they can be seen as a few corresponding signs are incised on a clay surface.

This example also shows us how ~~the~~ much wider the distance from the real could grow. The aggregate of such a large number of elements existed only in the written texts of the royal administration, it could not be seen in reality, nor could the processes that the text records in just a few lines of writing (e. g., the number of animals that died within a given period of time). The aggregate becomes the whole, a fictitious whole since it exists only on the tablet.

2. Hammurapi's "verdicts of justice"

2.1 A formal analysis of the text

We may look more closely at an ancient texts that is the best known and the most emblematic for the history of law – the "Code of Hammurapi". It is not properly a code of *laws*, but rather a collection of judicial *verdicts* that the king adopted as his own, thus making them in some way mandatory for the legal practice. There are two points that are of interest in the present context.

The first regards the form. It is a very long text, but it consists essentially of two extremely long nominal sentences.

- ***1a*** When the gods called me, ...
  Hammurapi, the king who built... conquered, etc...
- ***1b*** on that day:
  "If a man accuses another..."
  (282 decrees) ...:
- ***1c*** (these are) the verdicts of justice which Hammurapi decreed, ...
- ***2*** I am Hammurapi, the noble king ...

The first sentence starts with a temporal clause (***1a***) that introduces the king; it is resumed (***1b***) by a second temporal clause that in turn introduces a series of two hundred and eighty-two cases each with its own verdict; and it is concluded (***1c***) with the nominal predicate that defines both the verdicts and the king. An even more abbreviated scheme may be represented as follows: "When ..., on that day, XXX are the verdicts of justice...."

The structure emphasizes the rhetorical unity of the text: it brings together with a powerful stylistic trait what would otherwise remain an aggregate of fragments linked only by the fact of being assembled together in one single place as if a container. The text appears therefore as a cohesive linear sequence that gives formal unity to the verdicts, seen as a coherent block – as a "code".

2.2 The fragments and the whole

This "code" is more than a container not only on account of its formal traits, but also because of an underlying deep principle that concerns the substance. The words that open the epilog (section ***1c*** in the scheme given above) are *dīnāt mīšarim* "verdicts of justice" – which may be considered as the ancient title of the text. The emphasis on "justice" is pregnant with meaning. Justice (literally "directness", as in the Italian word "diritto", and more than the English "right" or "righteousness") is the principle by which the verdicts are inspired, and as such it gives coherence to the entire system. If the verdicts are the fragments, justice affirms the whole. The *verdicts* address specific cases and give the judicial resolution for each of the problems the cases entail. But these fragments are integrated in a way that transcends the particularity of any individual case, depending precisely on the notion of *justice* that gives the verdict their ultimate meaning.

The political persona which Hammurapi paints for himself accords with this: he proclaims to be the "capable king" who "has set the country on a safe path and a good direction". There is a clear consonance between the decisions taken to adjudicate concrete problems, the fragments, and the spirit of justice with which this has to be done, the whole. We can best appreciate this against the historical background out of which this document arises. With the growth of human settlements from small enclaves to large cities, conflicts that arose among individuals could no longer be settled on an ad hoc basis. The record of specific cases was building up and could now be recorded in writing. Individual judges would issue individual verdicts, based not on any set of laws but on a common sense understanding of what "justice" was. Hammurapi sees as one of his duties and prerogatives the need to unify this body of adjudications into a single corpus. This starts as an aggregate, but it is much more. It is a grandiose and organic whole, held together by the awareness of the central role of justice in defining human relationships. It is this that turns this collection of verdicts into something that is more than the sum of its parts. It is indeed a "code", even though the formal configuration of its content is not that of laws. The verdicts relate to individual cases but they are integrated into what turns out to be, in effect, a hymn to justice.

2.3 Relevance for today

We can see our current "transition to the digital" in the perspective of the "verdicts of justice". The code is a signpost for us today not in terms of the verdicts in their specificity

(the "fragments") but in terms of the insistence on the guiding principle, justice. On the other hand, this principle is not presented in the abstract, through theoretical statements, but rather as embodied in the concrete cases where this principle takes form. Had it come down to us as just a collection of discrete adjudications, it would have served an important function for philological analysis, but it would not have emerged as a standard point of reference.

What turns it into a "code", and makes it so significant for us at a level that goes well beyond philology, is the substantive import of what "justice" means – something that is more than an organizing principle of *disjecta membra*, and is rather the fundamental presupposition that holds together these fragments into a solid whole. Along these lines, the title of the journal that is hosting us, *Diritto politecnico*, may be seen to be particularly meaningful. *Diritto* is *mīšarum*, the foundation which holds together the whole legal construction. And *politecnico* may be seen as referring to the many technical components, i. e., the fragments, just as with the *dīnātum*, Hammurapi's "verdicts".

3. Beyond the fragments

3.1 The transition to digitality

In each of the cases mentioned in section 1, the transition was characterized by a considerable time lag between (1) the process of fragmentation of reality with the consequent re-aggregation into a functioning assemblage, and, on the other hand, (2) a perception of the whole that builds on these fragments as its constitutive fragments, but with an identity all its own, other than the sum of its parts. We are today, in our transition to digitality, at just the same juncture. Except that the time lag is incomparably shorter, given our awareness of the problem.

Fragmentation and quantification are deeply ingrained in our lives. We feel hot or cold depending on the degrees we are told the outside temperature has reached; our anxiety grows in the measure in which reports reach us of the number of deaths resulting from a new variant in a pandemic; and so on. Digitality is at the root: measuring is possible to a very minute degree, and we have become sensitive to even the slightest variation on the digital scale. The electronic medium has become the best embodiment of this mindset. Just as when language, and then writing, first came on the scene, so now, too, we are captured by the sense of distance and

control that fragmentation offers. And just as in those cases, we must look towards ways of reconquering the sense of immediacy and openness that may allow us to see the whole beyond the fragments: this can only happen by relying on as yet untapped resources of the digital medium.

As in the past, the transformation must happen not by avoiding the confrontation, but by discovering how the new mindset offered by digitality can be harnessed to enhance our sensitivity for the whole beyond the fragments. It is not a matter of bypassing, but rather of implementing. I will here illustrate briefly (in section 4) some of the salient points of the concrete approach I am suggesting, with regard specifically to the notion of a website. First, however, it is useful to point out (3.2) some of the misgivings that have been voiced about the internet in general, and then (3.3) to indicate the broad principles that may guide us today in order to redress the situation.

3.2 The impact of fragmentation

The universal reach of digitality as we experience it through the Internet rests ultimately on its power to dissect reality into uncounted bits and to offer ways of picking on the fly any fragment that suits our momentary interest. Two major mechanisms are available for connecting these fragments: the search function and the hyperlink. These mechanisms are meant to serve in the unfolding of an argument, but the construction of this argument is left entirely to the users: they have an argument in mind and as they construe it, they pursue a certain lead they have in mind either actively (search) or passively (hyperlink). There quickly ensues a very substantial problem, and that is that passivity takes over: the quantity and variety of the fragments is so alluring that one tends all to easily to loose one's grip on the initial argument, if any. Some of the terms that have come into common use give a subtle indication of the nature of this process, for instance "surfing" refers to skimming on the surface, "browsing" to nibbling at random. Therein lies the trap-like effect of a digital world that gives fragmentation exclusive pride of place.

A considerable literature has built up to show the broad impact that this has had and is having. From the early warnings by Dreyfus and Birkerts to the more recent work by Carr and Wolf, the case has been made that our cognitive capacities, in particular those of children, are being deeply affected. This becomes apparent with the loss of interest in any kind of "deep" reading (which is never the object of "surfing" and "browsing"). In fact, we may say that we

are losing any interest in simply "reading": we "use" a website, meaning precisely that we do not follow the linear path of a reasoned argument. Upstream of that, we do not "write" a website, but we "construct" it, meaning that we assemble pieces without aiming to develop a coherent argument that embraces the entire subject matter. What is emerging is also the evidence that there are neuronal changes that are concomitant with these new habits, so that changes in cognition are closely tied to physical changes in our brain, especially for children.

The point I wish to make here is that the impact is just as great with regard to the scholarly dimension. We do not "write" websites the way we write books or articles. There is no properly digital argument that is presented and pursued in a reasoned fashion. Darwin's notion of a "long argument" is wholly absent from scholarly websites, which aim exclusively to provide information. Where an argument is presented, it is in the form of a PDF that is couched essentially in an analog format, and stands next to the data to which it provides occasional links, without being integrated digitally with them. There is, in other words, no properly "digital" argument that is presented.

3.3 The new whole: digital discourse

The task is then to conceive a new whole that is fully integrated with the fragments by exploiting fully the potentiality of the digital medium. To this end I propose the notion of "digital discourse". The notion is very different from the one in current usage (e. g. in the book by Thurlow and Mroczek). This current understanding I will label as *e-discourse*, for electronic discourse, and I will use *d-discourse* for the understanding I am proposing (the terminology mimics the Chomskian terms e-language vs. i-language).

What I call e-discourse refers to a human discourse applied to data that are available in electronic format. The qualification given to it as "digital" refers only very indirectly to digitality: what is digital is the way in which data are originally mapped and presented; the discourse, on the other hand, is not digital. What is envisaged are, for example, the style of text messages or of blogs: what form does our communication take when channeled through these electronic media? Our expressive channels (contracted syntax, acronyms, etc) are affected by the medium, in a way similar to what wireless telegraphy did about a century ago.

A d-discourse, on the other hand, is a discourse that is itself structured digitally. Multiple, parallel layers are conceived and written concomitantly, and they interact, or "discourse", with each other. The argument itself emerges as intrinsically multi-linear, in the

sense that it unfolds along these parallel planes, drawing on all of them at the same time; in other words, the argument, while remaining essentially linear, travels along the different planes that are intrinsically interlaced.

A d-discourse is best formalized in the shape of a website, which must be both produced ("written") and used ("read") with such an awareness for such a co-presence of the different and co-varying lines of argument. It is with this in mind that I have produced websites relating to ancient Mesopotamia, and to these we can now turn briefly our attention.

4. Implementation

4.1 Websites as test cases

I have sought to implement this notion of digital discourse since the early stages of the digital era, in the 70es, when computers first came into common use, and from the beginning it was in the double direction of textual analysis and of the archaeological record.

It was especially the latter, archaeology dealing with the physical contact association of things in the matrix of the ground, that had a deep impact on my approach. We may say that archaeology understood as the record of emplacement is natively digital: there are myriads of bits of information that are found in a state of casual aggregation resulting from the long term process of deposition in the ground. They have to be recorded in this state of aggregation and then recomposed in multiple frameworks of meaning (e. g., chronology, typology, function, etc.). What ensued was the creation of a proper *grammar* that established not only the morphological categories where each bit would logically fit, but also the syntactical relationships that defined the constraints within which these same bits could relate to each other. What emerged was a segmented narrative that provided a truly objective record of the fragments and, at the same time, an argument that brought out the connection among these fragments. It was especially in this connection that I could see first hand the power and usefulness of programming as the mechanism that could organize data, once identified grammatically, into new wholes.

In a parallel vein, I sought to develop a new approach to the bibliography. An annotated bibliography as generally understood organizes titles according to given categories,

but does not normally integrate it within a discursive argument that relates to the annotations. This is instead the goal of a cluster of websites dealing with various aspects of Mesopotamian civilization. The goal here is to harmonize the individual titles within a wider *hermeneutic* framework, one that develops parallel narratives presenting a core topic and parallel themes, each of these interlaced with the other, so as to produce a broad interpretive whole that integrates the individual titles qua fragments.

These websites are now integrated into a unified system, available at mesop.org. Here, I will describe briefly the multi-linear model that informs these websites, in contrast with the two other models that are currently in use, the analog and the anecdotal model.

4.2 The analog and anecdotal models

The *analog model* is the one that dates back, in its essence, to the beginning of writing, but has been formalized only in the last couple of centuries, especially through the mechanism of the footnotes (Grafton). At the root, there is the notion that something said in the primary text contains a reference to another text. This reference may be generic (such as simply giving the name of an author) or specific (giving the details of publication). This may be rendered graphically as follows:

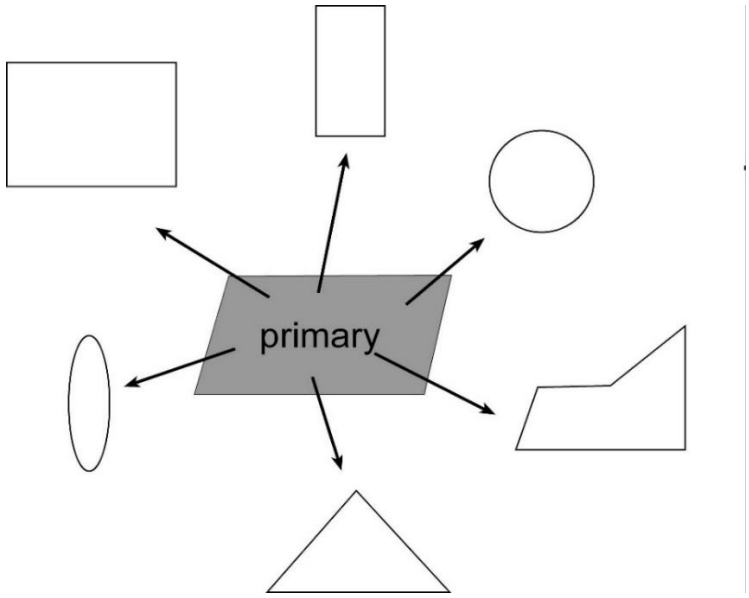
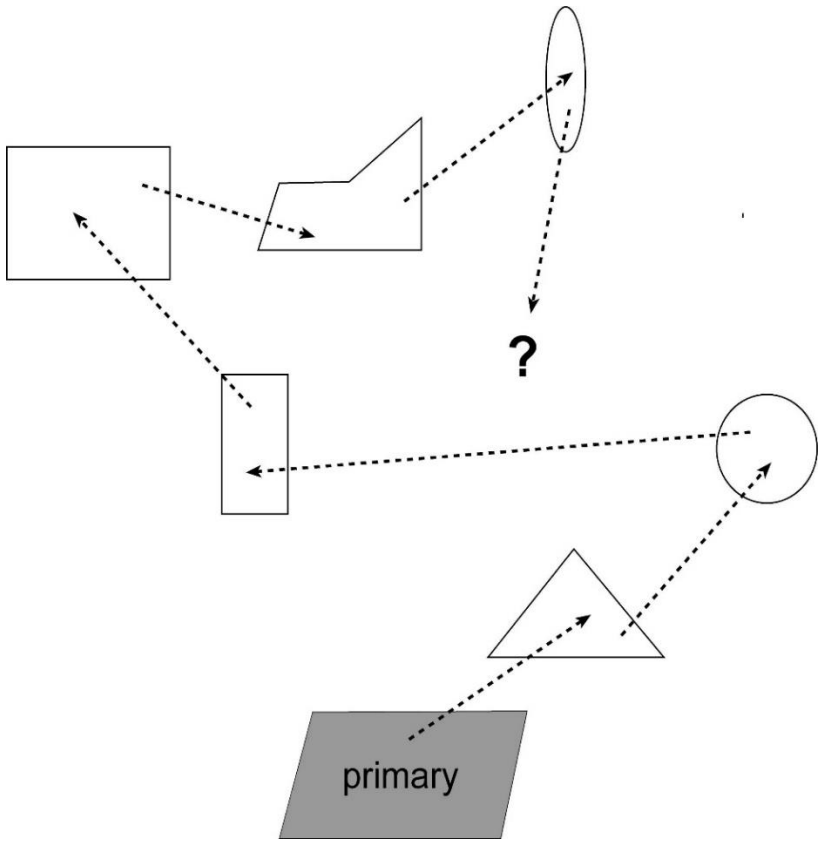


Fig. 1 The analog model

The primary text is shaded in gray. The other texts are shown as geometric figures of different shapes to highlight the fact that the texts were not written in function of each other, but as wholly different and autonomous compositions. The arrows indicate that the reference points to the pertinent item, but does not actually reach it: concretely, this means that one has to physically get hold of the book or article, on one's shelf or in the library, and go the page indicated when this is given, or else find the passage that the author of the primary text had in mind.

The *anecdotal model* is the one in current use with websites. The ample use of hyperlinks establishes live connections within a single website or from one to other websites, and may be rendered graphically as follows:

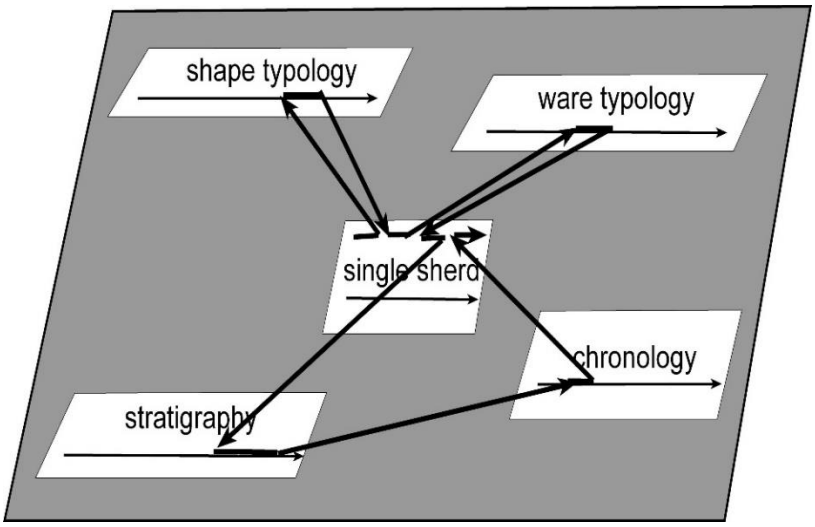


Here again the primary text is shaded in gray, and the other texts with difference geometric shapes to indicate that they were not generated in function of each other. However, they are all in digital format and are therefore concurrently available through the same electronic medium – assuming, that is, that there are no broken links. The links are shown here as entering the target to indicate that the link actually reaches it and the target reference is thus

immediately accessible. On the other hand, the arrows are dotted to indicate that, while the author of the primary text had in mind the target when creating the hyperlink, the linkage was not originally intended by the author of the target text. As one jumps from one text to another one easily loses sight of the original argument, as indicated by the question mark at the end of the trajectory.

4.3 The multi-planar model

The multi-planar[2] model is the one I propose. The components of a single website, or multiple related websites, are conceived together as a system (here shaded in gray), and are written with a full degree of reciprocal interlacing in mind. It may be represented graphically as follows:



The model is multi-planar in the sense that it integrates multiple planes in a single coherent argument. This single argument is indicated in the graph by the heavy line that follows a single direction across multiple planes: the narrative about single sherd, for example, presupposes a segment from shape and ware typology, and then from chronology and stratigraphy. The system as such is multi-linear in the sense that each plane has its own linear argument (indicated by the light arrow within each component plane). It should be noted that

[2] I owe the term to the insight of Paolo Paolini, who commented on an early oral version of this paper, and for which I am most grateful.

all linear arguments presuppose each other, in other words, the primary argument in the center (here the single sherd) could be in turn the shape typology, the ware typology, and so on.

5. Transformative transitions

The multi-planar model helps us understand why the transition to a digitally oriented world is on the level of the earlier epochal transformations. The distance from the natural sequences has increased exponentially, because what is now embedded in an extra-somatic dimension is a complex of arguments that are systemically interlaced. We are in a transitional period because we are still learning to control this new systemic complex, both in terms of constructing it in the first place and then to fully use it. "Writing" (constructing) and "reading" (using) are bound to acquire a wholly new meaning. What is different is not really the quantity of data over which we can now claim control, but rather the radically new sense of wholeness into which these data are now absorbed and metabolized. Here lies the real challenge of the transition to digital: not in defining the fragmentation, but in absorbing the fullness.

It is a new "form" of humanism. What will truly trans-form our way of knowing reality, our epistemology, is not the technology extrinsic to our human dimension, but our ability to perceive the whole through an immensely greater universe of fragments, and to effectively relate to it. We may use high resolution as a metaphor. The greater the number of pixels in a digital picture, the higher is our fruition of the whole which they constitute. What we enjoy is the fullness of the resulting picture, not the numeric quantity of its constitutive fragments. The notion of a multi-planar argument as embodied in a website of the type I have illustrated is a test case of what this means and how it can be realized. But it is only a test case. What really matters is keeping our awareness alert for the wholeness.

EDITORIALE

DANILA IACOVELLI (*)

La trasformazione digitale è una delle sfide più significative del momento. La tecnologia è una parte integrante, a volte coessenziale, del nostro vivere e del nostro lavoro.

La transizione verso i servizi digitali implica un processo di adattamento in tempi brevi da parte di tutti i soggetti dell'ordinamento, dalle piccole e medie imprese, che si muovono in un mercato in rapida evoluzione, alle pubbliche amministrazioni, alle istituzioni e agli enti, ai cittadini, chiamati a una partecipazione consapevole e attiva.

La pandemia del Covid-19 ha colpito duramente l'economia italiana. Nel 2020, il prodotto interno lordo si è ridotto dell'8,9 per cento, a fronte di un calo nell'Unione Europea del 6,2; l'Italia ha imposto per prima un *lockdown* generalizzato e ha subito la maggior perdita di vite nell'UE, secondo i dati riportati nel Piano nazionale di ripresa e resilienza ("PNRR" #nextgenerationitalia, in governo.it).

Non a caso, la prima missione del PNRR si concentra sulla "rivoluzione digitale" e sull'innovazione per la modernizzazione delle infrastrutture di comunicazione del paese, nella pubblica amministrazione e nel settore produttivo.

Nel settore pubblico, l'obbiettivo di semplificare le procedure, rendendole più rapide ed efficienti, anche sotto il profilo dei costi, per i cittadini, comporta l'acquisizione di nuove competenze e l'implementazione dei servizi digitali, nell'ambito dell'identità, della sanità, della giustizia; e al tempo stesso una comunicazione adeguata col cittadino per integrarlo nel processo.

Dietro l'andamento della produttività, vi è anche il ritardo nel cogliere le opportunità legate alla trasformazione digitale, la mancanza di infrastrutture adeguate, di formazione, di capacità dei pubblici dipendenti di muoversi in un mondo tecnologico, nonché la lentezza delle

---

(*) Ricercatrice di diritto amministrativo – Politecnico di Milano.

piccole e medie imprese, che rappresentano la struttura profonda dell'impianto produttivo italiano, nell'adottare strumenti digitali.

La rapidità delle istituzioni e delle imprese nell'acquisire le necessarie competenze e la disponibilità di reti digitali adeguate sono fattori essenziali per fornire risposte agli utenti e accrescere la competitività sul mercato, assicurando servizi fruibili con strumenti digitali.

Questo numero della rivista affronta il tema della transizione digitale con molteplici prospettive, mettendo in luce di volta di volta in volta i costi e i benefici connessi all'uso delle tecnologie IT, che impiegano un'enorme mole di dati, e i relativi impatti sulla tutela dei diritti.

I diversi Autori evidenziano tutti le nuove opportunità, ma anche i profili critici: dal dilemma giuridico del funzionario nel bilanciare diritti di accesso e riservatezza, per garantire la fruibilità di benefici pubblici (Perra); all'applicazione del BIM ("*Building information modeling*") e del *digital twin* per ridurre i costi di manutenzione delle opere (De Donno e Miorini); agli impatti della digitalizzazione sul futuro degli appalti pubblici (Colombo, Cavarra, Grassi); al possibile ricorso alla società mista pubblico-privata per lo sviluppo di piattaforme di *e-procurement*, sempre nel contesto della digitalizzazione delle procedure di appalto pubblico (Fontana e Rizzo). In un articolo (Accarpio) si indaga poi il tema del "*gaming online*" e della protezione dei dati personali del minore, evidenziando il conflitto tra gli obiettivi di marketing dei management aziendali nella raccolta dei dati e delle informazioni degli utenti target e i rischi per i soggetti minori, attratti dall'ecosistema digitale ma di per sé vulnerabili.

Un'indagine peculiare è stata poi condotta nel settore dell'archeologia, con il contributo di insigni studiosi, intervenuti nel corso di un seminario internazionale, tenutosi in data 16 novembre 2021, presso il Politecnico di Milano, coordinato dalla direttrice di questa rivista, sul tema "*A multi-linear digital discourse in theory and pratice; the Urkesh Global Record and the Four Banks Project*" (a cui hanno partecipato il prof. Giorgio, Buccellati, la prof. ssa Marilyn Kelly-Buccellati, il dott. Jonah Lynch, il dott. Laerke Recht, il dott. Will Raynolds, il prof. Paolo Paolini, il dott. Luca Peyronel, il prof. Federico Buccellati). È possibile accedere alla registrazione del seminario da apposito link inserito nella sezione "Formazione" del sito della Rivista (https://www.dirittopolitecnico.it/formazione/).

In questo contesto, si segnala il pregevolissimo articolo del prof. Giorgio Buccellati, che propone e analizza una nuova nozione di "discorso digitale" ("*d-discourse*"), come discorso strutturato digitalmente in sé, con la simultanea ideazione e creazione di livelli digitali multipli

e paralleli, i quali interagiscono fra di loro. Il modello proposto è visto dall'Autore come un'espressione di una possibile nuova forma di umanesimo per l'epoca digitale, basato sull'abilità di percepire il tutto attraverso un universo di frammenti, nonché porsi efficacemente in relazione con esso.

Il prof. Paolo Paolini esamina invece gli spazi informativi complessi, come a volte sono quelli pubblicati sul web, richiedono tecniche e metodologie di design adeguati. Questo articolo presenta alcune considerazioni generali su "*information modeling*" e le usa per discutere la proposta di "*multilinear digital discourse*", presentata nel convegno di novembre 2021 al Politecnico di Milano.

La transizione digitale pone innumerevoli sfide e richiede immaginazione e capacità progettuale, nell'orizzonte di uno sviluppo sostenibile anche per le generazioni future.

INFORMATION MODELING AND MULTILINEAR DIGITAL DISCOURSE

PAOLO PAOLINI (*)

SOMMARIO: 1. Information Modeling - 2. HDM Modeling - 3. "Multilinear Digital Discourse" and Information Modeling - 4. Final discussion

1. Information Modeling

Information Modeling is a well-established discipline, in the field Computer Science; its purpose is to describe how information can be represented. Representing information has basically two different purposes:

a) *to describe complex information spaces for human understanding;*

b) *to describe complex information spaces for efficient computer processing.*

Both purposes are important, but at times they create ambiguities and can also interfere one with the other. An example may be illuminating; when in 1970 Ted Codd [1] proposed the "relational model" to describe Data Bases, he had in mind an information model useful for "final users", e.g. managers accessing information. It turned out, however, that over the years the actual use of the relational model became more and more complex. If we look at contemporary[1] Data Bases, in fact, only well-trained professionals can "read" and understand their "schema" (description).

Information modeling started very early, when computers (initially conceived for computation and number crunching) started managing data. Data management in fact, until recently was, by far, the most relevant area of usage of "computers" (despite their name)[2].

In the '50 information modeling was quite crude: it described data as they were stored into "files". Their "conceptual structure" was quite simple; more or less equivalent to what we

---

(*) Politecnico di Milano (già professore ordinario).

[1] The Relational Model is one of the oldest technical devices (of computer science) still in use and well alive. Its longevity is really amazing in a field where an interval of few years is equivalent to an era, with most of the old inhabitants disappearing.

[2] Recent developments have seen the growing use of computers for transaction processing and for AI related algorithms processing.

experience when using paper forms. A stream of data was described as a flow of "records"; a record was described as a sequence of "fields".

There were, however, a few conceptual notions quite relevant and still in use:

a) *all records have same structure; i.e. same data items in the same order. Variants can be accommodated, but in a controlled and anticipated manner;*

b) *a "schema" is the description of the records of a file. The schema is described once for all, and it does not need to be repeated for each record*[3]*. A trivial example could be: ARCHEOLOGICAL OBJECT= <id, title, description, location_of_finding, date_of_finding>*

c) a*n instance of a schema is a record consistent with a schema. All instances of records, within the same file, share a common schema.*

It should be noted that the "schema" provides the key in order to properly interpret each instance[4]*.*

d) *Search: the notion of "search" is quite generic. Basically it means that user is looking for data exhibiting some properties. The result of a search could be: zero (no items satisfying the search criterion were found); or a set of items.*

Search mechanisms were devised in the '70s and were popular, until superseded by queries (see below). One problem was that each installation had their own way to formulate search, and for the user it was difficult to know all of them. Search became popular, again, over Internet since user could formulate what they wanted in generic terms ("almost" natural language).

e) *query: a query can be considered a "very structured" search. There is a "query language" (with some technicalities) and there is a very precise way to formulate queries. Queries were originally meant for directing use by users. Currently, however, they are mainly used by programmers, using languages full of technicalities. The most used language is SQL*[5]*, that being designed in 70's, is probably one of the oldest ICT artifacts still in use.*

f) *sequential organization: records "one after the other"; a very simple way to organize a group of records. Easy to process, sequential organization of information is not powerful enough to represent complex situations, that occur in reality.*

---

[3] In a file of paper forms, instead, each form keeps the description of the data together with the specific data of the individual form.

[4] We deliberately ignore recent developments, where self-describing data (as in XML and alike) are used.

[5] Created at the same IBM-lab where Ted Codd was working. The original name of the language was SQUARE.

g) *hierarchical organization: it is quite common and widely used. Everyone is familiar with indexes of books: they correspond to a hierarchical organization of material. Hierarchical organizations are widely used in libraries, archives, websites, etc.*

The problem with hierarchies is related to the criterion to organize the material. Consider for example "archeological objects": they could be organized in a hierarchy according to "location" or "time of creation" or "technique" or "material", … Whatever is the selected criterion, any use needing a different criterion will be difficult.

h) *menu (index): a menu is basically a graphic rendering of a hierarchical organization. Most websites use hierarchical organization of content and therefore use hierarchical.*

The "urkesh"[6] *web site, for example, is based on several hierarchical menus.*

Menus are very useful (and usable) in a specific situation: limited depth of hierarchy and limited "horizontal" extension (limited number of entries at each level). Another requirement is that users must be able to understand the entries offered by the menu.

Let us consider, for example, "site" submenu of the urkesh website: <"the Tell", "the City", "the Kingdom", "the Palace", "the temple", "the abi">; do all the users understand what the menu says? For most users the only possible action is to try and click on one entry of the menu, discovering afterword if they are interested or not.

i) *hypertext: the term "hypertext" was created by Ted Nelsons*[7]*, but the concept, however, is generally credited to Vannevar Bush*[8]*. In a seminal work* [2] *Bush acknowledged the weakness of the apparently "natural" hierarchical organization of information.*

Let us consider the example a specific "vase" in an archeological information space. Is there a natural way to classify it? If we consider the "material", we can put in the folder "ceramics"; if we consider the "aspect", we can put it in the folder "red figure on black background"; if we consider the "subject" we can put it in the folder "Greek mythology" (sub folder "Herakles"); etc. In each of these folders the vase can find a proper position, but overall we can't really classify it, unless we consider one of the above folders the master one (and this is what many museums and many websites do).

V. Bush uses the notion of "trail"; each trail organizes information differently. The trick is that the same item may belong to different trails; this invalidates the idea that there is a "natural position". Positioning an item depends on the trail being followed. Accessing to information becomes more sophisticated. A user may start on a trail and find item x, also belonging to another trail; the user can

---

[6] http://urkesh.org/
[7] https://en.wikipedia.org/wiki/Ted_Nelson
[8] https://en.wikipedia.org/wiki/Vannevar_Bush

continue on the original trail, or switch to the new one and finding other items of this new trail. After a few "deviations" the user may end up in a trail quite different from the original one[9].

Ted Nelson, working at XANADU project, defined an information architecture similar to the multi-trail idea of V. Bush. In a paper of the '60 he published the term "hypertext", although he was probably using it from the '50s[10]*. World Wide web was created within the Hypertext community, and it made popular the concept of hypertext navigation; at that time, however, there was a debate whether it implements a "true hypertext" model*[11].

j) *Navigation: it is the action of "moving" from one item to another one. Examples of navigation are: turning pages in a book, going to "next" in a playlist, following an interactive link, ...*

The information organization creates a "topology" and via navigation we use the topology to "move around".

Navigation can be conceptually simple: everyone can push NEXT button or follow a hyperlink. If the topology is complex, however, the user may get confused about her "current position" or about which "trail" to follow[12].

Over the years there have been several proposals for information modeling, and we have no room to discuss them; we synthesize here a few widely used concepts:

a) *Representing information helps designers to create a mental map of what the "discourse" is about.*

b) *The representation of information helps also users to create their mental map. So that they may understand the universe they are going through.*

c) *The representation of information is also necessary in order to create automatic processes of some kind: search, queries, navigation, filtering, …. The need to make these processes efficient may (negatively) affect "a" and "b", i.e. "mental maps" readable by SW can be a difficult reading for human beings.*

d) *A major problem is how to accommodate conflicting points of views. As described above, there is no "natural position" nor natural criterion for organizing the information space. Different points of view may need different organizations. If those conflicting points of view must coexist (say in the same website), there is a problem.*

---

[9] This has a lot of analogies with "multilinear digital discourse" discussed later.
[10] Personal communication.
[11] This debate is obviously irrelevant now; the Web is there and "true hypertexts" are nowhere.
[12] This is the reason why the most common actions on the web are "back" or "home".

e) *Networked information spaces easily become complex: several cases and several options need to be considered. Simple models do not adequately represent all possible situations. On the other side, considering all possible situations, make models often too difficult to deal with.*

In the next section we describe a specific model for designing hypertext information space. It helps to build a terminology that can be useful for further discussions.

2. HDM Modeling

In this section we present a specific model to design hypertext-like information spaces. This model will be used, in the next section, in order to discuss the "multilinear digital discourse" as proposed by Buccellati [3, 4].

HDM (Hypertext Data Model) [5, 6.], was an information modeling approach (notation plus design methodology) that appeared in the '90s and was followed by a number of similar techniques. Web sites, in the early '90s, were mainly created without a clear idea of the overall information organization[13]. Design started with the home page: pages were added one at the time, creating links "by hand", one at the time. As the amount of represented information[14] grew, this approach was not anymore adequate and more organized production processes were needed.

HDM was the first proposal devising a way to design "data-intensive" websites: i.e. websites offering large amount of information and needing a non-hierarchical way to access. HDM can be used to "design" hypertexts or to create a "mental map" to understand hypertexts.

We use it, here, to compare general information solutions with the multilinear digital discourse, as proposed by Buccellati.

[13] And, unfortunately, this is still the case, sometimes.
[14] We should remind the web was created by T.B. Lee to store papers, not large information.

HDM uses 3 main concepts: Entity, Relationships, Collections. The first two concepts were similar to the popular Entity-relationship model [7]; the notion of "collection", instead, is original, and specifically relevant for this paper.

We present first a simplified description of the concepts, and we discuss advanced issues later.

- *ENTITY: this is something that we can talk about (or, more precisely, we have information about). ARCHEOLOGICAL_OBJECT could be an "entity type"; instances could be "vase 321", "tablet 456", "figurine 321", ….*
- *A complex Entity may have subparts that we call COMPONENTS. Components of an archeological objects could be "description data", "excavation data", "technique", … Entities and components are defined via attributes: e.g. "title", "picture", "short description", "details", "provenance", ….*
- *RELATIONSHIP: is a connection between different entities, corresponding to some semantic value. Examples: "where" may connect an "object" to the "location" where it was excavated; "found objects" may connect a "location" to the "objects" excavated there.*
- *COLLECTION: it is a set of "entities" organized in some manner. Examples could be "all figurines", "recently excavated", "major findings". A crucial feature is that the same "entity instance" may belong to several collections (as for V. Bush an item may belong to different trails). A collection can be derived from semantic properties: e.g. "ceramic vases" or "clay figurines". Other collections could be more arbitrary: e.g. "masterpieces".*
- *Collections can have (and often have) a hierarchical organization, i.e. collections containing other collections. "All figurines", as an example, could have sub-collections as "ceramic figurines" and "clay figurines". "Clay figurines", in turn, could consist of "archaic figurines" and late "figurines", and so on.*

Let us examine some relevant issues, that designers of information spaces need to consider.

- There is no "natural organization"

The most common way to organize information spaces is, apparently, "hierarchy". Hierarchies are often based on "classifications". Libraries, that classify books, have hierarchical organizations; botanical or zoological classifications are hierarchical.

Classifications are inherently arbitrary. One of the attributes is considered to the basic property that can be used to organize the material: e.g. should animals be classified according

to the way they reproduce or according to the environment where they live? If we choose reproduction, whales are mammals; if we choose environment whales are fish.

Hierarchical websites make life easy for users who are comfortable with the criterion used for organization information; they are difficult for users needing a different criterion. If an archeological website, for example, organize "objects" according to "typology", what about users needing to browse those objects according to "material" or "technique"?

- Relationship generates collections

All the paintings related to "Botticelli", identifies a specific group of items: "paintings by Botticelli". Assume that, for example, we are positioned at a specific "location" in the "urkesh" website; we could be interested in all the "findings" excavated at that location. Collections generated by relationships are correlated to the "multilinear discourse", as proposed by Buccellati.

- Links and Navigation

A complex information space generates several links; so that the generic term "hyperlink" is ambiguous. The term "navigation" is used to indicate the action of following links. HDM acknowledge the specific aspects of various types of links

- *Structural navigatio*

  It is the navigation based on "structural links", i.e. the links interconnecting the different pieces of the same entity. In the website of the National Gallery of Washington, for example, a painting "Adorazione dei Magi" (by Botticelli) has "overview", "provenance" and "bibliography". Structural links are used and structural navigation allows to browse the various sections.

- *Collection Navigation*

  It is the navigation allowing to explore all the items belonging to the same collection. It may consist into different types of actions: a) ordering the collection (e.g. according to chronology); b) searching within the collection (e.g. "all objects such that"…); c) moving within the collection (e.g. NEXT); d) selecting (e.g. looking at a menu and clicking on something). Those various actions are often combined by most of the users, to create complex patterns of usage of links.

- *Hierarchical Navigation*

  It is a special kind of "collection navigation", needed when there are "sub-collections". An example could be the following chains of links OBJECTS->FIGURINES->HUMAN FIGURINES.

- Relationship Navigation

  It allows to explore the links created by a relationship.

  Let's consider an example. The user explores the collection of "painters" organized in alphabetical order and reaches "Botticelli"[15]; then she follows a relationship link, and reaches "adorazione dei magi"; via NEXT she can get another painting; so she is not anymore in the collection that she started with.

  The combination of the various methods of navigation creates a complex pattern, typical of hypertext-like navigation. In most cases a confused user recurs to BACKtracking or restarts from the homepage[16].

- Points of view (perspective)

The same object could be described quite differently according to different points of view. An object of the "urkesh" website may have different readers: e.g. i) excavation team; ii) outside archeologists; iii) historians; iy) art experts; v) religion experts, vi) civilization experts; vii) lay people, …Some users may be interested into only one of these perspectives; a few users may be interested into all of them.

In the next section we use the vocabulary of HDM in order to discuss the proposal by Buccellati of "Multilinear Digital Discours

3. "Multilinear digital Discourse" and information Modeling

Multi-linearity has been discussed by Buccellati[17] (Mary Kelly-Buccellati and Giorgio) in several occasions and trough different papers. We will mainly refer to the presentation given in November 2021, in Milan at Politecnico, for the workshop "multilinear digital discourse in theory and practice".

[15] We are loosely using the website NGA.gov, of the National Gallery of Washington.
[16] Despite the efforts by designers to create meaningful information spaces, BACK and HOME represent more than 50% of the links activated by users of websites.
[17] From now on we will use the acronym BB to indicate Buccellati-Buccellati.

Although the authors use in the subtitle the notion of "website-publishing", we can interpret their proposal as information modeling in a broad sense. We will use HDM terminology, in order to translate their proposal in general terms.

What BB (the two Buccellati) call "linear discourse", directly corresponds, in HDM terminology, to a "collection" traversed with a linear navigation. They recognize that this information architecture is too limited and therefore advocate a more complex organization.

Each linear discourse, according to BB, lays on a plane; each plane apparently corresponds to a knowledge domain (as described in the discussion about "points of view" in the previous section). Examples here could be "A: sherd", "B: emplacement", "C: chronology", "D: Typology ware", "E: typology / shape".

HDM has no direct correspondence with planes described there. To the best of our knowledge no other information model as an explicit reference to different points of view (planes in the BB proposal).

BB also introduce "tracks" that connect nodes belonging to different planes (domains). More or less tracks correspond to connecting different points of view: this is a reasonable requirement: users in fact may change their interest, as they navigate through a website. HDM has no similar concept, and acknowledging a new type of link (navigation) could be a useful extension.

The "multilinear digital discourse", as defined by BB, articulates a rich topology for the information space. Their proposal also raises a number of interesting issues:

- is that topology capable of describing all the possible situations? (designer point of view)
- Does the topology create a "mental map" that makes sense for a user? (reader point of view)
- Can we define effective search and navigation mechanisms to use that topology? (ICT point of view)

In a different work [4] BB claim that (beside search and hyperlink) there is no real difference between printed information and digital information. This claim does not seem to be fully accurate, since a complex information space (as the one defined by an HDM schema) does not even make sense on paper.

BB also propose a new concept. Using HDM terminology, we could say that they advocate the "borrowing" of information, based on relationships. In simplistic way we could say that a user, instead of following a link between "Botticelli" and "paintings", will find all the paintings incorporated within the description of Botticelli itself[18]. The idea is interesting but there are a number of implications to be clarified: are the paintings "copied" into Botticelli information or they only appear there? For the readers interested in those paintings, there is for sure an advantage: simplified navigation. But what about those readers not interested into paintings. In addition, should the information about "Botticelli" reciprocally be shown for each painting (instead than just placing a link)?

Following the proposal of "parallel tracks", the information space can become "bulimic", with duplicated info shown everywhere. Organizing an information space into small items interconnected via links was meant exactly to avoid the duplication of information and allowing different coexisting "trails". The proposal by BB may endanger these benefits, providing as a counterpart a simplified navigation.

In the same work BB seem to imply that narrative are "designed" as linear sequences. This is not generally true, however. Narratives are "instantiated" as linear sequences, in the sense that one item at the time is offered to the user. The design of the narrative, however, could be different. Simple information models describe narratives as they are offered to the reader. More sophisticated information models describe the information space as a complex space (items and links) "translated" into a linear narrative for the sake of the reader; the analogy is with touristic tpurs in a city: they are linear, but the underlying design of the city is not linear.

4. Final discussion

The "multilinear digital discourse" is an interesting proposal, for information design, developed by professional archeologists. It argues that simplistic information design is not adequate to represent complex information representations (that they call "web publishing"). On the other side "general and neutral and very dry" information modeling primitives, seem

[18] It is not clear why they call it "parallel track".

to be not directly usable by archeologists (and probably not by experts of other domains, in general).

It seems to emerge a strange situation: experts of any domain can personally deal with complexity. When they try to explicitly represent their knowledge (about their domain) they cannot do it, unless they oversimplify their knowledge. Any representation is partial, limited, and approximate: it represents a slice of knowledge for a specific purpose. Understanding the whole, with its inner connections, seems to be elusive.

Another general issue could be about the real meaning of designing an information space, vs the actual experience of using the information space to build a narrative. There are several analogies here: urban planners create the topology of a city; they create constraints and possibilities for people to move, but each individual can actually create her own tour. Another analogy could be the design of a large set of trails in the mountains. Trails intersect in several way; the user, selecting her own deviation, define her own specific tour.

So the game is flexibility vs. easiness and vs. usefulness. Extreme flexibility means that any connection is possible (difficult in a city, easier on the web); zero flexibility means that from each place there only one possible move. The compromise is, obviously, someway in between.

Extreme easiness possible corresponds to zero flexibility; if there is only one way to go, no one will make mistake. If, however, at each intersection there are several possibilities, the user may get confused. This is why users need to build mental maps (of the city or of the website) in order to make sense of their narrative.

Good touristic guide in fact suggest how to move around in a city. Maps, instead, describe the topology and do not suggest where to go from a starting position.

All the above discussion shows the complexity of designing effective information spaces and flexible/meaningful narratives. We can conclude that experts in different domains (say archeologists) should work together with information designers, in order to dig into the various issues; this is difficult, since, by established practices, researchers of the various disciplines write on different journals, and have few occasions to really meet.

This is why interdisciplinary meetings, as the one held at Politecnico di Milano in November 2021, are very valuable.

References:

1] E. CODD, *A Relational Model for Large Shared data Banks*, in *Communication of ACM*, Volume 13, Number 6, June, 1970.

2] V. BUSH*, As we may think*, The Atlantic, July, 1945.

3] G. BUCCELLATI*, A multilinear digital discourse in theory and practice*, in *A Multi-Linear Digital Discourse in Theory and Practice: The Urkesh Global Record and the Four Banks Project, Slide for presentation meeting Politecnico di Milano*, November 16th, 2021.

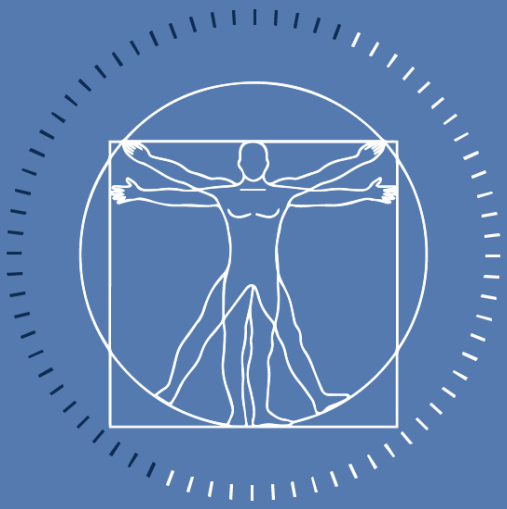
4] G. BUCCELLATI, M. KELLY-BUCCELLATI, *Archeological digital narratives*, (ebook), Zaphon, Munster, 2020.

5] F. GARZOTTO, P. PAOLINI, D. SCHWABE, *HDM - A Model for the design of Hypertext Applications - Proceedings of ACM Hypertext '91*, San Antonio, Texas, 1991.

6] F. GARZOTTO, P. PAOLINI, D. SCHWABE, *HDM - A Model-based Approach to Hypertext Application Design*, in *ACM Transactions on information Systems*, January 1993.

7] P. PEN, S. CHEN, *The Entity-Relationship Model: a unified view of data*, in *ACM Transactions on Data Base*, volume 1, Issue 1, March 1976.

ISSN 2785-4086



Diritto Politecnico.it

Fascicolo n. 1/2022

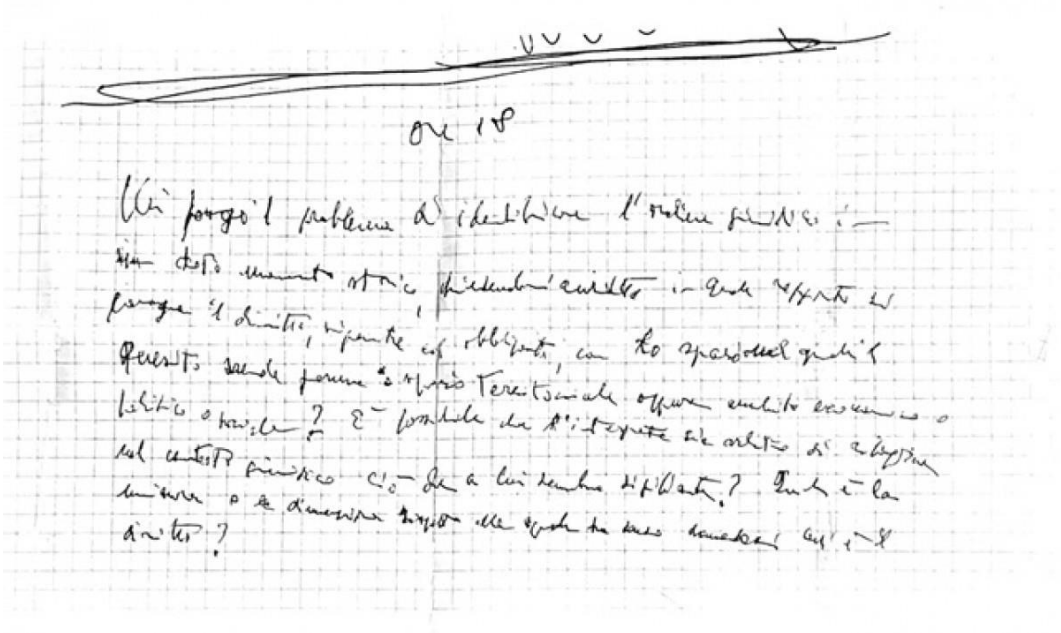
DirittoPolitecnico.it - Rivista Telematica
Editrice La Tribuna srl
Via Campo della Fiera, 4 29121 Piacenza
Registrazione ROC LA Tribuna n. 24492

ISSN 2785-4086

LA RIVISTA

L'idea della Rivista nasce nell'ambito del gruppo di ricerca giuridica del Politecnico di Milano e delle attività di formazione post-laurea (Corsi di perfezionamento e Master dedicati agli Appalti e Contratti pubblici, alla Protezione dati e transizione digitale), cui partecipano docenti provenienti anche da altre Università, magistrati delle diverse giurisdizioni, professionisti ed esperti dei settori interessati. L'integrazione disciplinare tra diritto e "altri" settori, tecnico-scientifici ma anche umanistici e sociali, è stata, fin dall'inizio, il tratto caratterizzante le suddette ricerche e proposte formative, così pensate al fine di meglio comprendere e per quanto possibile guidare – trattandosi di formare al più alto livello professionisti, funzionari e dirigenti dell'amministrazione – l'innovazione, con particolare riferimento alle applicazioni in ambito pubblicistico. Proprio questa esigenza di confronto fra differenti competenze, sensibilità, punti di vista sembra essere, in effetti, la più valida risposta alle fin troppo ovvie obiezioni che si potrebbero muovere al progetto - del tipo: era proprio necessaria una nuova Rivista? Non ce ne sono già troppe? -, sia sotto il profilo teorico, dato che gli iperspecialismi e la frammentazione delle conoscenze per SSD sembra spesso far perdere di vista la sintesi e la visione d'insieme (che segnano il passaggio dalla somma di conoscenze alla "cultura"), sia sotto quello pratico, giacché le sfide poste dal mutamento scientifico e tecnologico, dai cambiamenti climatici, dallo sviluppo sostenibile e dall'evoluzione dell'economia e della società (non ultime quelle derivanti dalla pandemia) reclamano uno spazio aperto di confronto sui temi di frontiera, che come tali non interessano e non possono essere adeguatamente trattati solo dagli operatori del diritto. Ferma la fondamentale impostazione di carattere giuridico dell'iniziativa, la Rivista si propone perciò di ospitare contributi "tecnici" (progettuali, urbanistici, economici, digitali, energetici, di sicurezza, etc.) che impattano sulla disciplina delle materie trattate, riflessioni di carattere filosofico, umanistico e artistico ma anche lavori a più mani e a più voci, come espressione immediata dell'atteggiamento scientifico che si ritiene più idoneo ad affrontare la complessità. Per assicurare il collegamento con i predetti corsi di perfezionamento e i Master, si intende riservare un congruo spazio ai migliori lavori di tesi e ai contributi comunque provenienti dai nostri Studenti ed ex allievi, anche per offrire una migliore "visibilità" alle loro ricerche e l'opportunità di partecipare attivamente al dibattito pubblico. Certo, siamo consapevoli dell'enormità della sfida e chissà se troveremo "venticinque lettori" disposti a seguirci in questa nuova avventura… impossibile, tuttavia, sottrarsi a quelle domande, che Giorgio Berti aveva sintetizzato nell'appunto manoscritto e che sono, oggi più

che mai, attuali: "Mi pongo il problema di identificare l'ordine giuridico in un dato momento storico chiedendomi anzitutto in quale rapporto si ponga il diritto, vigente ed obbligante, con lo spazio nel quale il quesito prende forma: spazio territoriale oppure ambito economico o politico o sociale? È possibile che l'interprete sia arbitro di ritagliare nel contesto giuridico ciò cha a lui sembra significante? Quale è la misura o la dimensione rispetto alla quale ha senso domandarsi cos'è il diritto?"



(G. BERTI, Appunto - uno degli ultimi, forse l'ultimo - preso qualche giorno nel mese di novembre 2007)

SOMMARIO

Editoriale

Articoli

Focus

EDITORIALE

DANILA IACOVELLI (*)

La trasformazione digitale è una delle sfide più significative del momento. La tecnologia è una parte integrante, a volte coessenziale, del nostro vivere e del nostro lavoro.

La transizione verso i servizi digitali implica un processo di adattamento in tempi brevi da parte di tutti i soggetti dell'ordinamento, dalle piccole e medie imprese, che si muovono in un mercato in rapida evoluzione, alle pubbliche amministrazioni, alle istituzioni e agli enti, ai cittadini, chiamati a una partecipazione consapevole e attiva.

La pandemia del Covid-19 ha colpito duramente l'economia italiana. Nel 2020, il prodotto interno lordo si è ridotto dell'8,9 per cento, a fronte di un calo nell'Unione Europea del 6,2; l'Italia ha imposto per prima un *lockdown* generalizzato e ha subito la maggior perdita di vite nell'UE, secondo i dati riportati nel Piano nazionale di ripresa e resilienza ("PNRR" #nextgenerationitalia, in governo.it).

Non a caso, la prima missione del PNRR si concentra sulla "rivoluzione digitale" e sull'innovazione per la modernizzazione delle infrastrutture di comunicazione del paese, nella pubblica amministrazione e nel settore produttivo.

Nel settore pubblico, l'obbiettivo di semplificare le procedure, rendendole più rapide ed efficienti, anche sotto il profilo dei costi, per i cittadini, comporta l'acquisizione di nuove competenze e l'implementazione dei servizi digitali, nell'ambito dell'identità, della sanità, della giustizia; e al tempo stesso una comunicazione adeguata col cittadino per integrarlo nel processo.

Dietro l'andamento della produttività, vi è anche il ritardo nel cogliere le opportunità legate alla trasformazione digitale, la mancanza di infrastrutture adeguate, di formazione, di capacità dei pubblici dipendenti di muoversi in un mondo tecnologico, nonché la lentezza delle

---

(*) Ricercatrice di diritto amministrativo – Politecnico di Milano.

piccole e medie imprese, che rappresentano la struttura profonda dell'impianto produttivo italiano, nell'adottare strumenti digitali.

La rapidità delle istituzioni e delle imprese nell'acquisire le necessarie competenze e la disponibilità di reti digitali adeguate sono fattori essenziali per fornire risposte agli utenti e accrescere la competitività sul mercato, assicurando servizi fruibili con strumenti digitali.

Questo numero della rivista affronta il tema della transizione digitale con molteplici prospettive, mettendo in luce di volta di volta in volta i costi e i benefici connessi all'uso delle tecnologie IT, che impiegano un'enorme mole di dati, e i relativi impatti sulla tutela dei diritti.

I diversi Autori evidenziano tutti le nuove opportunità, ma anche i profili critici: dal dilemma giuridico del funzionario nel bilanciare diritti di accesso e riservatezza, per garantire la fruibilità di benefici pubblici (Perra); all'applicazione del BIM ("*Building information modeling*") e del *digital twin* per ridurre i costi di manutenzione delle opere (De Donno e Miorini); agli impatti della digitalizzazione sul futuro degli appalti pubblici (Colombo, Cavarra, Grassi); al possibile ricorso alla società mista pubblico-privata per lo sviluppo di piattaforme di *e-procurement*, sempre nel contesto della digitalizzazione delle procedure di appalto pubblico (Fontana e Rizzo). In un articolo (Accarpio) si indaga poi il tema del "*gaming online*" e della protezione dei dati personali del minore, evidenziando il conflitto tra gli obiettivi di marketing dei management aziendali nella raccolta dei dati e delle informazioni degli utenti target e i rischi per i soggetti minori, attratti dall'ecosistema digitale ma di per sé vulnerabili.

Un'indagine peculiare è stata poi condotta nel settore dell'archeologia, con il contributo di insigni studiosi, intervenuti nel corso di un seminario internazionale, tenutosi in data 16 novembre 2021, presso il Politecnico di Milano, coordinato dalla direttrice di questa rivista, sul tema "*A multi-linear digital discourse in theory and pratice; the Urkesh Global Record and the Four Banks Project*" (a cui hanno partecipato il prof. Giorgio, Buccellati, la prof. ssa Marilyn Kelly-Buccellati, il dott. Jonah Lynch, il dott. Laerke Recht, il dott. Will Raynolds, il prof. Paolo Paolini, il dott. Luca Peyronel, il prof. Federico Buccellati). È possibile accedere alla registrazione del seminario da apposito link inserito nella sezione "Formazione" del sito della Rivista (https://www.dirittopolitecnico.it/formazione/).

In questo contesto, si segnala il pregevolissimo articolo del prof. Giorgio Buccellati, che propone e analizza una nuova nozione di "discorso digitale" ("*d-discourse*"), come discorso strutturato digitalmente in sé, con la simultanea ideazione e creazione di livelli digitali multipli

e paralleli, i quali interagiscono fra di loro. Il modello proposto è visto dall'Autore come un'espressione di una possibile nuova forma di umanesimo per l'epoca digitale, basato sull'abilità di percepire il tutto attraverso un universo di frammenti, nonché porsi efficacemente in relazione con esso.

Il prof. Paolo Paolini esamina invece gli spazi informativi complessi, come a volte sono quelli pubblicati sul web, richiedono tecniche e metodologie di design adeguati. Questo articolo presenta alcune considerazioni generali su "*information modeling*" e le usa per discutere la proposta di "*multilinear digital discourse*", presentata nel convegno di novembre 2021 al Politecnico di Milano.

La transizione digitale pone innumerevoli sfide e richiede immaginazione e capacità progettuale, nell'orizzonte di uno sviluppo sostenibile anche per le generazioni future.