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# Augmenting Conceptualization by Visual Knowledge Organization

## 1. Introduction

Recent developments within cognitive and computer supported conceptualization have helped us to see why externalizing conceptual knowledge in visual forms has proved to be a much deeper problem than it was assumed to be in the pioneering era of Artificial Intelligence (AI). Visualization has played a role in *both* recognizing the importance of sub-symbolic cognitive structures in explaining the difficulties of simulating our visual capacities, and in the emergence of *graphical* Knowledge Organization (KO) tools of Human and Computer Interactions (HCI). Among the KO tools that support memory recall, concept organization or design, and problem solving, we not only find tables, maps and diagrams but first of all *graph based* combinations of textual and non-textual symbolic structures.

## 2. Computational Simulation *versus* the Augmentation of Human Conceptualization

While debates in the pioneering period of AI centered on the question of whether physical symbol systems can think, in the seminal years of the 1960s in which computational semantics and machine representations of scientific conceptualization appeared to converge into a happy *symbiosis*, alternative approaches already sought to address conceptual problem solving with a view not to simulate but to *augment* our knowledge organization activities. These approaches did not seek to demarcate the personal from objective knowledge, or human cognition from machine knowledge representation, they rather viewed *cognitive structures*, including “visual” ones, and their *externalizations* as *co-evolving systems*. Though the – by now obvious – idea of co-evolution became essential in various fields from processual archaeology to cognitive science, from the point of view of KO when situating the development of our symbolic and cognitive structures within the embodied and intent-dependent context of the human quest for meaning, it is important to contrast the computational alternatives of *simulating* conceptualization and *augmenting* the KO of the *human* intellect. If we review the prehistory of AI this distinction helps us to make clear that the way taken in the

1960s for using such a powerful tool as the computer for human problem solving was far from necessary.<sup>1</sup>

### 3. Co-evolution & Time-binding: Contexts of the Nietzsche-Korzybski-Sapir-Whorf Hypothesis

The interdisciplinary issue of the *coevolution* of human cognition and *external* information structure records is more than a century old in linguistics, archaeology, anthropology, brain and cognitive sciences and the philosophy of mind. The interplay between words and written texts not only produced reflection on “impressions” and “ideas”, internal and external images, it moulded and gave substance to philosophical thinking from Plato to Wittgenstein. The detection of *change* in human thinking surfaced slowly. Nietzsche in particular helped to facilitate the linkage between *languages* and cultures, and “grammatically” determined “paths” of thought and ways of looking at the world.<sup>2</sup> In the 1960s, Havelock’s *Preface to Plato*<sup>3</sup> highlighted changes in *linguistic* KO with his philological analysis of orality and textual literacy. Although *The Gutenberg Galaxy*<sup>4</sup> shifted attention to the supremacy of the visual, the context of the so-called “Sapir-Whorf hypothesis” remained essentially “linguistic”<sup>5</sup> in the sense that the reference points of paradigmatic changes were textual externalization and its use. Media studies (including the pre-McLuhan ones) only gradually made computational interpretations, extending slowly to a full-blown consideration of the effect and potential of interacting *with* and *by* all forms of “computational” and human “presentational” devices. We cannot refer here to every historical turning point, except the crucial one, when it was both recognized and considered a call for alternative ways of conceptualization “that it [language] enslaves

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- 1 Thierry Bardini, *Bootstrapping: Douglas Engelbart, Coevolution, and the Origins of Personal Computing*, Stanford, CA: Stanford University Press, 2000.
  - 2 Friedrich Nietzsche, *Beyond Good and Evil* (1886), New York: Vintage Books, 1966, pp. 27–28.
  - 3 Cambridge, MA: Harvard University Press, 1963.
  - 4 Marshall McLuhan, *The Gutenberg Galaxy: The Making of Typographic Man*, Toronto: University of Toronto Press, 1962.
  - 5 “We dissect nature along lines laid down by our native languages ... the world is presented in a kaleidoscopic flux of impressions which has to be organized by our minds – and this means largely by the *linguistic* systems in our minds.” (*Language, Thought and Reality: Selected Writings of Benjamin L. Whorf*, Cambridge, MA: MIT, 1956, p. 213. Italics added, acknowledging that Whorf distanced himself from exclusively linguistic conceptions of thinking.)

us through the mechanism of the s[emantic] r[eaction] and the structure which a language exhibits, and impresses upon us unconsciously, is *automatically projected* upon the world around us”.<sup>6</sup> Although – without computers – the consequences of this thought were immediately drawn for human *communication*, suggesting new evaluative attitudes towards abstraction, I assert that separating the *media of human cognition* from *computational facilities in terms of simulation* (viewed as *algorithmic programming*) hindered the study of the *non-linguistic structural* aspects of *concept development*. It ignores the continuous correlation between the “external” and the “internal”, conscious and unconscious *feedback* mechanisms involving HCI, in spite of the impressive “mother of all demos” exhibiting the first systematic integration of the already available tools for such interactions in 1968.<sup>7</sup>

#### 4. General Semantics and the “Anthropometric” Structural Differential

A. Korzybski, founder of the *General Semantics* school, attempted to break the “bindings” of linguistic conceptualization as early as in 1921, and introduced in his *Manhood and Humanity*<sup>8</sup> his notion of “time-binding”. It placed verbal and textual externalization of thought in the context of the general human ability to preserve experiences, together with the sharing and passing on of structurally organized information; with *new forms* of communication – the source(s) of an exponential growth of knowledge. He claimed that the unlimited development of higher and higher *loops* of abstractions opened the way for new *kinds* of scientific representation, arguing later in *Science and Sanity* against “elementalism”, and the object-essentialist, “subject–predicate” nature of “Aristotelian verbalism”. Instead of looking for epistemic casual connections between experience, propositions, and facts in terms of exclusively internal or external relations, as did Russell or the early Wittgenstein, he rejected the *separation* of (1) internal

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6 Alfred Korzybski, *Science and Sanity: An Introduction to Non-Aristotelian Systems and General Semantics* (1933), Lakeville, CT: Inst. of General Semantics, 1958, p. 90. Cf. Robert P. Pula, “The Nietzsche-Korzybski-Sapir-Whorf Hypothesis?”, *ETC Review of General Semantics*, vol. 49, no. 1 (1992), pp. 50–57.

7 See the demos of Engelbart’s oN-Line System (NLS: <http://www.doungengelbart.org/firsts/dougs-1968-demo.html>) which not only included a structured, cross linked collaborative Open Hyperdocument System, but developed the computational kernel of its prospective permanent development.

8 Lakeville, CT: Inst. of General Semantics, 1950.

activities of the mind, (2) their expression in externalized forms, and (3) the conception of objects in a mind-independent (or “neuro-logically” unaffected) external world. Despite the influence of Wittgenstein’s *Tractatus* (including the desire to save our language use from certain types of verbalism), he gradually distanced himself from both an empiricist epistemology and linguistic theories of meaning which captured it within syntactic and external “semantic” systems. Starting from contemporary theories of “colloido-chemical” stimulus-response behaviour within organisms, problems arising within behaviour therapy, and the inseparability of the observer and the observed, he attempted to establish a new *practical science of communicative human behaviour* using “extensional” (physico-mathematical) methods. His new science of *General Semantics* drew up a *model of human abstraction* represented by his patented educational device, the *Anthropometer* (cf. Figure 1). It helped its users to focus on the “Structural Differential” inherent in our loops of abstractions, including perceptual object formation, and in distinguishing “silent” and “verbal” levels in different levels of our understanding processes (Figure 2).

He saw “all knowledge as structure” and abstraction as leaving out and bringing about differences. Impressed by Wittgenstein’s picture theory he identified a *generalized* similarity in all kinds of (physico-mathematical, verbal, etc.) structures operating at every (silent and verbal) level of abstraction, underlining that just as “the map is not the territory”, we are only able to grasp *certain* aspects *with*, and *of* our cognitive processes. This is because the “territory” does not lie outside these processes, and so the best we can do is try to keep track and make ourselves conscious about the generation of all those structures which our communicative processes permanently feed back into our abstractive processes. Anticipating in many aspects Polanyi’s conception of *Personal Knowledge* and current theories of *embodied cognition*, the *Anthropometer* was offered as an educational device for learning and practicing a new “evaluative orientation”, or epistemic “attitude” towards our “neuro-semantic” processes. As a learning tool it helps us to focus on abstraction moves, making its user recognize that it is not so much language that is the “limit of our world” but the totality of accumulated mathematical and “extensional” structures at our disposal – which can be considered as “languages” only in a parabolic sense. One may wonder what Korzybski would say if computers had been able to assist the “extensional” methods he proposed for developing better and better means for expressing, analyzing, and understanding what we mean.

Figure 1: Korzybski's Anthropometer. The (infinite) parabola represents a domain of events (E) where "what we infer is going on" beyond our direct observation. The disc O (Object), different for humans ( $O_{h1}$ ,  $O_{h2}$ ,  $O_{h3}$ ) and animals ( $O_a$ ,  $O_s$ ), represents a "first (finite) abstraction": the non-verbal perceptual result (sights, smells, sounds, etc.) of our human nervous systems reacting to the submicroscopic stuff on the non-verbal levels of experience. The disc represents what we experience versus what the events (E) actually are (and what we infer): a "joint phenomenon" of the observer and the observed. The first level labeled tag (L) represents the "descriptive" second order abstraction associating a symbol to the further abstracted, and symbolically related ( $A_3$  ...) aspects of the "Object" naming/ symbolizing "just the facts" by semantic reactions. Higher level, evaluative abstractions ( $L_1, \dots, L_n$ ) which can be expressed by statements about lower level ones, are linked together in distinctively human chains ( $V_1, V_2, V_3$ ) of inferences, with the last one attached (feedback) to the domain of events about which we make our inferences. The holes represent the characteristics that exist at each level. The characteristics that are abstracted to the next level are indicated by the attached lines of abstractive links ( $A_1, A_2, A_3$ ) produced by our nervous system. The strings that don't make it to the next level ( $B_1, B_2, \dots$ ) represent characteristics left out of (by) our abstractions, as do the holes without strings (A. Korzybski, Science and Sanity, pp. 387-398).

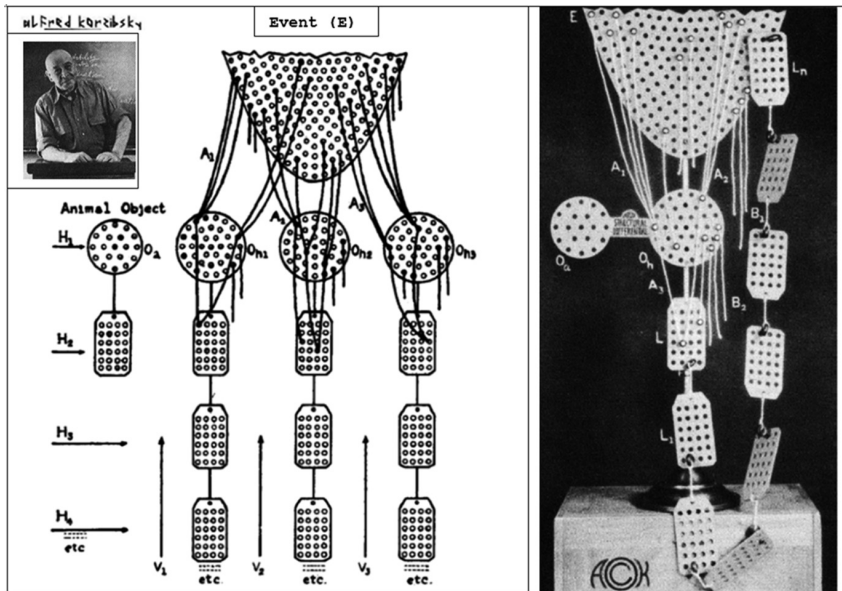
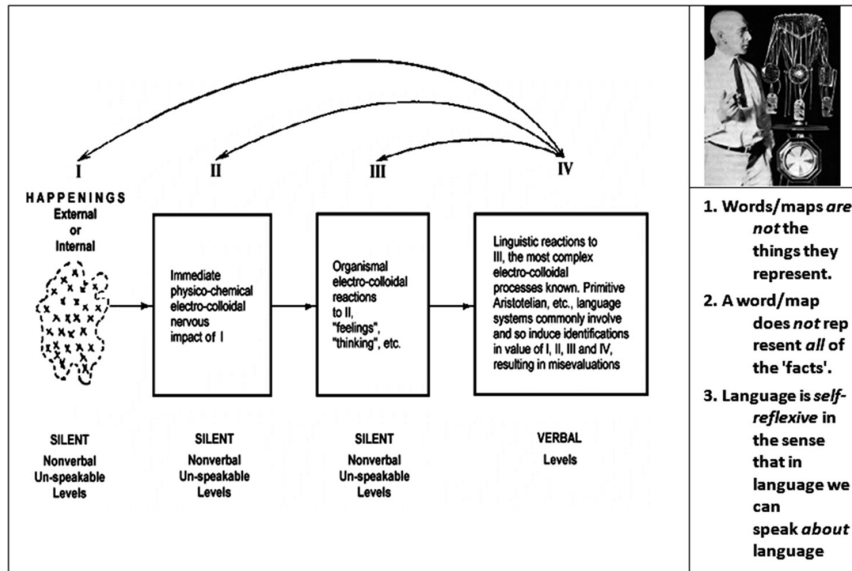


Figure 2: The main levels of abstracting from an “electro-colloidal” point of view in Korzybski’s non-Aristotelian system (A. Korzybski, “The Role of Language in the Perceptual Process”, in Robert R. Blake and Glenn V. Ramsey, eds., *Perception: An Approach to Personality*, New York: The Ronald Press Co., 1951).



## 5. Bootstrapping Augmentation Research

In the pioneering era of AI the “simulation approach” became dominant, exemplified by research programs promoted in the U.S. by J. C. R. Licklider which sought a “symbiosis” of man and machine. In these approaches the human and the “computational” domain were cognitively separated.<sup>9</sup> Consequently, in “weak AI” the “simulation” and the “symbiosis” were expected to take place

9 Although Licklider’s approach was different from Wiener’s or from M. Minski’s, his attitude (like contemporary command line programmers’) is based on a division of labour: “Men will set the goals, formulate the hypotheses, determine the criteria and perform the evaluations. Computing machines will do the *routinizable* work that must be done to prepare the way for insights and decisions.” Cf. Giulio Jacucci et al., “Symbiotic Interaction: A Critical Definition and Comparison to other Human-Computer Paradigms”, in Giulio Jacucci et al. (eds.), *Symbiotic Interaction*, Springer, 2014, pp. 3–20; and Bardini, *op. cit.*, for the differences between Licklider’s and Engelbart’s human development oriented approach.

only at a behavioural level, but even in strong AI without one domain partaking in the processes of the other; a separation with far reaching consequences for the development of computer science and technology to the present day. There is now a general agreement that the huge investment in weak AI did not meet Licklider's expectations, in spite its contribution to computing, and to modeling linguistic structures and verbal behaviour. Chinese-room resistant strong AI was essentially given up even in the case of neuron computers. Since the 1960s there were warnings about the developments which have led to the inability of the internet and the Semantic Web to deal with problems of information overload and complexity, but did not mobilize behind an alternative problem solving paradigm. The attempts to translate first the *Tractatus*, than the later Wittgenstein into computational terms were apparently unaware of both Korzybski's model of abstraction, and the adaptability of his thought to formal languages that "the structure which a language exhibits, and impresses upon us unconsciously" automatically influences our conceptualizations and language design. Economic interests had their role, but it is telling that despite the temporal "coincidence" of drawing the *media theoretic* consequences of these problems in the work of the members of the Toronto School and their disciples, another ground-breaking research program, led by D. C. Engelbart at SRI failed. He concentrated on the *computational implementation* of a system for collaborative KO in a *Korzybskian* self-reflective conception of "time-binding" which promoted the co-evolution of man *and* machine within the field of effective conceptualization and tool creating human problem solving.<sup>10</sup> Engelbart generalized the "Sapir-Whorf hypothesis" (in the cultural, in the cognitive as well as in a *technological* sense) into a new approach based on what he called the "Neo-Whorfian hypothesis"<sup>11</sup>, which developed the central claim that cognitive conceptual structures *co-evolve* with the means of externalization. *Augmentation research* proceeds from the insight that the externalization of human symbol manipulation influences both our language and our way of thinking (including higher level visual and scientific abstractions) and that computers can "reveal the subtle relationships among its interacting elements".<sup>12</sup> Among the few whom

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10 D. Engelbart, "Computer Augmentation of Human Knowledge Work", in B. Shaw (ed.), *Computers and Communications: Proceedings of the Joint IBM/University of Newcastle Upon Tyne Seminar Held in the University Computing Laboratory 4th-7th September 1973*, University of Newcastle upon Tyne Computing Laboratory, 1973.

11 Cf. <http://www.dougenelbart.org/pubs/augment-3906.html>, 2c4f and ff.

12 *Ibid.*, 2c4d (pp. 23 f.).



he explicitly names in his 1962 Conceptual Framework, introducing the term “Augmentation” for the synergistic amplification of the Human Intellect, in which the “repertoire hierarchy” of Human and “Artifact Processes” co-evolve, Korzybski is referred at a key inspiration.<sup>13</sup> Engelbart not only carries over Korzybski’s structural approach of concept formation to information system engineering and computational languages, but is also aware of the social, cognitive, and evolutionary feedback mechanisms of concept and symbol manipulation. “Under such evolutionary conditions”, he writes, “it would seem unlikely that the language we now use provides the best possible service to our minds in pursuing comprehension and solving problems. It seems very likely that a more useful language *form* can be devised.”<sup>14</sup>

## 6. Engelbart’s Conception of Bootstrapping

With his team at SRI he not only managed to “show rather than tell” how the first NLS provides computer support for the collaborative solution of complex problems, but devised a “hard core” of computational solutions which produced the kernel of an augmented system that included many tools used in personal “computing” to this day. The extension of these early insights to computer supported knowledge work, including the externalization of conceptualization processes in all fields of end-user governed design and problem solving, requires that we reconsider the “symbiotic interactions” in the foundations of literate, conceptual, reflective and intentional, meta-programming in an Engelbartian vein. He re-interpreted and “externalized” the Korzybskian processes of abstraction ploughing through the interface of the *Innenwelt* and the *Umwelt* in terms of HCI. In his view *Bootstrapping* the – computational – Augmentation of the human intellect assumes the development of cognitive *and* “extensional” symbolic methods of semiotic feedback looping which supervene – by the meaning spirals of HCI – on verbalism.<sup>15</sup> The goal of building Augmentation Systems is to support the co-evolution of conceptual and computational knowl-

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13 *Ibid.*, 2c4c. In Toronto, Cambridge, Dartmouth, Pittsburg or Stanford no one seems to know Korzybski’s name in spite of some apparent latent mediations.

14 *Ibid.*, 2c4e, italics added.

15 *Bootstrapping* the – computational – Augmentation of the human intellect assumes the Augmentation of the Bootstrapping cycles themselves, not just a community approach for “Boosting the Collective IQ” (as it is sometimes interpreted). Note that the lines of abstractions of the *Antropometer* are also fed back into the process, as the picture on the right side of Figure 1 above shows.



edge architectures in generating emergent solutions to complex problems. In Bootstrapping (as a result of HCIs) *meaning evolves*. This is an implication not only of *Science and Sanity* but also of Peirce's *processual semiotics*: “[f]or every symbol is a living thing, in a very strict sense that is no mere figure of speech ... in its origin, either an image of the idea signified, or a reminiscence of some individual occurrence, person, or thing, connected with its meaning, or is a metaphor.”<sup>16</sup>

## 7. Processual Semiotics and Emergent Meaning

It is quite a distance from noting that “meaning inevitably grows, incorporates new elements and throws off old ones” to computer supported meaning construction and emergent semantics.<sup>17</sup> Peirce not only affected Korzybski, who read his *Chance, Love and Logic*,<sup>18</sup> but his *processual semiotics* paved the way via new relational formalisms from association theories to symbolic graph-based interpretation of KO. Contemporary Peirce scholarship tends to consider his work on Existential Graphs as an attempt to formulate a common “language” for the representation of reasoning which was capable to incorporate symbolic logic.<sup>19</sup> The Engelbartian conclusion that just as the “state of a language at a given time strongly affects its own evolution”, can be extended in terms of Peirce's concep-

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16 *The Essential Peirce* 2:264 (*The Ethics of Terminology*, 1903), see also MS 618 and 634 (1909).

17 *Ibid.*, 2:222. Especially, because a computational process is quite different from a physical process, and its scientific description in terms of “extensional” methods as Korzybski suggests.

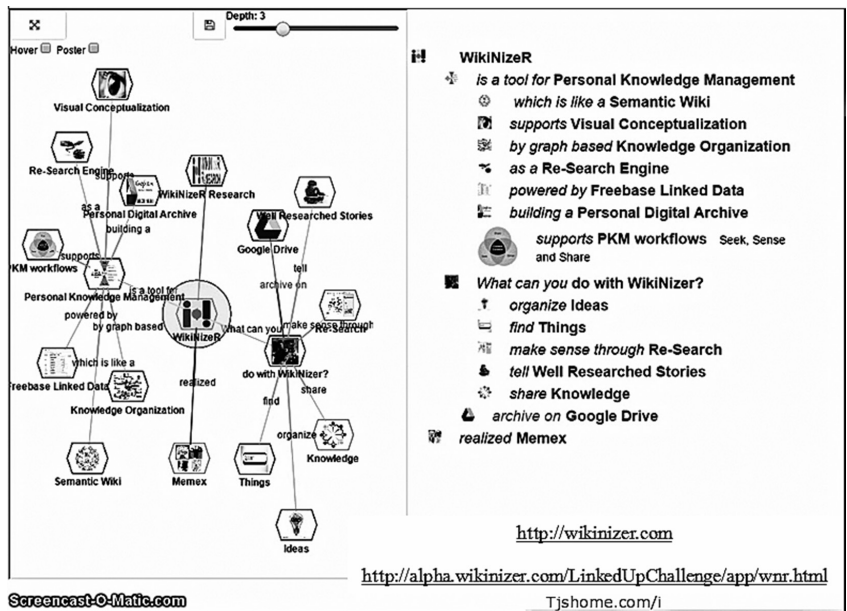
18 Charles S. Peirce, *Chance, Love and Logic: Philosophical Essays*, ed. by M. R. Cohen, New York: Harcourt, Brace & Co., 1923.

19 See e.g. John F. Sowa, “Conceptual Graphs for Representing Conceptual Structures”, in Pascal Hitzler and Henrik Scharfe (eds.), *Conceptual Structures in Practice*, Chapman and Hall/CRC, 2009, pp. 101–136; also Sowa, “The Role of Logic and Ontology in Language and Reasoning”, in Roberto Poli and Johanna Seibt (eds.), *Theory and Applications of Ontology: Philosophical Perspectives*, Dordrecht: Springer, 2010, pp. 231–263; or Ahti-Veikko Pietarinen, “Getting Closer to Iconic Logic”, in Susan Stuart and Gordana Dodig Crnkovi (eds.), *Computation, Information, Cognition: The Nexus and the Liminal*, Newcastle: Cambridge Scholars Publishing, 2007; and Frederik Stjernfelt, “Iconicity of Logic – and the Roots of the ‘Iconicity’ Concept”, in Hiraga et al. (eds.), *Iconicity: East Meets West*, Amsterdam: John Benjamins, 2015, pp. 35–53. Pietarinen even rejects “the distinction between logical and extra-logical notion of diagrammatic representations”.

tion of semiosis and dynamics of knowledge production to visual “languages” because their meta-level organization can be treated as an evolving articulation process.<sup>20</sup> Such dynamic systems are capable of developing into a succeeding state if the applied technology provides us with the means/tools for meta-reflection that are able to enhance the utilization of our tacit knowledge in externalized forms. The evolving and self-organizing nature of articulation, however, can be detected in *both* cognitive and artificial systems. This is because the augmentation of conceptualization, just as the external manipulation of “things”, and their conceptual architectures in a human created environment is essential both for *embodied cognition* and for computer supported KO. Reflecting on current positions on computational (Engelbart) and cognitive aspects of bootstrapping (Quine, Carey),<sup>21</sup> we can “show rather than tell” their co-active interdependency. Just like the NLS demo did, it is possible to demonstrate this interdependency within creative problem solving by an exploratory implementation of *MindGraph*.<sup>22</sup> It is the alpha version of the first App of the kernel of a knowledge augmentation engine, *WikiNizer™Research*, which is not only a tool for linked data visualization but also a WYSIWYM interface for the semantic enrichment of meaning, adopting new forms of graph-based Emergent Semantics.<sup>23</sup>

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- 20 Engelbart, see <http://www.dougenelbart.org/pubs/augment-3906.html>, 2c4d. Cf. Torill Strand, “Peirce’s Rhetorical Turn: Conceptualizing Education as Semiosis”, *Educational Philosophy and Theory*, vol. 45, no. 7 (2013), pp. 789–803; and Ahti-Veikko Pietarinen, “Existential Graphs: What a Diagrammatic Logic of Cognition Might Look Like”, *History and Philosophy of Logic*, vol. 32, no. 3 (2011), pp. 265–281.
- 21 Susan Carey, *The Origin of Concepts*, New York: Oxford University Press, 2009; see also Vyvyan Evans, *How Words Mean: Lexical Concepts, Cognitive Models and Meaning Construction*, Oxford: Oxford University Press, 2009.
- 22 See <http://linkedup-project.eu/2014/12/22/wikinizer-introducing-mindgraph>.
- 23 “What-You-See-Is-What-You-Mean”, cf. Ali Khalili and Sören Auer, “WYSIWYM – Integrated Visualization, Exploration and Authoring of Semantically Enriched Unstructured Content”, *Semantic Web* (2013); see also Karl Aberer et al., “Emergent Semantics Principles and Issues”, in Y. Lee et al. (eds.), *Database Systems for Advanced Applications*, Berlin: Springer, 2004.

Figure 3: A Snapshot of WikiNizeR™ MindGraph



## 8. Concept Maps and the Dynamics of MindGraph

*MindGraph* delivers a semantic visualization framework for human conceptualization as a personal knowledge organization tool which augments conceptual problem solving by interfacing personal knowledge and web research. It uses Concept Map-type visual, and page based Wiki-like knowledge management in the conviction that a visualized meta-reflective analysis of Knowledge Architectures (in the form of concept nets, and higher conceptual architectures) helps us discover effective concepts. D. Ausubel’s and Novak’s approach to concept learning has generated *static* CMaps to represent individual cognitive structures and became, as J. Sowa points out, visual KO applications of the originally logically minded relational graphs of Peirce.<sup>24</sup> The “WikiNizer Way” of conceptualization confirmed that CMaps as semantic tools of conceptualization enhance our visual knowledge organization and symbol-structuring, whereas Wikinizer not only supplies *static* computational representations of inter-personal knowledge (e. g.,

24 Cf. <http://cmap.ihmc.us/docs/theory-of-concept-maps>; see also the references to Sowa in note 19 above.

semantic representations of the structure of propositions, or lexical ontologies) but can support the situated *dynamics* of concept formation. Unlike “God’s eye” conceptions of ontology building, the externalization of semantic information is *intent dependent*. Defining new relations and discovering semantically rich structures is a precondition of emergent semantics and meaning construction.<sup>25</sup> *MindGraph* creates dynamic graph based visual structures which articulate the relationships that exist within knowledge items blending iconic, pictorial, lexical, and potentially any digital form. Creating a visual Memex it facilitates the emergence of new concepts in an associative trail-bush of contents organized in page based graph structures. The *homoiconicity* of these graph structures offers a uniform treatment of intent dependent sorts, attributes, aspects, and typed relations within some given material as a self-organizing system, supplying us with a technological key to conceptual reorganization at the meta levels of the knowledge graph. At the same time it makes possible simultaneous mapping of the corresponding changes into the organization of the domain knowledge. The implementation of a *dynamic* visual conceptualization environment speaks for itself given the current problems of the Semantic Web. It answers the need to realize a *bootstrappable* dynamic visual concept organization framework for intent dependent problem solving fifty years after the implementation of NLS.

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25 András [G.] Benedek and G. Lajos, “Conceptualization and Visual Knowledge Organization: A Survey of Ontology Based Solutions”, *INTED2014 Proceedings* (2014), pp. 4609–4619.