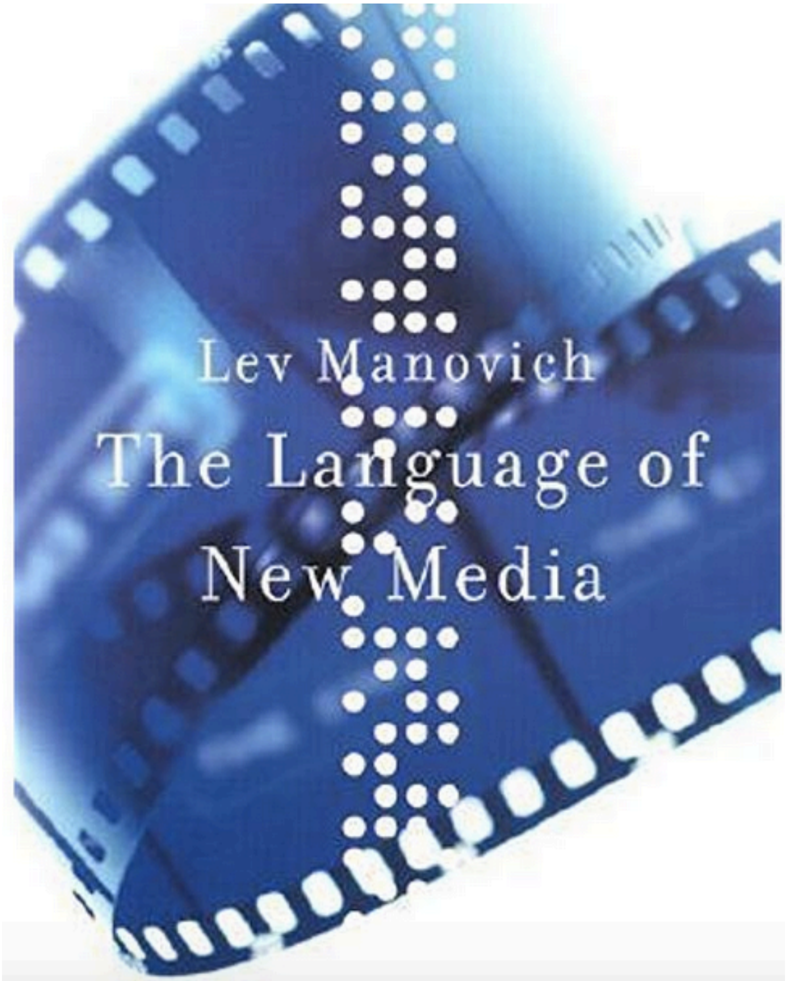

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Five Characteristics of New Media

Excepts from

The Language of New Media

by Lev Manovich

The following excerpts come from Lev Manovich's seminal book The Language of New Media*. In this 2001 work, Manovich establishes an critical vocabulary for discussing what he calls "New Media": the collective body of digital forms that include web pages, video games, online video, word processing, texting, social media, streaming services, software, apps, etc.*

Early in this work, Manovich tackles a fundamental question: if these various digital forms compose a single category, is this category a medium--just as print, radio, or television is each a medium--or something more? In answer, he argues that New Media is a language *rather than just a medium, and systematically discovers and defines what that language is made up of and how it works.*

In the first of the following excerpts (including a very helpful introduction to this section), Manovich tells the story of two early nineteenth-century technologies (for calculating numbers and for creating images) that rarely crossed paths for two hundred years until they converged very recently. This convergence, Manovich claims, formed a "New Media" complex that is so distinct from other media that it represents a cultural and psychological transformation much more fundamental than the invention of just another new telegraph or cable television medium.

Thought Question: According to Manovich, why will New Media always be categorically different from the various old media that came before it, even when New Media is no longer new?

Citation

Manovich, Lev. *The Language of New Media*. MIT Press, 2001.

In the section "Media and Computation," I show that new media represents a convergence of two separate historical trajectories: computing and media technologies. Both begin in the 1830s with Babbage's Analytical Engine and Daguerre's daguerreotype. Eventually, in the middle of the twentieth century, a modern digital computer is developed to perform calculations on numerical data more efficiently; it takes over from numerous mechanical tabulators and calculators widely employed by companies and governments since the turn of the century. In a parallel movement, we witness the rise of modern media technologies that allow the storage of images, image sequences, sounds, and text using different material forms—photographic plates, film stocks, gramophone records, etc. The synthesis of these two histories? The translation of all existing media into numerical data accessible through computers. The result is new media—graphics, moving images, sounds, shapes, spaces, and texts that have become computable; that is, they comprise simply another set of computer data. In "Principles of New Media," I look at the key consequences of this new status of media. Rather than focusing on familiar categories such as interactivity or hypermedia, I suggest a different list. This list reduces all principles of new media to five—numerical representation, modularity, automation, variability, and cultural transcoding. In the last section, "What New Media Is Not," I address other principles that are often attributed to new media. I show that these principles can already be found at work in older cultural forms and media technologies such as cinema, and therefore in and of themselves are in sufficient to distinguish new media from old.

How Media Became New

On August 19, 1839, the Palace of the Institute in Paris was filled with curious Parisians who had come to hear the formal description of the new reproduction process invented by Louis Daguerre. Daguerre, already well known for his Diorama, called the new process *daguerreotype*. According to a contemporary, "a few days later, opticians' shops were crowded with amateurs panting for daguerreotype apparatus, and everywhere cameras were trained on buildings. Everyone wanted to record the view from his window, and he was lucky who at first trial got a silhouette of roof tops against the sky."[1] The media frenzy had begun. Within five months more than thirty different descriptions of the technique had been published around the world—Barcelona, Edinburgh, Naples, Philadelphia, St. Petersburg, Stockholm. At first, daguerreotypes of architecture and landscapes dominated the public's imagination; two years later, after various technical improvements to the process had been made, portrait galleries had opened everywhere—and everyone rushed to have her picture taken by the new media machine.[2]

In 1833 Charles Babbage began designing a device he called "the Analytical Engine." The Engine contained most of the key features of the modern digital computer. Punch cards were used to enter both data and instructions. This information was stored in the Engine's memory. A processing unit,

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1. Quoted in Beaumont Newhall, *The History of Photography from 1839 to the Present Day*, 4th ed. (New York: Museum of Modern Art, 1964), 18.
2. Newhall, *The History of Photography*, 17–22.

which Babbage referred to as a "mill," performed operations on the data and wrote the results to memory; final results were to be printed out on a printer. The Engine was designed to be capable of doing any mathematical operation; not only would it follow the program fed into it by cards, but it would also decide which instructions to execute next, based on intermediate results. However, in contrast to the daguerreotype, not a single copy of the Engine was completed. While the invention of the daguerreotype, a modern media tool for the reproduction of reality, impacted society immediately, the impact of the computer was yet to be seen.

Interestingly, Babbage borrowed the idea of using punch cards to store information from an earlier programmed machine. Around 1800, J. M. Jacquard invented a loom that was automatically controlled by punched paper cards. The loom was used to weave intricate figurative images, including Jacquard's portrait. This specialized graphics computer, so to speak, inspired Babbage in his work on the Analytical Engine, a general computer for numerical calculations. As Ada Augusta, Babbage's supporter and the first computer programmer, put it, "The Analytical Engine weaves algebraical patterns just as the Jacquard loom weaves flowers and leaves."[3] Thus a programmed machine was already synthesizing images even before it was put to processing numbers. The connection between the Jacquard loom and the Analytical Engine is not something historians of computers make much of, since for them computer image synthesis represents just one application of the modern digital computer among thousands of others, but for a historian of new media, it is full of significance.

We should not be surprised that both trajectories—the development of modern media and the development of computers—begin around the same time. Both media machines and computing machines were absolutely necessary for the functioning of modern mass societies. The ability to disseminate the same texts, images, and sounds to millions of citizens—thus assuring the same ideological beliefs—was as essential as the ability to keep track of their birth records, employment records, medical records, and police records. Photography, film, the offset printing press, radio, and television

3. Charles Eames, *A Computer Perspective: Background to the Computer Age* (Cambridge, Mass: Harvard University Press, 1990), 18.

made the former possible while computers made possible the latter. Mass media and data processing are complementary technologies; they appear together and develop side by side, making modern mass society possible.

For a long time the two trajectories ran in parallel without ever crossing paths. Throughout the nineteenth and the early twentieth centuries, numerous mechanical and electrical tabulators and calculators were developed; they gradually became faster and their use more widespread. In a parallel movement, we witness the rise of modern media that allow the storage of images, image sequences, sounds, and texts in different material forms—photographic plates, film stock, gramophone records, etc.

Let us continue tracing this joint history. In the 1890s modern media took another step forward as still photographs were put in motion. In January 1893, the first movie studio—Edison's "Black Maria"—started producing twenty-second shorts that were shown in special Kinetoscope parlors. Two years later the Lumière brothers showed their new Cinématographie camera/projection hybrid, first to a scientific audience and later, in December 1895, to the paying public. Within a year, audiences in Johannesburg, Bombay, Rio de Janeiro, Melbourne, Mexico City, and Osaka were subjected to the new media machine, and they found it irresistible.[4] Gradually scenes grew longer, the staging of reality before the camera and the subsequent editing of samples became more intricate, and copies multiplied. In Chicago and Calcutta, London and St. Petersburg, Tokyo and Berlin, and thousands of smaller places, film images would soothe movie audiences, who were facing an increasingly dense information environment outside the theater, an environment that no longer could be adequately handled by their own sampling and data processing systems (i.e., their brains). Periodic trips into the dark relaxation chambers of movie theaters became a routine survival technique for the subjects of modern society.

The 1890s was the crucial decade not only for the development of media, but also for computing. If individual brains were overwhelmed by the amount of information they had to process, the same was true of corporations and of governments. In 1887, the U.S. Census Bureau was still

4. David Bordwell and Kristin Thompson, *Film Art: An Introduction*, 5th ed. (New York: McGraw-Hill), 15.

interpreting figures from the 1880 census. For the 1890 census, the Census Bureau adopted electric tabulating machines designed by Herman Hollerith. The data collected on every person was punched into cards; 46,804 enumerators completed forms for a total population of 62,979,766. The Hollerith tabulator opened the door for the adoption of calculating machines by business; during the next decade electric tabulators became standard equipment in insurance companies, public utility companies, railroad offices, and accounting departments. In 1911, Hollerith's Tabulating Machine Company was merged with three other companies to form the Computing-Tabulating-Recording Company; in 1914, Thomas J. Watson was chosen as its head. Ten years later its business tripled, and Watson renamed the company the "International Business Machines Corporation," or IBM.[5]

Moving into the twentieth century, the key year for the history of media and computing is 1936. British mathematician Alan Turing wrote a seminal paper entitled "On Computable Numbers." In it he provided a theoretical description of a general-purpose computer later named after its inventor: "the Universal Turing Machine." Even though it was capable of only four operations, the machine could perform any calculation that could be done by a human and could also imitate any other computing machine. The machine operated by reading and writing numbers on an endless tape. At every step the tape would be advanced to retrieve the next command, read the data, or write the result. Its diagram looks suspiciously like a film projector. Is this a coincidence?

If we believe the word *cinematograph,* which means "writing movement," the essence of cinema is recording and storing visible data in a material form. A film camera records data on film; a film projector reads it off. This cinematic apparatus is similar to a computer in one key respect: A computer's program and data also have to be stored in some medium. This is why the Universal Turing Machine looks like a film projector. It is a kind of film camera and film projector at once, reading instructions and data stored on endless tape and writing them in other locations on this tape. In fact, the development of a suitable storage medium and a method for coding data represent important parts of the prehistory of both cinema and the computer. As we know, the inventors of cinema eventually settled on using discrete images recorded on a strip of celluloid; the inventors of the computer—which needed much greater speed of access as well as the ability to quickly read and write data—eventually decided to store it electronically in a binary code.

5. Eames, *A Computer Perspective,* 22–27, 46–51, 90–91.

The histories of media and computing became further entwined when German engineer Konrad Zuse began building a computer in the living room of his parents' apartment in Berlin—the same year that Turing wrote his seminal paper. Zuse's computer was the first working digital computer. One of his innovations was using punched tape to control computer programs. The tape Zuse used was actually discarded 35mm movie film.[6]

One of the surviving pieces of this film shows binary code punched over the original frames of an interior shot. A typical movie scene—two people in a room involved in some action—becomes a support for a set of computer commands. Whatever meaning and emotion was contained in this movie scene has been wiped out by its new function as data carrier. The pretense of modern media to create simulations of sensible reality is similarly canceled; media are reduced to their original condition as information carrier, nothing less, nothing more. In a technological remake of the Oedipal complex, a son murders his father. The iconic code of cinema is discarded in favor of the more efficient binary one. Cinema becomes a slave to the computer.

But this is not yet the end of the story. Our story has a new twist—a happy one. Zuse's film, with its strange superimposition of binary over iconic code, anticipates the convergence that will follow half a century later. The two separate historical trajectories finally meet. Media and computer—Daguerre's daguerreotype and Babbage's Analytical Engine, the Lumière Cinématographie and Hollerith's tabulator—merge into one. All existing media are translated into numerical data accessible for the computer. The result: graphics, moving images, sounds, shapes, spaces, and texts become computable, that is, simply sets of computer data. In short, media become new media.

This meeting changes the identity of both media and the computer itself. No longer just a calculator, control mechanism, or communication device,

6. Ibid., 120.

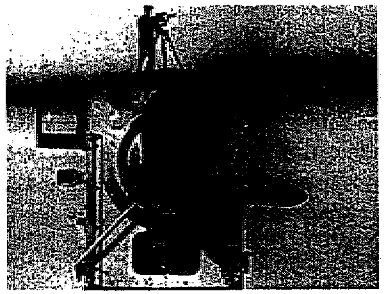
the computer becomes a media processor. Before, the computer could read a row of numbers, outputting a statistical result or a gun trajectory. Now it can read pixel values, blurring the image, adjusting its contrast, or checking whether it contains an outline of an object. Building on these lower-level operations, it can also perform more ambitious ones—searching image databases for images similar in composition or content to an input image, detecting shot changes in a movie, or synthesizing the movie shot itself, complete with setting and actors. In a historical loop, the computer has returned to its origins. No longer just an Analytical Engine, suitable only for crunching numbers, it has become Jacquard's loom—a media synthesizer and manipulator.

In "Principles of New Media," Manovich defines five characteristics of New Media: numerical representation, modularity, automation, variability, and transcoding. As you read, think about the ways that these characteristics serve both to unify the diverse forms of New Media into a single category, while also helping distinguish what is and isn't New Media.

Thought Question: How does breaking down New Media into these characteristics help us see, say, and understand more than if we defined New Media simply as including anything digital?

Regarding "Numerical Representation":
If we digitalize a picture, song, map, or sculpture, we make a copy of it. But in the following pages, Manovich explores other consequences of translating an old medium (or producing an original performance) in a "numerical representation." What are some of these consequences and possibilities?

Principles of New Media



The identity of media has changed even more dramatically than that of the computer. Below I summarize some of the key differences between old and new media. In compiling this list of differences, I tried to arrange them in a logical order. That is, the last three principles are dependent on the first two. This is not dissimilar to axiomatic logic, in which certain axioms are taken as starting points and further theorems are proved on their basis.

Not every new media object obeys these principles. They should be considered not as absolute laws but rather as general tendencies of a culture undergoing computerization. As computerization affects deeper and deeper layers of culture, these tendencies will increasingly manifest themselves.

1. Numerical Representation

All new media objects, whether created from scratch on computers or converted from analog media sources, are composed of digital code; they are numerical representations. This fact has two key consequences:

1. A new media object can be described formally (mathematically). For instance, an image or a shape can be described using a mathematical function.
2. A new media object is subject to algorithmic manipulation. For instance, by applying appropriate algorithms, we can automatically remove "noise" from a photograph, improve its contrast, locate the edges of the shapes, or change its proportions. In short, *media becomes programmable.*

When new media objects are created on computers, they originate in numerical form. But many new media objects are converted from various forms of old media. Although most readers understand the difference between analog and digital media, a few notes should be added on the terminology and the conversion process itself. This process assumes that data is originally *continuous,* that is, "the axis or dimension that is measured has no apparent indivisible unit from which it is composed."[7] Converting continuous data into a numerical representation is called *digitization.* Digitization consists of two steps: sampling and quantization. First, data is *sampled,* most often at regular intervals, such as the grid of pixels used to represent a digital image. The frequency of sampling is referred to as *resolution.* Sampling turns continuous data into *discrete* data, that is, data occurring in distinct units: people, the pages of a book, pixels. Second, each sample is *quantified,* that is, it is assigned a numerical value drawn from a defined range (such as 0–255 in the case of an 8-bit greyscale image).[8]

While some old media such as photography and sculpture are truly continuous, most involve the combination of continuous and discrete coding. One example is motion picture film: each frame is a continuous photograph, but time is broken into a number of samples (frames). Video goes one step further by sampling the frame along the vertical dimension (scan lines). Similarly, a photograph printed using a halftone process combines discrete and continuous representations. Such a photograph consists of a number of orderly dots (i.e., samples), although the diameters and areas of dots vary continuously.

As the last example demonstrates, while modern media contain levels of discrete representation, the samples are never quantified. This quantification of samples is the crficial step accomplished by digitization. But why, we may ask, are modern media technologies often in part discrete? The key assumption of modern semiotics is that communication requires discrete units. Without discrete units, there is no language. As Roland Barthes put it, "Language is, as it were, that which divides reality (for instance, the continuous spectrum of the colors is verbally reduced to a series of discontinuous terms)."[9] In assuming that any form of communication requires a discrete representation, semioticians took human language as the prototypical example of a communication system. A human language is discrete on most scales: We speak in sentences; a sentence is made from words; a word consists of morphemes, and so on. If we follow this assumption, we may expect that media used in cultural communication will have discrete levels. At first this theory seems to work. Indeed, a film samples the continuous time of human existence into discrete frames; a drawing samples visible reality into discrete lines; and a printed photograph samples it into discrete dots. This assumption does not universally work, however: Photographs, for instance, do not have any apparent units. (Indeed, in the 1970s semiotics was criticized for its linguistic bias, and most semioticians came to recognize that a language-based model of distinct units of meaning cannot be applied to many kinds of cultural communication.) More important, the discrete units of modern media are usually not units of meanings in the way morphemes are. Neither film frames nor halftone dots have any relation to how a film or photograph affects the viewer (except in modern art and avant-garde film—think of paintings by Roy Lichtenstein and films of Paul Sharits—which often make the "material" units of media into units of meaning).

7. Isaac Victor Kerlov and Judson Rosebush, *Computer Graphics for Designers and Artists* (New York: Van Nostrand Reinhold, 1986), 14.

8. Ibid., 21.

In the section "Modularity," Manovich explores how the elements or "objects" that make up a New Media production remain "independent." This is different from old media where elements are integrated and transformed: paint colors are mixed into new colors and textures, shots of a film are cut and spliced together into scenes. Can you think of examples of New-Media software or documents in which the independence of various elements are preserved? What are the implications of such modularity for creating or experiencing New Media products?

2. Modularity

This principle can be called the "fractal structure of new media." Just as a fractal has the same structure on different scales, a new media object has the same modular structure throughout. Media elements, be they images, sounds, shapes, or behaviors, are represented as collections of discrete samples (pixels, polygons, voxels, characters, scripts). These elements are assembled into larger-scale objects but continue to maintain their separate identities. The objects themselves can be combined into even larger objects—again, without losing their independence. For example, a multimedia "movie" authored in popular Macromedia Director software may consist of hundreds of still images, QuickTime movies, and sounds that are stored separately and loaded at run time. Because all elements are stored independently, they can be modified at any time without having to change the Director "movie" itself. These "movies" can be assembled into a larger "movie," and so on. Another example of modularity is the concept of "object" used in Microsoft Office applications. When an "object" is inserted into a document (for instance, a media clip inserted into a Word document), it continues to maintain its independence and can always be edited with the program originally used to create it. Yet another example of modularity is the structure of an HTML document: With the exemption of text, it consists of a number of separate objects—GIF and JPEG images, media clips, Virtual Reality Modeling Language (VRML) scenes, Shockwave and Flash movies—which are all stored independently,

locally, and/or on a network. In short, a new media object consists of independent parts, each of which consists of smaller independent parts, and so on, down to the level of the smallest "atoms"—pixels, 3-D points, or text characters.

The World Wide Web as a whole is also completely modular. It consists of numerous Web pages, each in its turn consisting of separate media elements. Every element can always be accessed on its own. Normally we think of elements as belonging to their corresponding Web sites, but this is just a convention, reinforced by commercial Web browsers. The Netomat browser by artist Maciej Wisnewski, which extracts elements of a particular media type from different Web pages (for instance, images only) and displays them together without identifying the Web sites from which they are drawn, highlights for us this fundamentally discrete and nonhierarchical organization of the Web.

In addition to using the metaphor of a fractal, we can also make an analogy between the modularity of new media and structured computer programming. Structural computer programming, which became standard in the 1970s, involves writing small and self-sufficient modules (called in different computer languages *subroutines, functions, procedures, scripts*), which are then assembled into larger programs. Many new media objects are in fact computer programs that follow structural programming style. For example, most interactive multimedia applications are written in Macromedia Director's Lingo. A Lingo program defines scripts that control various repeated actions, such as clicking on a button; these scripts are assembled into larger scripts. In the case of new media objects that are not computer programs, an analogy with structural programming still can be made because their parts can be accessed, modified, or substituted without affecting the overall structure of an object. This analogy, however, has its limits. If a particular module of a computer program is deleted, the program will not run. In contrast, as with traditional media, deleting parts of a new media object does not render it meaningless. In fact, the modular structure of new media makes such deletion and substitution of parts particularly easy. For example, since an HTML document consists of a number of separate objects each represented by a line of HTML code, it is very easy to delete, substitute, or add new objects. Similarly, since in Photoshop the parts of a digital image usually kept placed on separate layers, these parts can be deleted and substituted with a click of a button.

3. Automation

The numerical coding of media (principle 1) and the modular structure of a media object (principle 2) allow for the automation of many operations involved in media creation, manipulation, and access. Thus human intentionality can be removed from the creative process, at least in part.[10]

Following are some examples of what can be called "low-level" automation of media creation, in which the computer user modifies or creates from scratch a media object using templates or simple algorithms. These techniques are robust enough so that they are included in most commercial software for image editing, 3-D graphics, word processing, graphics layout, and so forth. Image-editing programs such as Photoshop can automatically correct scanned images, improving contrast range and removing noise. They also come with filters that can automatically modify an image, from creating simple variations of color to changing the whole image as though it were painted by Van Gogh, Seurat, or another brand-name artist. Other computer programs can automatically generate 3-D objects such as trees, landscapes, and human figures as well as detailed ready-to-use animations of complex natural phenomena such as fire and waterfalls. In Hollywood films, flocks of birds, ant colonies, and crowds of people are automatically created by AL (artificial life) software. Word processing, page layout, presentation, and Web creation programs come with "agents" that can automatically create the layout of a document. Writing software helps the user to create literary narratives using highly formalized genre conventions. Finally, in what may be the most familiar experience of automated media generation, many Web sites automatically generate Web pages on the fly when the user reaches the site. They assemble the information from databases and format it using generic templates and scripts.

Researchers are also working on what can be called "high-level" automation of media creation, which requires a computer to understand, to a certain degree, the meanings embedded in the objects being generated, that is, their

10. I discuss particular cases of computer automation of visual communication in more detail in "Automation of Sight from Photography to Computer Vision," *Electronic Culture: Technology and Visual Representation*, ed. by Timothy Druckrey and Michael Sand (New York: Aperture, 1996), 229–239; and in "Mapping Space: Perspective, Radar, and Computer Graphics," *SIGGRAPH '93 Visual Proceedings*, ed. by Thomas Linehan (New York: ACM, 1993), 142–147.

semantics. This research can be seen as part of a larger project of artificial intelligence (AI). As is well known, the AI project has achieved only limited success since its beginnings in the 1950s. Correspondingly, work on media generation that requires an understanding of semantics is also in the research stage and is rarely included in commercial software. Beginning in the 1970s, computers were often used to generate poetry and fiction. In the 1990s, frequenters of Internet chat rooms became familiar with "bots"—computer programs that simulate human conversation. Researchers at New York University designed a "virtual theater" composed of a few "virtual actors" who adjusted their behavior in real-time in response to a user's actions.[11] The MIT Media Lab developed a number of different projects devoted to "high-level" automation of media creation and use: a "smart camera" that, when given a script, automatically follows the action and frames the shots;[12] ALIVE, a virtual environment where the user interacts with animated characters;[13] and a new kind of human-computer interface where the computer presents itself to a user as an animated talking character. The character, generated by a computer in real-time, communicates with the through user natural language; it also tries to guess the user's emotional state and to adjust the style of interaction accordingly.[14]

How might automation--especially what Manovich calls "high-level automation"--affect the creative process? the relationship of creator and audience? Can you think of some clear examples of automation from your use of particular software or a web-based interface either in creating or consuming some form of New Media? How is high-level automation different from low-level?

11. http://www.mrl.nyu.edu/improv/.

12. http://www-white.media.mit.edu/vismod/demos/smartcam/.

13. http://pattie.www.media.mit.edu/people/pattie/CACM-95/alife-cacm95.html.

14. This research was pursued at different groups at the MIT lab. See, for instance, the home page of the Gesture and Narrative Language Group, http://gn.www.media.mit.edu/groups/gn/.

4. Variability

A new media object is not something fixed once and for all, but something that can exist in different, potentially infinite versions. This is another consequence of the numerical coding of media (principle 1) and the modular structure of a media object (principle 2).

Old media involved a human creator who manually assembled textual, visual, and/or audio elements into a particular composition or sequence. This sequence was stored in some material, its order determined once and for all. Numerous copies could be run off from the master, and, in perfect correspondence with the logic of an industrial society, they were all identical. New media, in contrast, is characterized by variability. (Other terms that are often used in relation to new media and that might serve as appropriate synonyms of *variable* are *mutable* and *liquid.*) Instead of identical copies, a new media object typically gives rise to many different versions. And rather than being created completely by a human author, these versions are often in part automatically assembled by a computer. (The example of Web pages automatically generated from databases using templates created by Web designers can be invoked here as well.) Thus the principle of variability is closely connected to automation.

Variability would also not be possible without modularity. Stored digitally, rather than in a fixed medium, media elements maintain their separate identities and can be assembled into numerous sequences under program control. In addition, because the elements themselves are broken into discrete samples (for instance, an image is represented as an array of pixels), they can be created and customized on the fly.

The logic of new media thus corresponds to the postindustrial logic of "production on demand" and "just in time" delivery logics that were themselves made possible by the use of computers and computer networks at all stages of manufacturing and distribution. Here, the "culture industry" (a term coined by Theodor Adorno in the 1930s) is actually ahead of most other industries. The idea that a customer might determine the exact features of her desired car at the showroom, transmit the specs to the factory, and hours later receive the car, remains a dream, but in the case of computer media, such immediacy is reality. Because the same machine is used as both showroom and factory, that is, the same computer generates and displays media—and because the media exists not as a material object but as data that can be sent through wires at the speed of light, the customized version created in response to the user's input is delivered almost immediately. Thus, to continue with the same example, when you access a Web site, the server immediately assembles a customized Web page.

Variability explains one fundamental way that, for instance, video games differ from movies (and that New Media differs from old media). How so? Can you think of other examples of particular New Media productions or services offering themselves in customized versions or variations? Does this variability have social, economic, culture, or political consequences?
More on the next page.

17. See my "Avant-Garde as Software," in *Ostranenie*, ed. Stephen Kovats (Frankfurt and New York: Campus Verlag, 1999) (http://visarts.ucsd.edu/~manovich).

18. For an experiment in creating different multimedia interfaces to the same text, see my *Freud-Lissitzky Navigator* (http://visarts.ucsd.edu/~manovich/FLN).

The principle of variability exemplifies how, historically, changes in media technologies are correlated with social change. If the logic of old media corresponded to the logic of industrial mass society, the logic of new media fits the logic of the postindustrial society, which values individuality over conformity. In industrial mass society everyone was supposed to enjoy the same goods—and to share the same beliefs. This was also the logic of media technology. A media object was assembled in a media factory (such as a Hollywood studio). Millions of identical copies were produced from a

20. Frank Halasz and Mayer Schwartz, "The Dexter Hypertext Reference Model," *Communication of the ACM* (New York: ACM, 1994), 30.

21. Noam Chomsky, *Syntactic Structures* (The Hague and Paris: Mouton, 1957).

master and distributed to all the citizens. Broadcasting, cinema, and print media all followed this logic.

In a postindustrial society, every citizen can construct her own custom lifestyle and "select" her ideology from a large (but not infinite) number of choices. Rather than pushing the same objects/information to a mass audience, marketing now tries to target each individual separately. The logic of new media technology reflects this new social logic. Every visitor to a Web site automatically gets her own custom version of the site created on the fly from a database. The language of the text, the contents, the ads displayed—all these can be customized. According to a report in *USA Today* (9 November 1999), "Unlike ads in magazines or other real-world publications, 'banner' ads on Web pages change with every page view. And most of the companies that place the ads on the Web site track your movements across the Net, 'remembering' which ads you've seen, exactly when you saw them, whether you clicked on them, where you were at the time, and the site you have visited just before."[22]

22. "How Marketers 'Profile' Users," *USA Today* 9 November 1999, 2A.

23. See http://www.three.org. Our conversations helped me to clarify my ideas, and I am very grateful to Jon for the ongoing exchange.

24. Marcos Novak, lecture at the "Interactive Frictions" conference, University of Southern California, Los Angeles, 6 June 1999.

With "Transcoding," Manovich describes the process by which the underlying logic of New Media technologies soaks into the logic of New Media forms, and eventually into our cultural experiences ("culture" defined as a shared way of thinking, feeling, and acting among members of a society or group). For example, how has the transformation of television from a broadcast signal into an on-demand streamed service changed the ways television is produced or watched?

5. Transcoding

Beginning with the basic, "material" principles of new media—numeric coding and modular organization—we moved to more "deep" and far-reaching ones—automation and variability. The fifth and last principle of cultural transcoding aims to describe what in my view is the most substantial consequence of the computerization of media. As I have suggested, computerization turns media into computer data. While from one point of view, computerized media still displays structural organization that makes sense to its human users—images feature recognizable objects; text files consist of grammatical sentences; virtual spaces are defined along the familiar Cartesian coordinate system; and so on—from another point of view, its structure now follows the established conventions of the computer's organization of data. Examples of these conventions are different data structures such as lists, records, and arrays; the already-mentioned substitution of all constants by variables; the separation between algorithms and data structures; and modularity.

Similarly, new media in general can be thought of as consisting of two distinct layers—the "cultural layer" and the "computer layer." Examples of categories belonging to the cultural layer are the encyclopedia and the short story; story and plot; composition and point of view; mimesis and catharsis, comedy and tragedy. Examples of categories in the computer layer are process and packet (as in data packets transmitted through the network); sorting and matching; function and variable; computer language and data structure.

Because new media is created on computers, distributed via computers, and stored and archived on computers, the logic of a computer can be expected to significantly influence the traditional cultural logic of media; that is, we may expect that the computer layer will affect the cultural layer. The ways in which the computer models the world, represents data, and allows us to operate on it; the key operations behind all computer programs (such as search, match, sort, and filter); the conventions of HCI—in short, what can be called the computer's ontology, epistemology, and pragmatics—influence the cultural layer of new media, its organization, its emerging genres, its contents.

Of course, what I call "the computer layer" is not itself fixed but rather changes over time. As hardware and software keep evolving and as the computer is used for new tasks and in new ways, this layer undergoes continuous transformation. The new use of the computer as a media machine is a case in point. This use is having an effect on the computer's hardware and software, especially on the level of the human-computer interface, which increasingly resembles the interfaces of older media machines and cultural technologies—VCR, tape player, photo camera.

In summary, the computer layer and the culture layer influence each other. To use another concept from new media, we can say that they are being composited together. The result of this composite is a new computer culture—a blend of human and computer meanings, of traditional ways in which human culture modeled the world and the computer's own means of representing it.