Summary: Emerging Technology Elliot Chandler

Emerging technologies are innovative technologies that have not yet reached a conclusion of becoming mainstream, at least within their specific domains, or failing.

Predicting whether new technologies will be successful is often very difficult, for three primary reasons. First, these new technologies are not yet proven to work, and often have not even implemented in any practical form yet, being at the invention or prototyping stage. Second, new technologies have not been ensured to be scalable, and third, they have not been demonstrated to adequately resolve the entire range of problems their development is intended to solve.

In addition, new technologies often represent a financial risk, because they are frequently expensive and time-consuming to realize.

As an example of these challenges, when cloud storage systems were developed, it was not yet proven that they would be sufficiently better than the existing systems, such as per-company data warehousing, to make them competitive. That meant they were initially a risk to implement, since companies had to make significant investments to build the necessary infrastructure and software to test the idea at scale without any guarantee of profitability. As can be seen now, cloud storage systems did succeed and become common, but there are many other ideas that had similar investment that failed; those failed ideas are not as famous because they never gained currency.

In the words of Eric S. Raymond, "the most dangerous enemy of a better solution is an existing codebase that is just good enough".

Emerging technologies are the implementations of ideas. Often, those ideas are the product of refining or combining other ideas or technologies.

As an example of a formerly emerging technology that has become mainstream, consider near-field communication technologies, a subset of radio-frequency identification protocols. NFC became common in the mobile telecommunications industry around 2004 to 2006, on the basis of its technological precursors that emerged in the late 1990s. That popularity was driven by the collaborative efforts of Nokia, Sony, and Phillips as the NFC Forum.

Near-field communication is used for payments. While NFC payment technologies were an emerging technology just a few years ago, they have become very common, in forms such as tap-to-pay bank cards and credit cards, and near-field payment capabilities in cell phones and smart watches.

While NFC payment technology is not yet ubiquitous, it has become quite common, with approximately forty percent of the bankcard market outside of the United States supporting NFC. (The United States is trailing behind in this regard, with only approximately three to five percent.)

Another technology that has recently become widespread is the Unicode Standard, a specification for converting writing into computer-readable data. First proposed in 1988, Unicode in its most basic form was widely supported by the mid 2000s, and is now thoroughly supported by most or all current electronic information processing systems. While Unicode itself is supported, not all related technologies have reached the same level of maturity, and so not all Unicode-encoded text will necessarily be displayed to computer users correctly, despite being stored in a format that is understood by the computer.

Cascading Style Sheets have become widely used in Web site design as a way to store information about the intended presentation of documents independently from the documents' semantic content. The CSS specification was first released in 1996, and has grown in complexity since then. The current revisions of the standard are generally implemented by Web clients, as are parts of draft versions of the standard.

While most current databases are either relational databases using SQL-based retrieval systems or non-relational stores such as HBase, a number of systems have been proposed that use a graph-based storage and retrieval model to enable more complex semantic queries based on the relationships between entities.

The basic model of information used by graph databases uses the concepts of *vertices* and *edges*. By assigning semantic meaning to these structures, they can be used to store information. In many situations, the type of information being stored has directionality, such as one letter preceding another in the English alphabet. Those relationships can also be stored and read in either direction with just as much semantic validity when using a graph database.

The existing models of databases, generally flat-file databases, relational databases, or NoSQL object stores, present challenges when attempting to represent complex graphs in a simple, intuitive manner. For that reason, models for native graph storage have seen substantial research in the 2000s and 2010s, and the technology shows significant potential to simplify storing graph-mappable data in semantically consistent models.

For instance, a graph database could have an organizational model based on three classes of information which can be used to represent knowledge: entities, relationships, and metadata. A vertex represents an entity, which is an individual item or concept. A relationship, represented by an edge, is a description of the connection between two entities, and a metadatum, attached to an entity or relationship, is an objective truth about an entity, such as the number of words in a book or the dimensions of a sculpture.

Another possible model for a graph database is to use a key-value append-only object store to record descriptions of the graph, which would likely be a superior solution due to the simpler and more flexible type structure. While such a system would not be a pure graph database, it would have the same effective capabilities as one, and consequently this is a preferable solution to current relational databases. Graph databases are capable of storing existing data models, and also provide superior retrieval capacities for some datasets.

Since graph databases or hybrid graph-database–driven systems are not yet particularly popular, it is difficult to say whether they will be successful in the market.

Multifactor biometric identification is one ongoing area of research with significant potential, since it could allow individual humans to be distinguished from each other in an automated and hard to mislead manner, unlike currently popular systems such as passphrases (which can be inappropriately shared), ID cards (which can be forged or stolen), and single-factor biometric identification such as fingerprints or voice recognition (which can be fooled). Developing effective and reliable multifactor biometric identification systems is dependent on research in other related areas such as artificial intelligence and big data processing. One large-scale implementation of multifactor biometric identification is the Aadhaar system developed by the Unique Identification Authority of India, which uses fingerprints and iris scans and has over a billion enrolled people.

One of the biggest threats to the preservation of historical knowledge is that when it is stored using computers, the knowledge necessary to read the physical media and understand their digital contents will likely be lost. Because computer systems are very complex, it could be quite difficult to implement one compatible with existing computer systems only from a specification, without hardware to use as reference.

Artificial intelligence is the field of study of computer systems' ability to perform tasks that cannot be accomplished easily using straightforward mathematical algorithms. It encompasses technologies such as detecting lines within raster images, natural language parsing, and computer programs that refine their algorithms using information regarding their past performance. Line detection is fairly simple, and can be performed using many typical home computers. Natural language parsing is moderately complex, but is widely available through cloud translation services that allow Web-based use of sufficiently capable computer systems. Automated learning is very complex, and is not yet widely available, being generally only within the domain of corporations, governments, and research projects with sufficient funding.

Graph databases hold significant potential for use in education. Consider Unicode, which has been very valuable to academics' study of historic texts. It has provided improved accessibility of and searching within texts written using historic writing systems. Those historic writing systems were not included in the standards predating Unicode, because those standards were developed primarily for the use of governments and business. In contrast, Unicode enables researchers to submit proposals for the addition of writing systems to the standard. As more proposals are accepted into the Unicode standard, it will expand the range of texts to which Unicode-supporting tools can be applied. However, there is a large area of the textual research process that is not covered by Unicode: the storage and understanding of words within a text, their meanings, their etymologies, and their relationships to one another. That linguistic information is ideally suited to storage and processing using a graph database system, since graph databases can hold those complex relationships in their native form, rather than relying on the complex and unintuitive mappings that traditional databases frequently require.

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