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## **Theory of Information and Communication**

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### **1.3 Evolution of ICTs**



### 1.3.1 From Pioneers to Ubiquitous Technology

Before the advent of platforms like *Instagram*, *TikTok*, and *Google*, the technological and digital landscape was notably different. However, to understand the development and transformation of these services, it is essential to explore the theoretical and philosophical contributions of various personalities who laid the groundwork for the modern Internet and the concept of information, digital documents, and communication technologies. These pioneering ideas paved the way for technological evolution and influenced how we interact, share information, and communicate in the digital age.

#### Paul Otlet

Paul Otlet (1868-1944) was a prominent Belgian thinker and documentalist, recognized as the creator and founder of Documentation as a science and disciplinary field within the social sciences. His most influential work is the "Treatise on Documentation," published in 1934 in collaboration with Henri La Fontaine. Among his notable contributions are:

- He was the first to use the term "document," emphasizing the value of content and anticipating the ubiquity of information beyond physical media. Additionally, he addressed the differences between a book and a document, proposing a broader and more universal concept of the latter, which included written works and other formats such as photographs, slides, films, and radio programs. For Otlet, the document was at the center of a complex communication and knowledge transmission process, laying the groundwork for Information Science.
- He argued for the urgency of an emerging discipline, Documentation, asserting that the traditional library science approach would not suffice to handle the growing torrent of information and new formats arising from the technologies in the 1920s-1950s, especially in the post-war context of 1945. This discipline understood a document as various formats in which information is supported beyond books, objects of documentary processes.
- The Treaty of Documentation marked the first cooperation between archives, libraries, and museums, beginning the post-custodial phase. The emphasis of processes in these institutions shifted from physical storage to access and use of information as a social and human phenomenon. This philosophical change in the use of information in society laid the groundwork for the expansion, leading to what is now known as the Information Society.
- Another critical contribution was developing a universal classification system called the Universal Decimal Classification (UDC). This classification allowed for the organization and categorization of a wide range of information, altering standards in cataloging and laying the foundations for indexing and data retrieval in the digital age. One of the main benefits of the UDC in document analysis is its ability to provide a coherent and standardized structure for organizing information, facilitating the identification of relevant documents and efficient navigation through extensive collections. Additionally, being a widely used and recognized system internationally, the UDC facilitates communication and information exchange between institutions and users. Today, hashtags, tagging in social media, and searches by content and free text owe much to this system.
- Otlet pioneered creating information networks through his most ambitious project, the "International Office of Bibliography" (OIB). This organization sought to collect and organize information worldwide to create a global interconnected knowledge network or an International catalog. His vision transcended the boundaries of his time and anticipated the concept of a worldwide network by imagining an interconnected system of what he called "book radios." This vision conceived long before the era of modern computing and

the Internet, aimed to enable remote access to information, prefiguring in some ways the essence of what would later become the World Wide Web.

- Additionally, Otlet co-founded the Mundaneum, a precursor initiative to the modern digital library. The Mundaneum aimed to collect and organize information from around the world in a single physical location, thus laying the groundwork for a global digital library. Although the project did not reach its full realization, his vision and efforts significantly contributed to the development of the idea of a worldwide library accessible through digital means.

### **Vannevar Bush**

Vannevar Bush (1890-1974) was an American engineer, inventor, and politician prominent in developing Anglo-Saxon Information Science. In 1945, he published an essential article titled "As We May Think," which is considered a visionary reflection on the role of information in scientific and technological advancement.

Under the immediate post-war phenomenon, "Vannevar Bush begins to question the problem posed by the exodus of recorded information, accumulated after several years of conflict" (Camaraza, 2005). In his article, he proposed the concept of a device called the Memex, designed to organize and retrieve information associatively, thus reflecting human thought processes. Although revolutionary, the Memex did not materialize into practical applications. However, Bush's ideas anticipated the emergence of hypertext and digital storage systems such as CD-ROMs and DVDs.

Bush's work reveals a profound connection between scientific research, information, and technological development. Concurrently, the University of Pennsylvania's 1946 development of the first electronic digital computer, the ENIAC, marked the beginning of computational theories.

Bush raised the need to address the problem of information explosion using emerging computational technology. The first original idea, emerging in the 1950s, is information retrieval, introducing information processing based on formal logic. The second, emerging shortly after that, is relevance, directly orienting and associating the process with human information needs. The third, derived from elsewhere about two decades later, is interaction, enabling direct exchanges and feedback between systems and individuals immersed in the information retrieval process. These ideas propose to create information organization and retrieval systems with less artificial structures, capable of simulating the associative nature of human thought, considering the deluge of knowledge that occurred and, consequently, the exponential and sustained growth of scientific-technical publication.

### **The beginning of the Internet: ARPANET**

ARPANET was the precursor of the Internet, designed to facilitate communication between geographically distant computers. It was created by the United States Department of Defense's Advanced Research Projects Agency (ARPA) in the 1960s. The inception of ARPANET dates back to 1969 when the first connection was established between two computer nodes located at the University of California, Los Angeles (UCLA), and the Stanford Research Institute (SRI). This event marked the birth of the network that would eventually become the Internet.

ARPANET was created to develop a resilient and reliable communication system that could remain operational even during military attacks or natural disasters. Instead of using a centralized route, ARPANET employed a decentralized approach, where data could be transmitted through multiple routes, ensuring the network's resilience and availability.

ARPANET's design was based on packet switching, which divided data into smaller packets for transmission, allowing for more efficient and robust communication. This decentralized architecture and packet switching laid the groundwork for the later development of the Internet.

ARPANET experienced significant growth in the 1970s, adding more academic and research institutions to the network. As more nodes were added, ARPANET became an invaluable resource for scientific and educational collaboration, facilitating the exchange of information and resources between institutions worldwide. This growth continued in the following decades until ARPANET was officially retired in 1990, paving the way for the expansion and evolution of the Internet as we know it today.

After ARPANET, one of the most significant milestones in Internet development was the creation of the TCP/IP (Transmission Control Protocol/Internet Protocol) communication protocol in the 1980s. TCP/IP became the fundamental standard for communication in computer networks and is the protocol that underpins Internet operation today.

TCP/IP enabled the interconnection of various computer networks, creating a global network with worldwide reach. This interconnected network began to be known as the Internet in the early 1980s.

Besides the development of TCP/IP, significant milestones in the Internet's evolution include launching the first email service in 1971. Tim Berners-Lee created the first web browser in 1990, and the introduction of the World Wide Web to the public in 1991.

Along with other technological advances and innovative developments, these milestones have contributed to expanding and popularizing the Internet as a fundamental tool in communication, information exchange, e-commerce, and many different areas of modern life.

### **Ubiquitous technology**

Ubiquitous technology, also known as ubiquitous computing or pervasive computing, refers to integrating computing into people's everyday lives, such that electronic devices are present ubiquitously and transparently in the environment. The main idea behind ubiquitous technology is that electronic devices can be used intuitively and naturally without the user needing to know their presence or operation.

Ubiquitous technology is characterized by the interconnection of devices and their ability to communicate with each other and the physical environment through communication networks. This allows devices to automatically collect, process, and share information without direct human intervention.

A typical example of ubiquitous technology is smart home devices, such as smart thermostats, automated lights, and Internet-connected security systems. These devices can be controlled and monitored remotely through mobile applications or voice commands, giving users more convenience and control over their home environment.