connected sustainable cities

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one/how cities have evolved

It is helpful to put the emergence of connected sustainable cities into long-term evolutionary perspective. For cities, like living organisms, have evolved from simple forms to more complex, internally differentiated, and intelligent versions.

Skeletons and skins

The earliest cities consisted of little more than skeleton and skin. They provided walls, floors, and roofs for shelter and protection, in combination with simple structural skeletons to hold them up. Climate control in building interiors was largely achieved by passive means, through the use of waterproofing, insulation, thermal mass, sunlight and shade, and ventilation. Water, food, and fuel were carried into cities with human and animal muscle power, and carried out in much the same way. The intelligence needed to operate these cities resided in the heads of their inhabitants.

Before long, though, primitive networks emerged to enhance operational efficiency and enable growth to larger scales. Roman cities, for example, had quite sophisticated water supply and sewage systems that served the urban fabric internally and connected it to increasingly distant sources and sinks in the surrounding territory. Similarly, street and road networks developed to enable the free circulation of people and to facilitate the supply of goods and the removal of waste.

Mechanical metabolisms

In the industrial era, urban networks multiplied, differentiated, and grew in scale. Furthermore, their operation was mechanized through the introduction of engines, pumps, and mechanically powered vehicles. Buildings acquired complex indoor plumbing networks connected to increasingly varied appliances and fixtures, heating, mechanical ventilation, air conditioning systems, gas and other fuel systems, electrical systems, movement systems, and safety systems. On urban and regional scales, cities developed massive infrastructures for water supply and liquid waste removal, energy supply, transportation, and solid waste removal. In other words, they added mechanical metabolic systems to the skeletons and skins that they had traditionally provided. These systems then became major consumers of energy and producers of waste and pollution.

Electronic nervous systems

At the dawn of the electronic era, buildings and cities began to develop primitive nervous systems. Telegraph, telephone, and radio communication systems provided the first artificial nerves. These allowed architectural and urban systems to develop simple reflexes and feedback loops. Thermostats controlled heating systems, elevators were called by pushbutton controls, and the telegraph system controlled the operations of the railroad. It became increasingly apparent that information and control were key to the efficient operation of buildings and cities.

In the Internet era, these primitive nervous systems rapidly evolved into something approximating the advanced nervous systems of higher organisms. Ubiquitous digital networks supplanted the older analog networks and formed a new kind of urban infrastructure. Distributed systems of networked computers and server farms became the brains of cities. Pervasive sensing connected vast, new streams of data about urban activities to these brains. The flows of resources into cities, the processing and distribution of materials, energy, and products, the coordination of the actions of individuals and organizations, and the eventual removal or recycling of waste were increasingly informed, coordinated, and sometimes controlled by the new, rapidly growing, digital nervous systems.

Working smarter

Throughout history, cities have grown larger and worked harder to meet the needs of their inhabitants. Now it is time for them to work smarter. The emerging conditions open up new opportunities for intelligently efficient, sustainable operation of cities. We describe these in the following pages.

Connected sustainable cities, which will evolve over the next decade, employ ubiquitous, networked intelligence to ensure the efficient and responsible use of the scarce resources – particularly energy and water – that are required for a city's operation, together with the effective management of waste products that a city produces, such as carbon emissions to the atmosphere.

Through a series of prospective scenarios, *Connected Sustainable Cities* illustrates some of the ways in which inhabitants may use and manage their living spaces, move around the city, work, shop, pursue their educational, cultural, and recreational interests, and make well informed, responsible personal choices. These scenarios are accompanied by brief sketches of the existing and emerging technologies, products, and systems that will support new, intelligently sustainable urban living patterns. In addition, there are short discussions of some of the theoretical, policy, and design issues that these scenarios raise.

Connected Sustainable Cities is a starting point for the investigations and debates that will be necessary as citizens, technologists, designers, policy experts, and political and business leaders begin to shape the new urban areas we urgently need to create in the near future.