Pyongyang: Peaceful Land for All

In 2220, Pyongyang (population: 2 million), in the East Asian nation of North Korea, is a symbol of human redemption and a vibrant tourist hub: businesses and restaurants line the Taedong river, while the island of Turusŏm is a recreation hub, with first-class entertainment facilities. Yet back in the 21st century, Pyongyang was plagued with poverty, hunger, as well as societal and economic inequalities. With more than 40% of the population undernourished, the elderly and the disabled suffered greatly. Crimes against humanity, including deliberate starvation and political internment, were widespread. After a military conflict inflicted severe population loss, the government integrated the Aging, Impaired, and Disabled (AID) population into productive members of the economy: it was known as the Great Awakening. A center of peace, unity, and inclusivity, Pyongyang was designed around three core principles: **safety, independence, and social connections**, through cutting-edge technology and a carefully phased approach.

PHASE I - Wearable Technology: Enhancing Daily Routine and Increasing Safety

Assistive, wearable technology fostered independence for all Pyongyang citizens, starting with a modular, tailored bionic suit. **Biotech Engineers** used digital technologies to connect bionic suits with a smart environment, enabling data collection harnessed by the city to improve problem-response. Exoskeletons use wireless transmitter properties to connect brain signals to a bionic suit, mostly replacing wheelchairs. Our modular bionic suit is powered through electrical impulses sent directly from the wearer's brain, through electrodes or chips placed in or on the brain. Brain signals are translated into commands and relayed to a machine, like a robotic arm, carrying out the desired action. The fast brain-to-robotics interface mimics natural-motion.

The suit's reversible fabric keeps skin at a comfortable temperature whatever the weather. It combines thermal engineering concepts with nanophotonic structures enabling new functionalities. On one side, a copper coating traps heat between a polyethylene layer and the skin. On the other, a carbon coating releases heat under another layer of polyethylene.

Figure 1 – Customizable Self-Learning Bionic Suit (IoT)

The visually-impaired were fitted with a retinal prosthesis system, with tiny cameras mounted on glasses sending signals directly to the eyes and brain through a retinal implant. An auditory brainstem implant restores hearing to the deaf via an implanted microphone and transmitter placed inside the ear converting sounds to electrical signals, transmitted to an internal receiver implanted on the brain stem. With augmented reality glasses converting input into information, customized and pre-programmed for cognitive impairment, users better respond to situations such as finding an exit in case of a fire. For individuals suffering memory loss, the glasses are pre-programmed with directions associated with daily routine. People with degenerative diseases use programmed self-driven wheelchairs taking them directly to their destination. Interaction between people and the environment was enhanced, increasing safety, autonomy, and decreasing healthcare costs, making the city more resilient.

PHASE II – Smart Living Environments: Autonomy and Dignity

City planners, architects, and **Building Engineers** designed smart-homes, promoting safe, autonomous living for the AID population while reducing stress for relatives and caretakers. Smart sensors monitor potential hazards: gas and floor sensors near key areas (bed, kitchen, bathroom) send alerts in real-time to social service responders. Floor sensors work via image processing: each sensing element is connected to a pixel of an image. The bathroom mirror has an inlaid scanner analyzing facial features for signs of depression or stroke, picking up face drooping. Smart toilets perform automatic analysis for early detection of infections and diseases with biosensors. Results are sent directly to Pyongyang's Central Hospital. **Bioengineers** exploited DNA-sequencing, so that the smart toilet recognizes its user and carries out microbiota analysis, anticipating viral outbreaks. This lab-on-chip technology is also applied to sewage wastewater, connected to a smart city-wide grid for public-health strategies. These human centric

solutions resulted in a 35% savings in assistance and care. These non-invasive smart technologies support autonomous living -a form of luxury living.

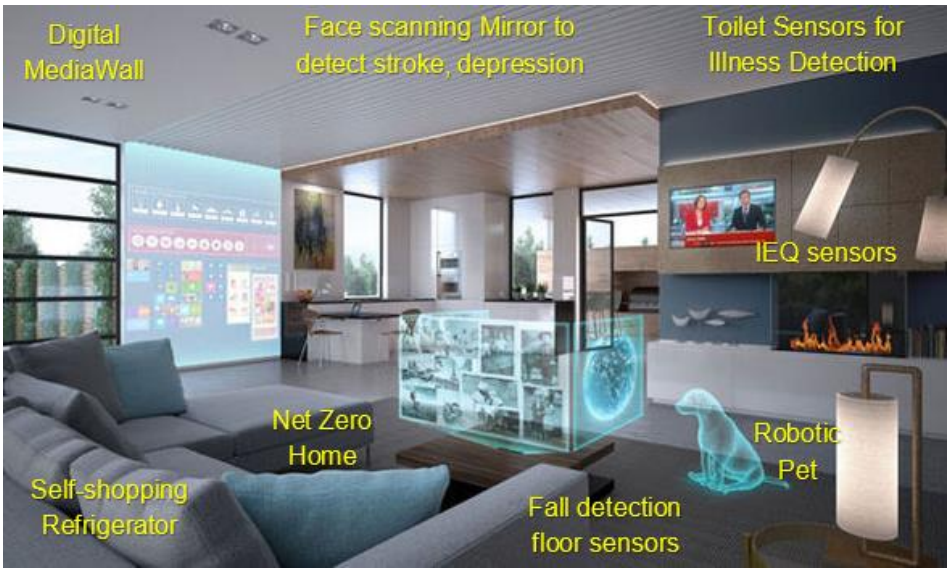

Figure 2 - An integrated smart-living environment

Living alone does not mean living lonely. To reduce social isolation, **Computer Engineers** utilized virtual imaging communication for remote interactions with loved ones and an immersive visual experience from the comfort of the living-room. A curved Digital MediaWall provides an optical display system creating an Augmented Reality environment with endless applications, from chatting with relative and friends to having a virtual doctor's appointment.

PHASE III – Planning a Smart(-)City: Fostering Resilience and Social Connections with ELIXIR

ELIXIR is a 6-principle plan (see figure 3) for an inclusive and exhaustive city design. This human centric approach was essential as the AID population faces diverse challenges and evolving needs. For instance, 76-year-old Chae-Won is quite mobile but suffers from a declining memory, whereas her neighbor Dae-Jung, 80, has diabetes and must monitor his diet carefully.

Figure 3 – ELIXIR: A Principled Approach to City Planning

- **Smart-City Technologies and Equality**

Pyongyang combines sensing and monitoring capabilities with data analytics to respond in real-time and more personally to citizen needs. Our bionic suit has strategically-placed sensors connected to a GPS system. Data points enable instant notification of on-the-ground issues (e.g. registering falls) to monitoring IT hubs. Health sensors in public spaces track the origin of disease outbreaks. **Bioengineers** and physicians created an innovative mobile telemedicine platform using holographic interfaces. Supported by biorobots, paramedics and EMT access mixed-reality information, giving them here-and-now access to digitized medical data. Lives are saved, medical impact is reduced, and financial burden is reduced.

Smart-city technologies yielded economic benefits, with high employment of specialized engineers and data-analytics experts, and supports top-notch education. This non-invasive human-computer interaction increased quality of life for everyone: public parks have an interactive interface informing visitors of upcoming events; immersive interactive environments also keep citizens informed in real-time (i.e., weather alerts, disasters, and criminal acts). While some bring up privacy loss as a tradeoff, clear gains in dignity living and active social lifestyle offset it.

- **Modularity for Maximizing Space, Social Connections and Reducing Inefficiencies**

Inspired by biomimetic concepts, city planners adopted a modular, beehive-like structure emphasizing independence and interactions. It underscores **scalability, autonomy,** and **community**. Each interconnected yet autonomous hexagon ‘village’ has schools, health services, and commercial quarters, enhancing access, minimizing traveling, and fostering inclusivity. The

beehive pattern allows for highly efficient micro grid power plants and shared strategic resources.

Public spaces are designed for interaction and exercise. Animal parks assist seniors with stress and cognitive issues; seniors and youth can enjoy each other's company and experience in libraries and recreation spaces; and Meet-Me-at-the-Park friendship groups battle loneliness and improve human connections. **Lifelong learning** is the basic tenet of education. Retired people can learn and/or teach and impart their wisdom to the youth. The Biomimicry Institute is a world class facility that teaches about nature-inspired designs that do not overconsume, waste nothing, and recycle all.

Each community is food and energy self-sufficient, thanks to **U**rban **V**ertical **E**cology **T**owers. **UVET**s take in CO_2 and NO_X, as well as food waste, treated sewage, and rainwater. Algae tubes are in the glass, and CO_2 and NO_X filter through, allowing the algae to photosynthesize and produce water and oxygen for other plants. Many of these food towers employ the elderly, who stay physically active and connect with nature.

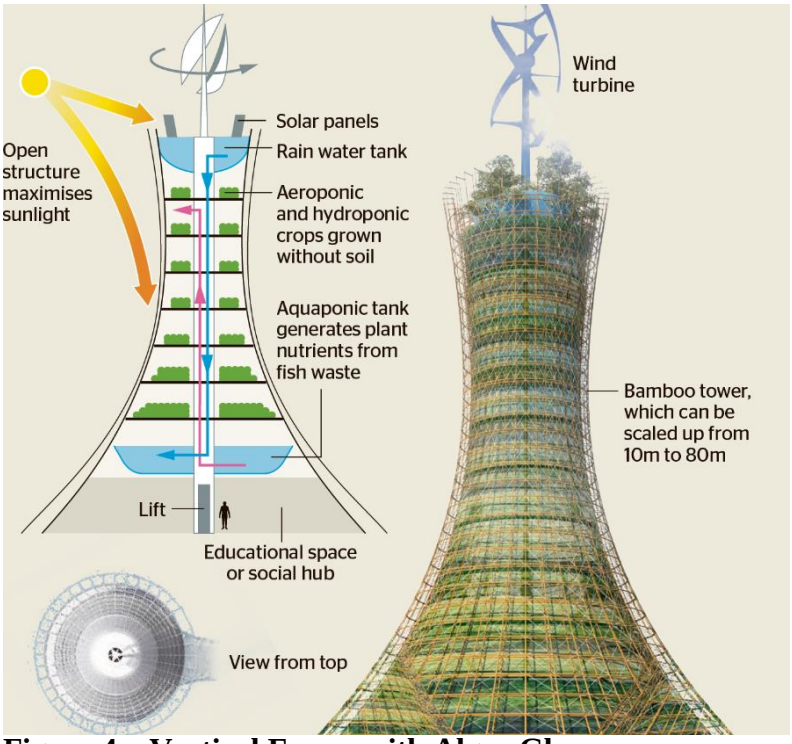

Figure 4 – Vertical Farms with Algae Glass

Pyongyang's **waste system** is automated, decentralized, and integrated into city infrastructure, diverting all waste from the landfill. Two bins (compost; other) minimize waste placement mistakes. All buildings have underground waste storage cleared out into a WM facility. Metals are magnetically separated from the waste, put in algae tanks. Dense bioplastics float to the top, are removed and melted into new materials. A plasma gasifier ($8{,}000^{O}$ C) treats remaining materials, producing energy and plasmarok slag used for construction.

Transportation Engineers designed a comprehensive, safe transportation system, solving AID's accessibility issue. Modes of transit include maglev, skytram, and electric pods that link up, reducing traffic. Transportation systems were relocated underground, and surface roads converted to parks and community gardens, curbing urban pollution. Fossil fuels caused pollution, CO, SO x and NO x, lethal for AID with compromised immune systems. Electric cars solved the air quality issue, and fully autonomous vehicles solved problems related to clumsy, emotional human driving. **Environmental Engineers** regularly monitor air quality.

Banning fossil fuels led to a surge of **green power for the micro-grids**. Cyanobacterial nano-photoreceptors on all surfaces transform light into electricity using opto-electronic converters. Our biophotovoltaic circuits printed on paper with ink-jet printers generate electricity both in dark and light. Using nanotechnology, energy-generating, optoelectronic-converters convert light to electricity or excess electricity into light.

Fire **safety** drones equipped with an Electrical Wave Blaster sends pressure waves, bending and extinguishing flames. Police drones use sensors for incident determination, and are equipped with tranquilizers, defibrillators and first aid kits to provide basic first-aid. Sweat Illness Detection Sensors uplink to city database for early detection of illnesses. **Nanorobotics Engineers** developed nanobots capable of detecting cancers and diseases.

Not only is Pyongyang inclusive by design, but its innovations benefit everyone - young or old, abled or disabled. Using smart technologies and human centric solutions, Pyongyang devised its ELIXIR, raising everyone's quality of life.

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