Soft and Social Robotics for Improved Human Centred Applications

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INNOVATION SCHOOL
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ROBOSOFT

Singapore · 3-7 April 2023

Perspectives on future environments, robotic interactions and design evaluation

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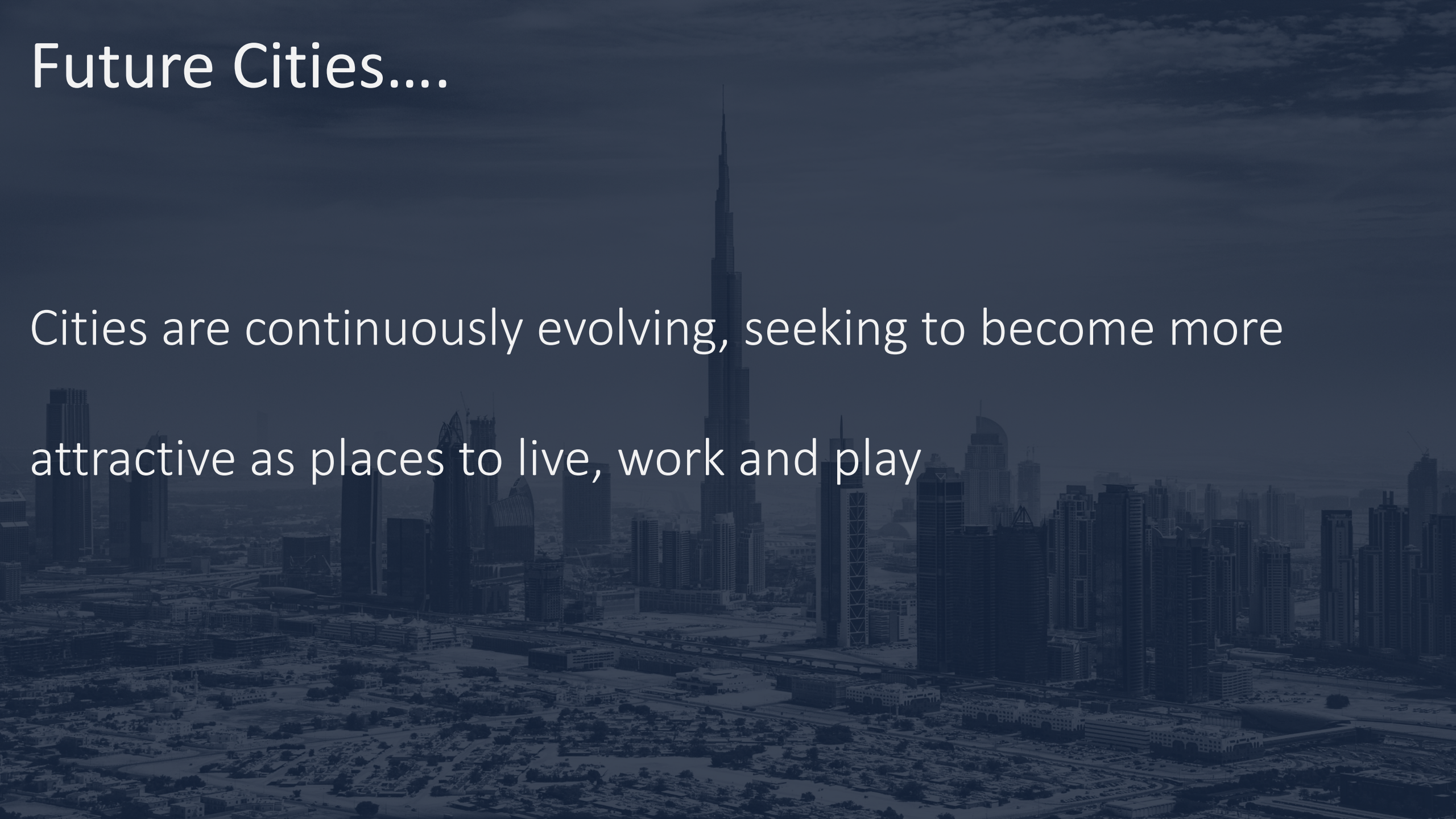
“It is difficult to know what the future holds.

The future is by no means empty – it will be occupied by built environments, infrastructures and things that we have designed. It will bear the consequences of our histories, structures, policies and lifestyles, which we daily (re)produce by habit or with intent in design.”

Mazé (2016)

Future Cities….



Cities are continuously evolving, seeking to become more attractive as places to live, work and play

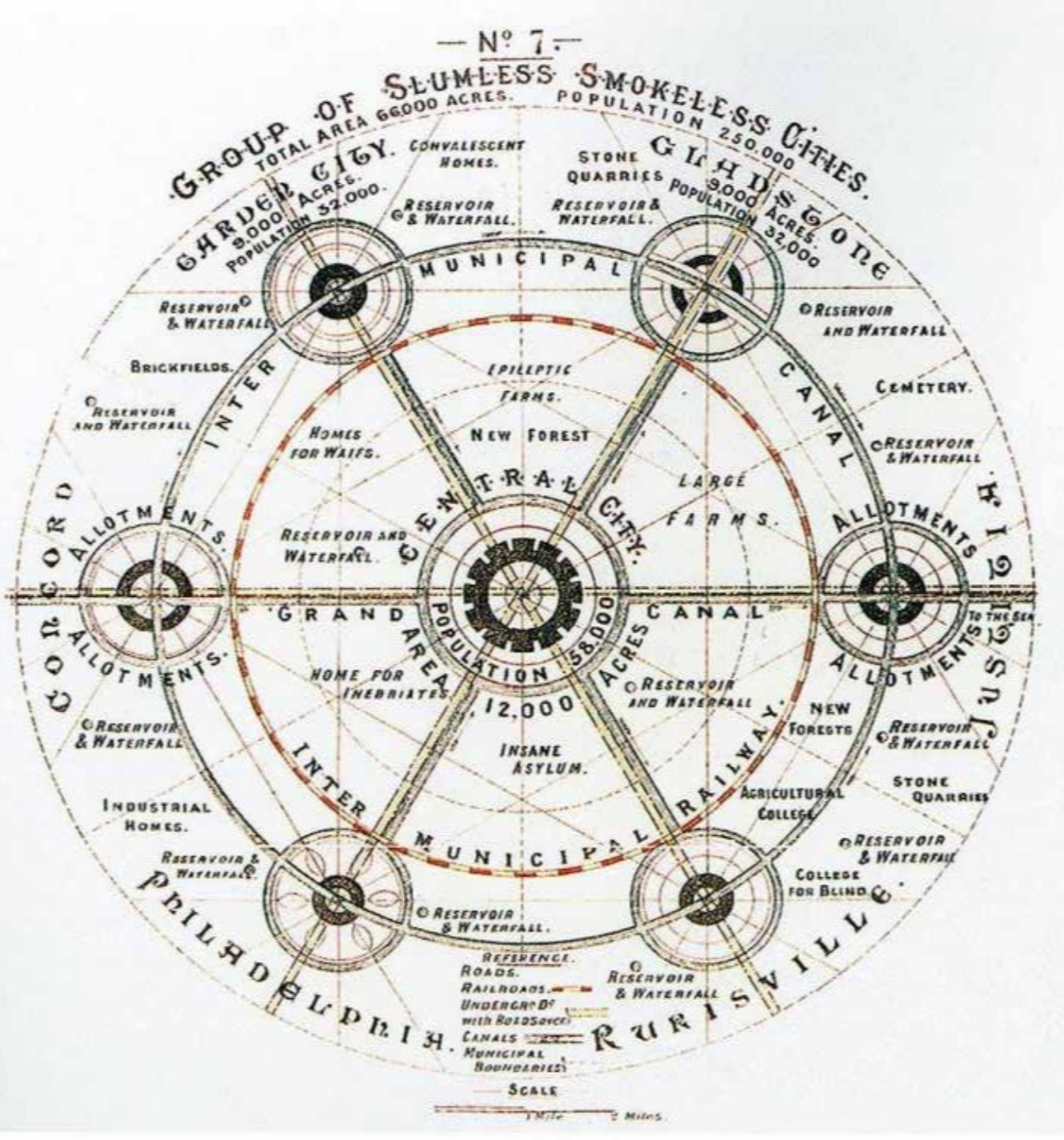
Future Cities….

They are engines of economic growth as well as the key to our future health and wellbeing.

Future Cities – Looking back…

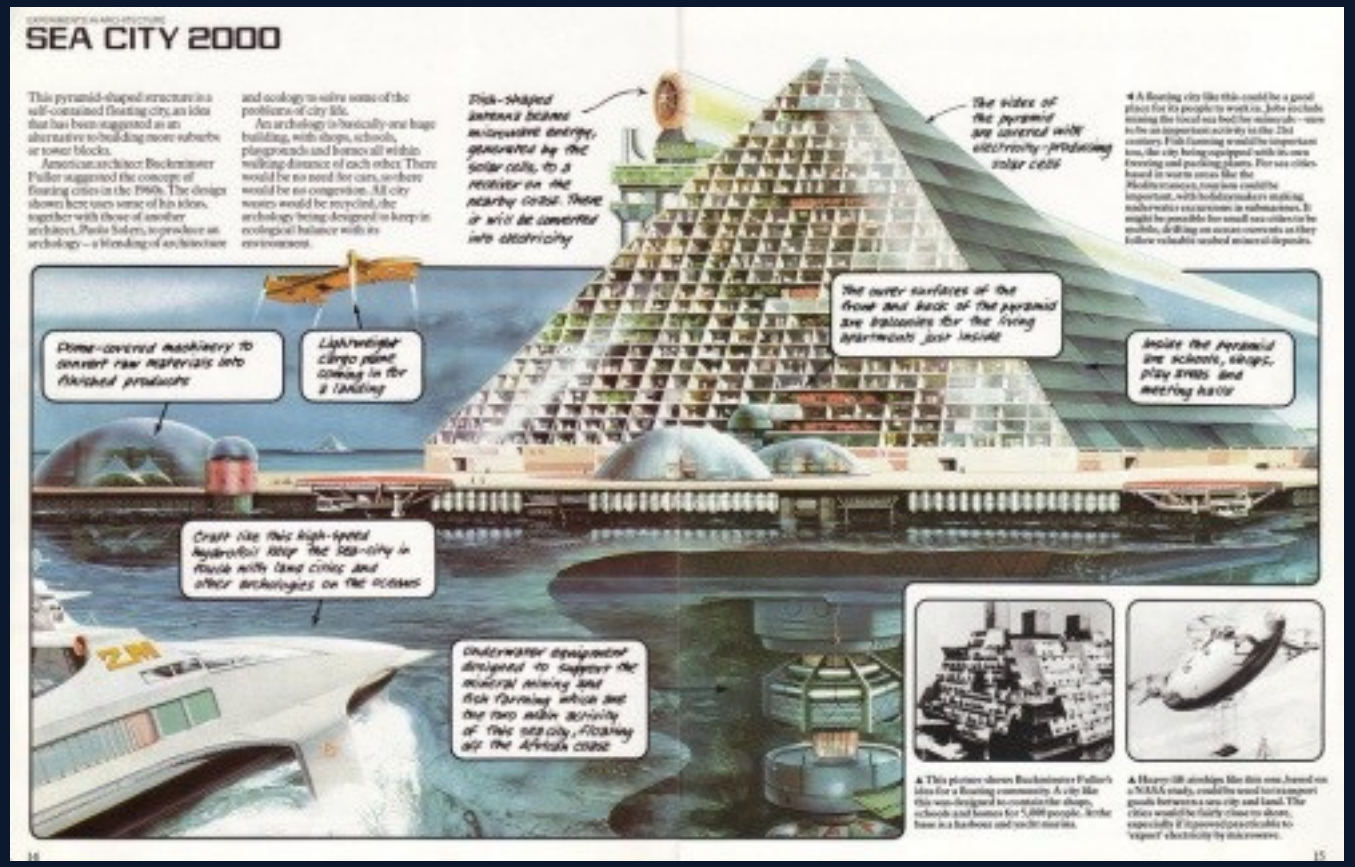
Ebenezer Howard – Garden City

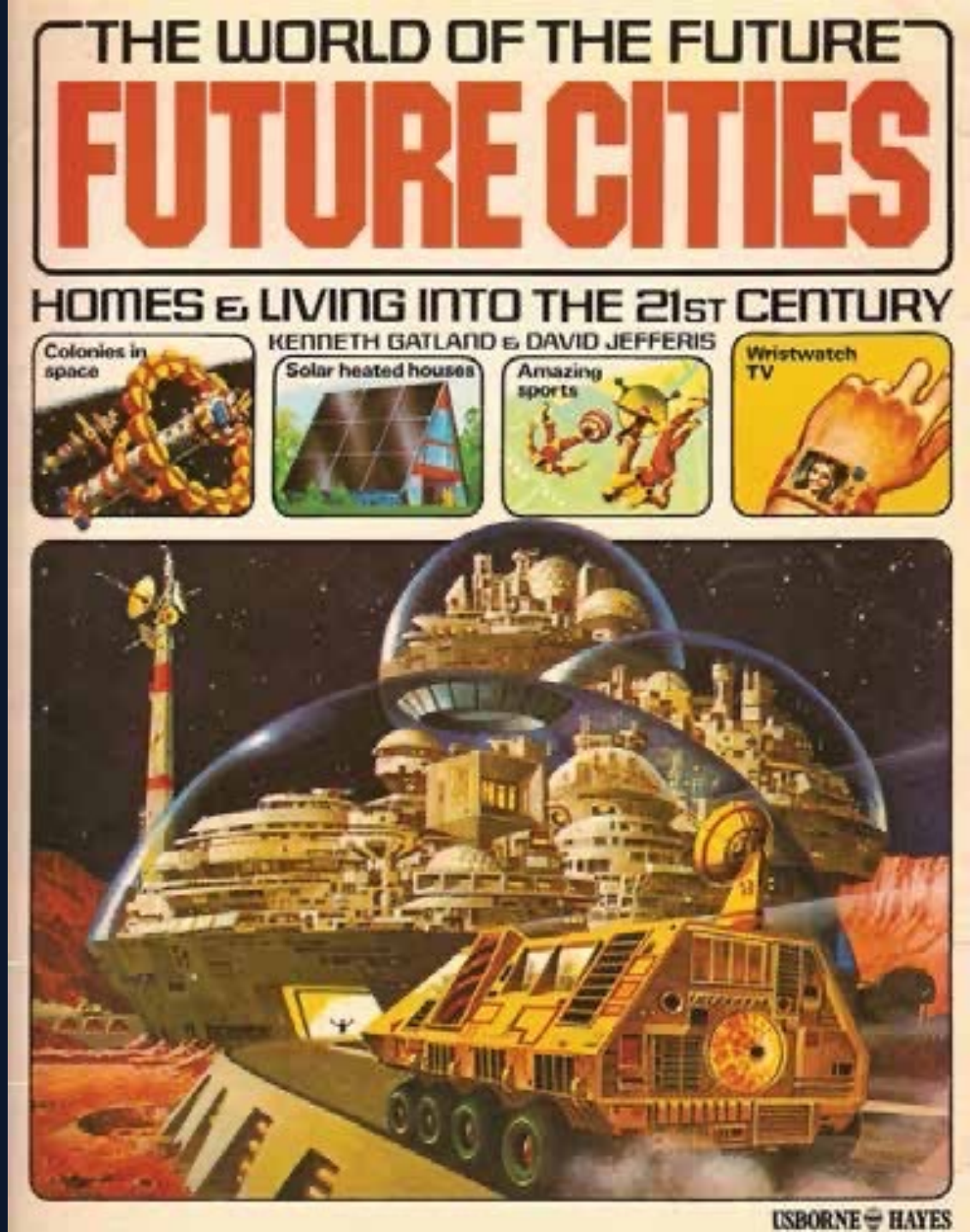
Well connected and biodiversity rich public parks, and a mix of public and private networks of well managed, high-quality gardens, tree-lined streets and open spaces. Distinct separation of the residential, industrial and civic areas and in the use of parks to screen residential neighbourhoods from roads and other undesirable things. strong local cultural, recreational and shopping facilities in walkable neighbourhoods



Future Cities – 1979

Ken Gatland & David Jefferis

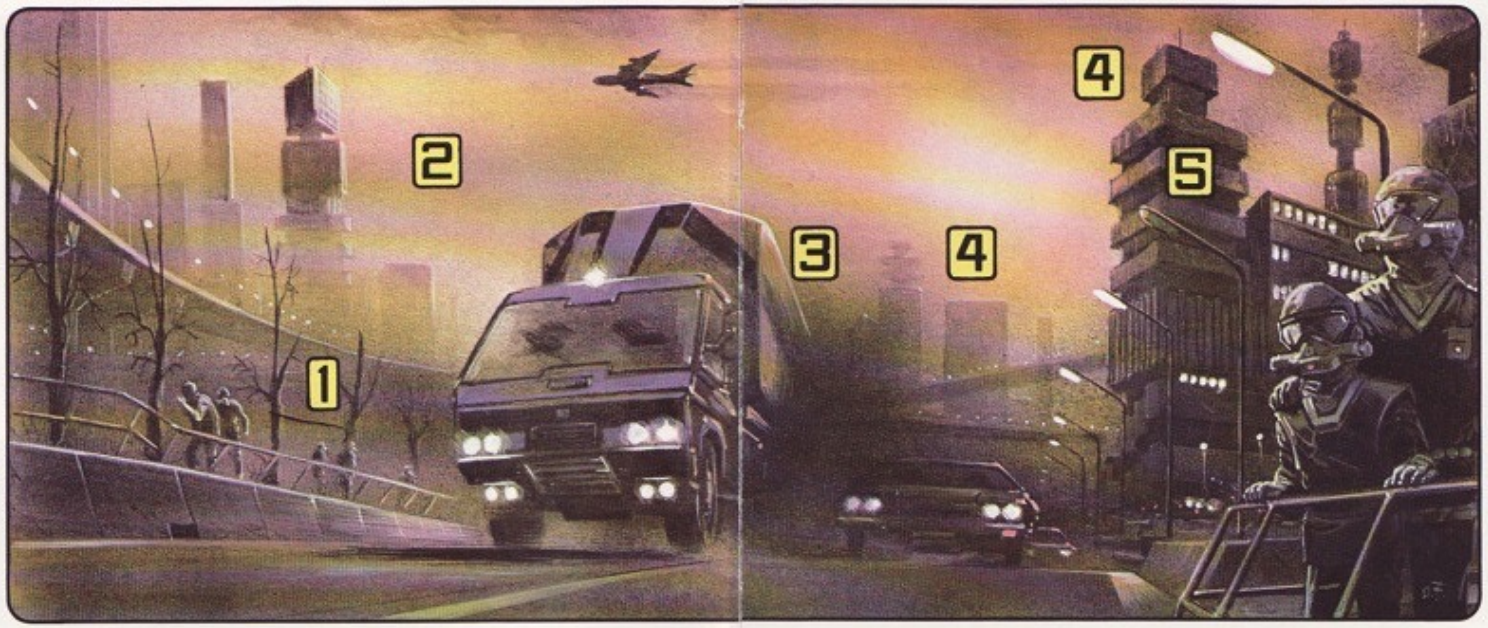




TWO TRIPS TO THE 21ST CENTURY

On these pages, you can see two sorts of city. The top one, a polluted pest-hole, already exists in at least one respect – traffic cops in the Tokyo of today have to wear smog masks. The bottom picture, a fairly clean, moderately attractive place, is possible if planners and people strive to make it so.

Some help is already to hand. People are at least aware of many of the problems of city life and are trying to solve them; and space satellites can be used for pollution control. The picture below showing northern Europe and its weather is a typical example of the clear pictures possible using 'sky-spies'.



Polluted city of a dying world

If drastic steps are not taken to control pollution and to try and achieve some sort of ecological balance in the world, the picture on the left is likely to be typical of a city of the early 21st century. Its unpleasant features include:

1 Line of stunted, dying trees. At least these are still alive. In some present-day cities, planners have included plastic ones as bright, colourful, easy-clean alternatives to the real, oxygen-producing, thing.

2 Smog-laden sky. Visibility is limited and rain washes acids down from the sky. A jet trails a plume of filth.

3 Heavy trucks thunder along the pitted roadway while cars battle their way through the traffic fumes. Vehicles are running on petrol fuel, a rare but valuable item in this future world. Alternatives to petrol, such as solar or nuclear fusion power, have not been pursued, so there is nothing to replace the oil when it runs out.

4 Huge, ugly, apartment blocks are thrown up to keep pace with the rapidly increasing population of the city. Birth control measures have failed and most people are out of work and ill-fed.

5 Neglect and decay result in city systems – such as lighting – breaking down.

Garden city on a cared-for planet

This scene, though not pretending to show that a perfect world is possible, nevertheless indicates that tomorrow's towns could be pleasant places to live, work and play in.

1 Electric monorail train provides an effective though not especially elegant solution to the problem of high speed travel.

2 Below the line runs a pipe network through which most bulk cargo (such as fuel, water, grain) is pumped, silently and efficiently.

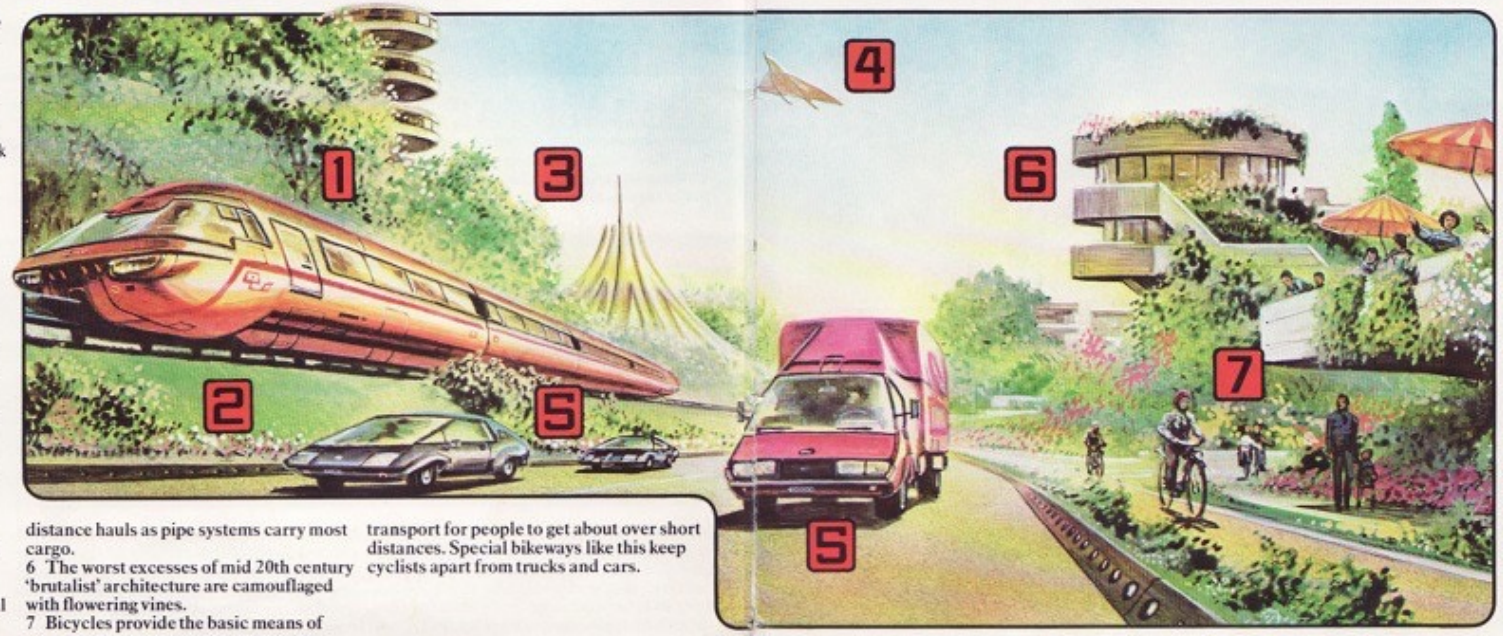
3 The city is green all over, the result of a massive world-wide tree-planting scheme started in the 1980s. It is estimated by present-day researchers that every man, woman and child on Earth needs to plant a tree a day in order to keep a balance with those that are removed or killed. The world's main oxygen-producing area is, at present, the Brazilian rain-forest. This is being chopped down, slowly but surely. A balance must be kept.

4 Non-polluting jet, powered by hydrogen fuel (whose waste is water) flies quietly across the sky.

5 Fumeless electric vehicles used for local travel. Trucks are only needed for short-distance hauls as pipe systems carry most cargo.

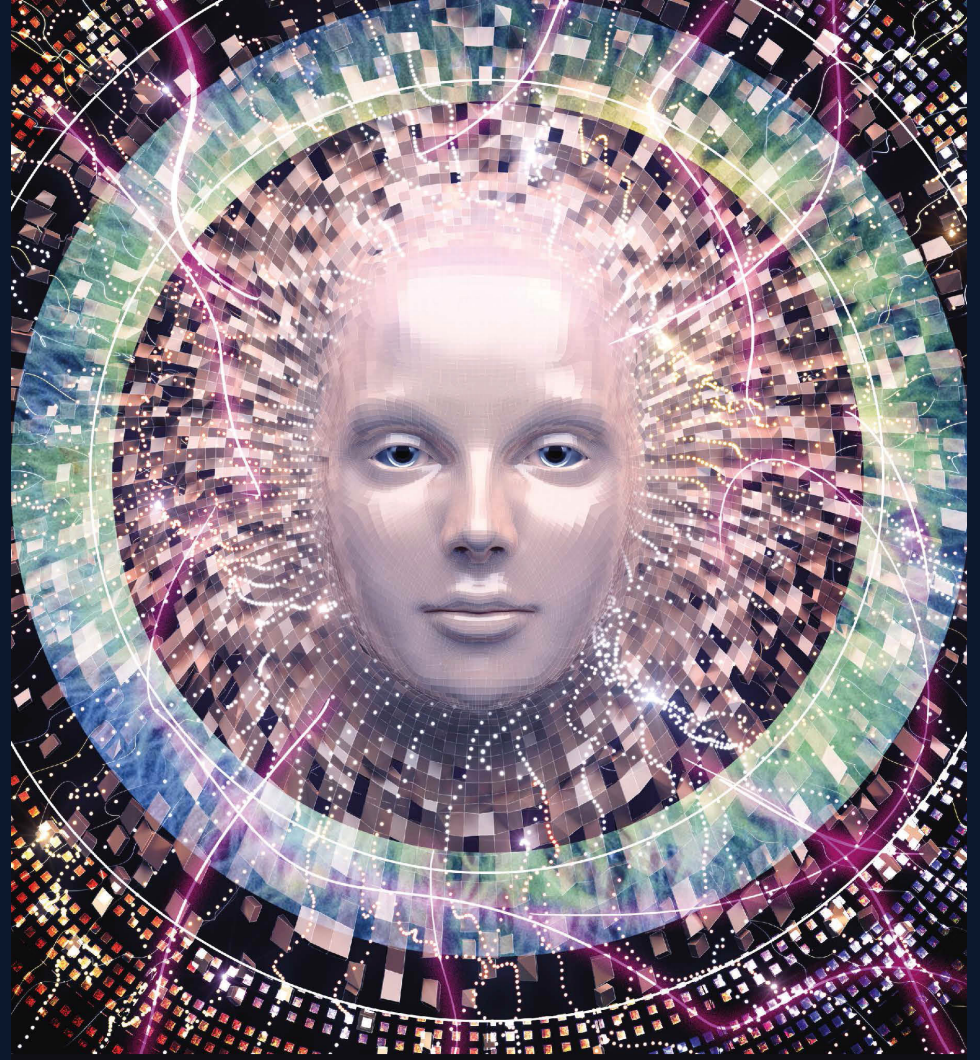
6 The worst excesses of mid 20th century 'brutalist' architecture are camouflaged with flowering vines.

7 Bicycles provide the basic means of transport for people to get about over short distances. Special bikeways like this keep cyclists apart from trucks and cars.



Power for tomorrow's towns

Present research in Europe, USA and the USSR indicates that the 'Tokamak' nuclear fusion reactor could provide much of the energy for the people of tomorrow's towns. A Tokamak generates an intense magnetic field in its doughnut shaped reaction chamber to burn atoms of deuterium and tritium fuel. The result, like a controlled H-bomb, is heat and light. The heat can be used to generate electricity. Deuterium, which comes from seawater, is virtually limitless in supply. Tritium supplies will take 50,000 years to run out. One litre of the fuel is equivalent, in terms of energy, to about 300 litres of oil.



TRANSGENERATIONAL TECHNOLOGY AND INTERACTIONS FOR THE 21ST CENTURY

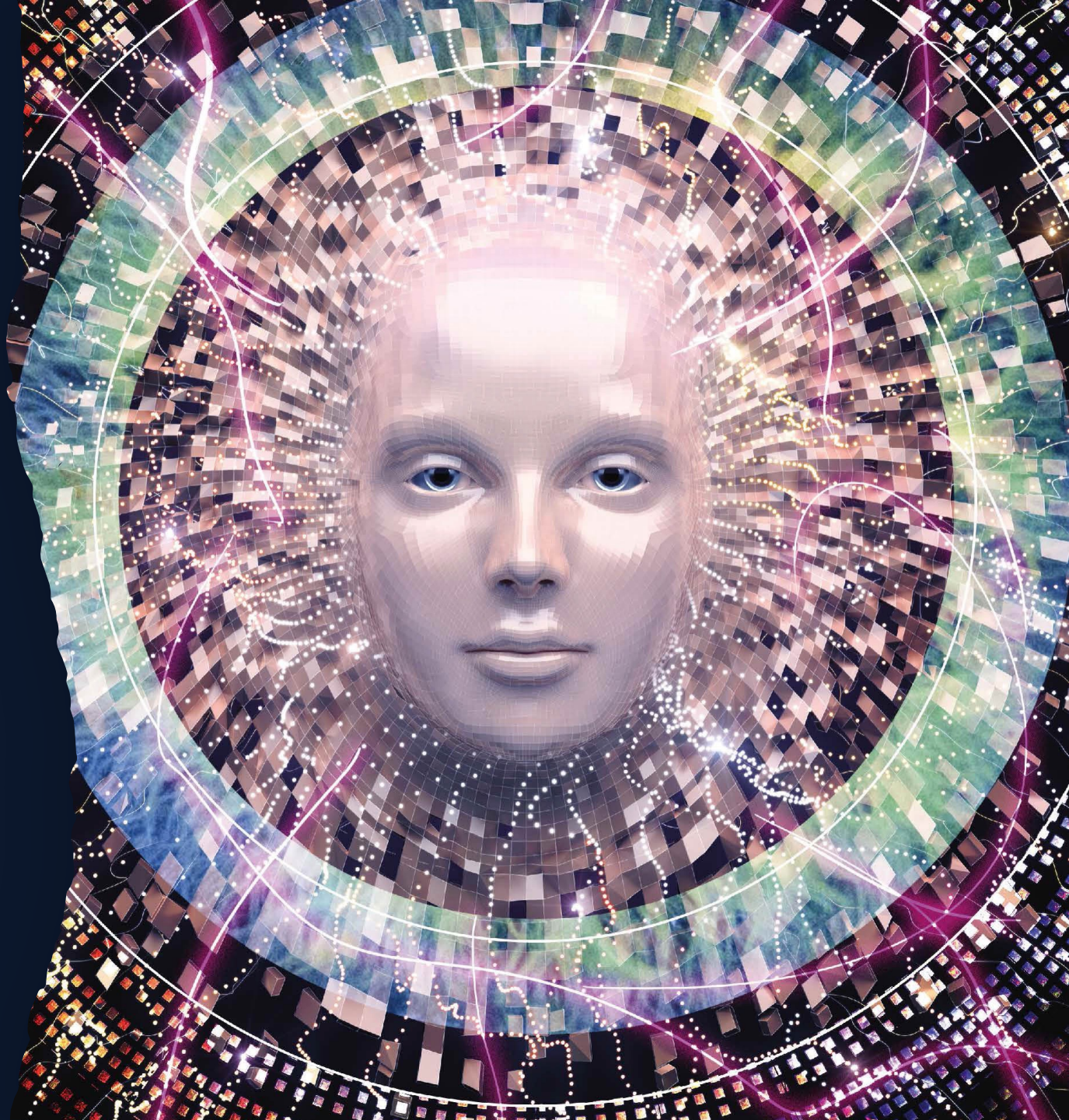
Perspectives and Narratives

Hannah R. Marston • Linda Shore • Laura Stoops • Robbie S. Turner

Transgenerational Technology (TT)

Optimises use, adoption, autonomy, and acceptance of technology to assist and enhance the lived experience across the generations

Marston, Shore, Stoops & Turner, 2022



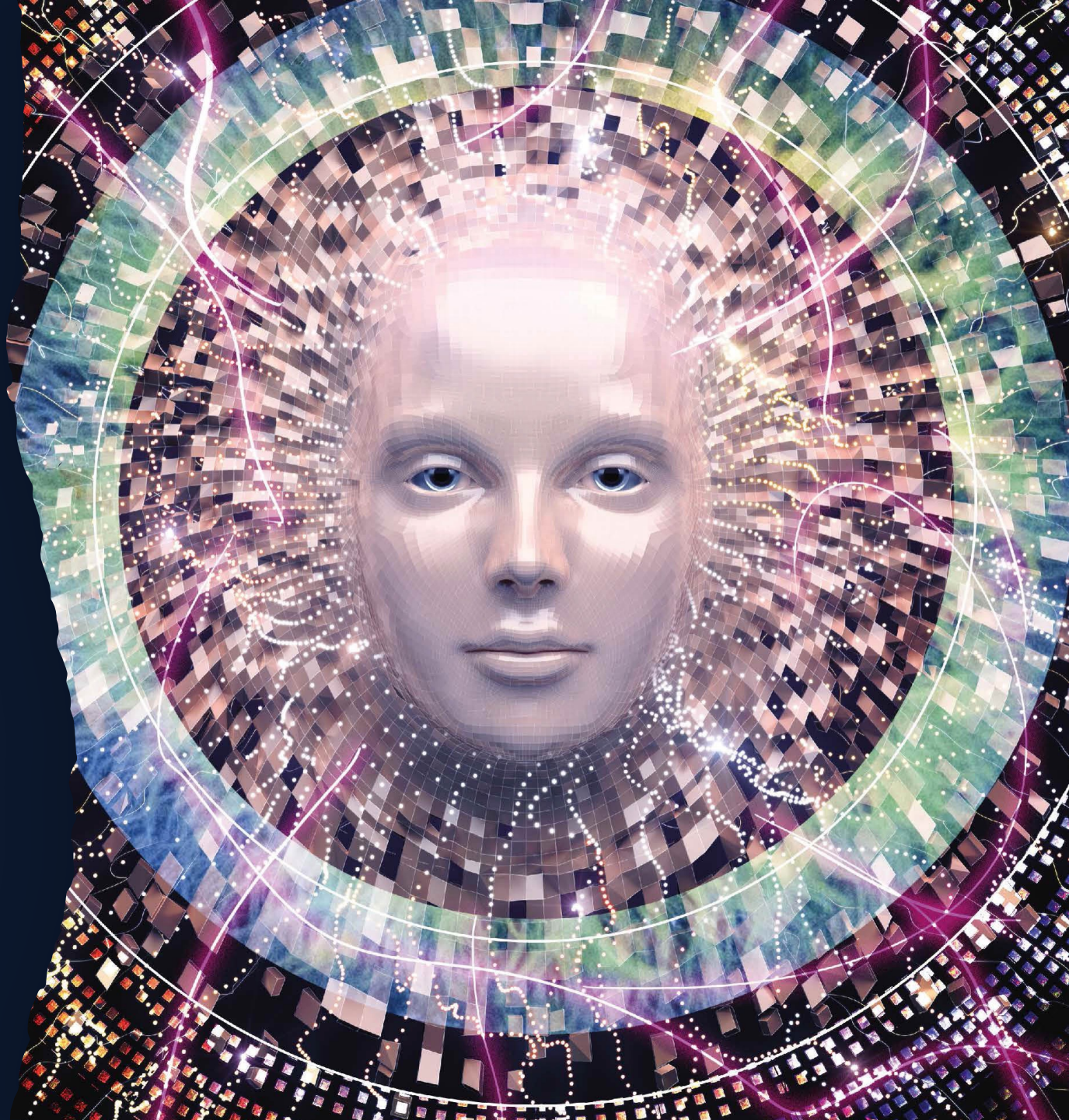
Transgenerational Assistive/Accessible Technology (TAT)

Refers to Assistive Technologies designed to be adaptive and supportive to people across the generations who experience physical and/or cognitive limitation

Transgenerational Assistive Robotic Technology (TART)

Refers to powered robotic orthosis/prosthetics that enhance, augment ability and body connective awareness - embodiment which are adaptive across the life course and to user needs requirements

Marston, Shore, Stoops & Turner, 2022



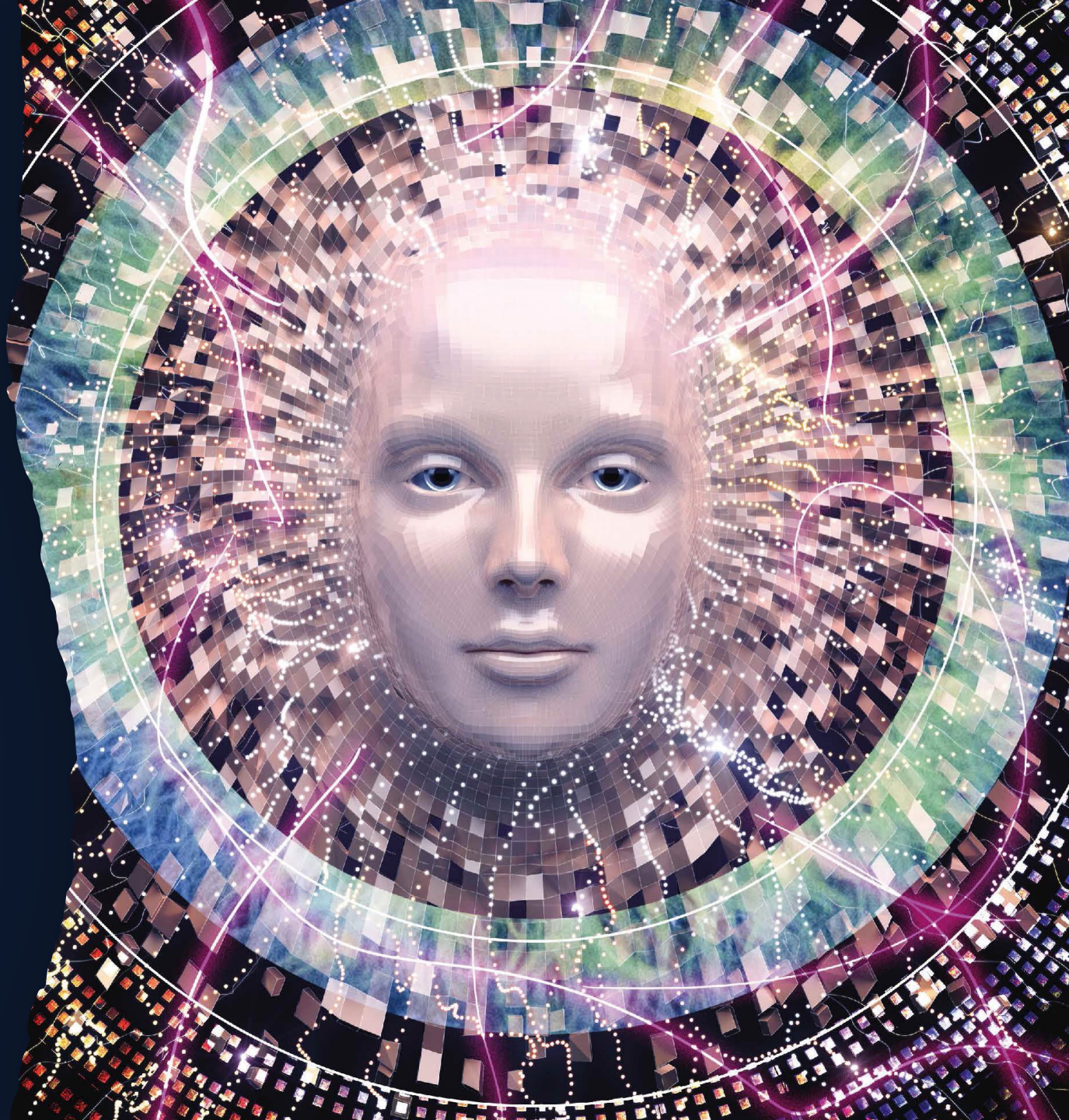
Transgenerational Living Communities & Cities (TLCC)

Posits that all generations in a community experience and feel part of inclusive and autonomous ecosystems

Transgenerational Gaming (TG)

Encourages optimized digital game experiences irrespective of the age or ability of the player

Marston, Shore, Stoops & Turner, 2022



Transgenerational Technology: Well-Being & Innovation Opportunity for the 21st Century - A Manifesto

We are an Interdisciplinary team that share a common focus – the value and quality of peoples' interactions and experiences with technologies should be enhanced, supported and unhindered. Commercial gain, hurried assumptions or lack of enquiry to human concern should remain secondary to the primary intent and value of defining the user needs requirements identified during research. Empathic and purposeful design approaches offers inclusive and human centred focus defining the 'how' and positive augmentation of abilities, experience and activity of not just the person & context of use, but also of their network of stakeholders.

1) We believe that chronological age should not determine vulnerability, for we are aware, vulnerability and age/longevity is not always mutually exclusive.

2) People should not be discriminated upon because of their beliefs, who they are, identify as, or what role they partake in society, and their voices should be expressed freely and listened to.

3) As a follow to Point 2, the expressive commentary voiced and expressed freely should not harm or hurt others by malicious criticism or attack.

4) Research and recruitment of participants who are perceived to be and/or are marginalized in society should not result in discrimination or biased research outputs.

5) We believe that a citizen continues to learn and gain life experiences and can offer contribution to society across their lifespan.

6) Innovation and research practices must consider democratised voices and user experiences as valuable catalysts to creativity and technology well-being for all.

7) Interdisciplinary research must be recognised across all disciplines as a vital contributor to societal growth and documented interactions

8) Inter & multi-disciplinary and unique language and terminology is recognised across disciplines through collaborative research providing a rich embrace and appreciation as we co-design, innovative research approaches and create new technologies, services and systems that benefit all.

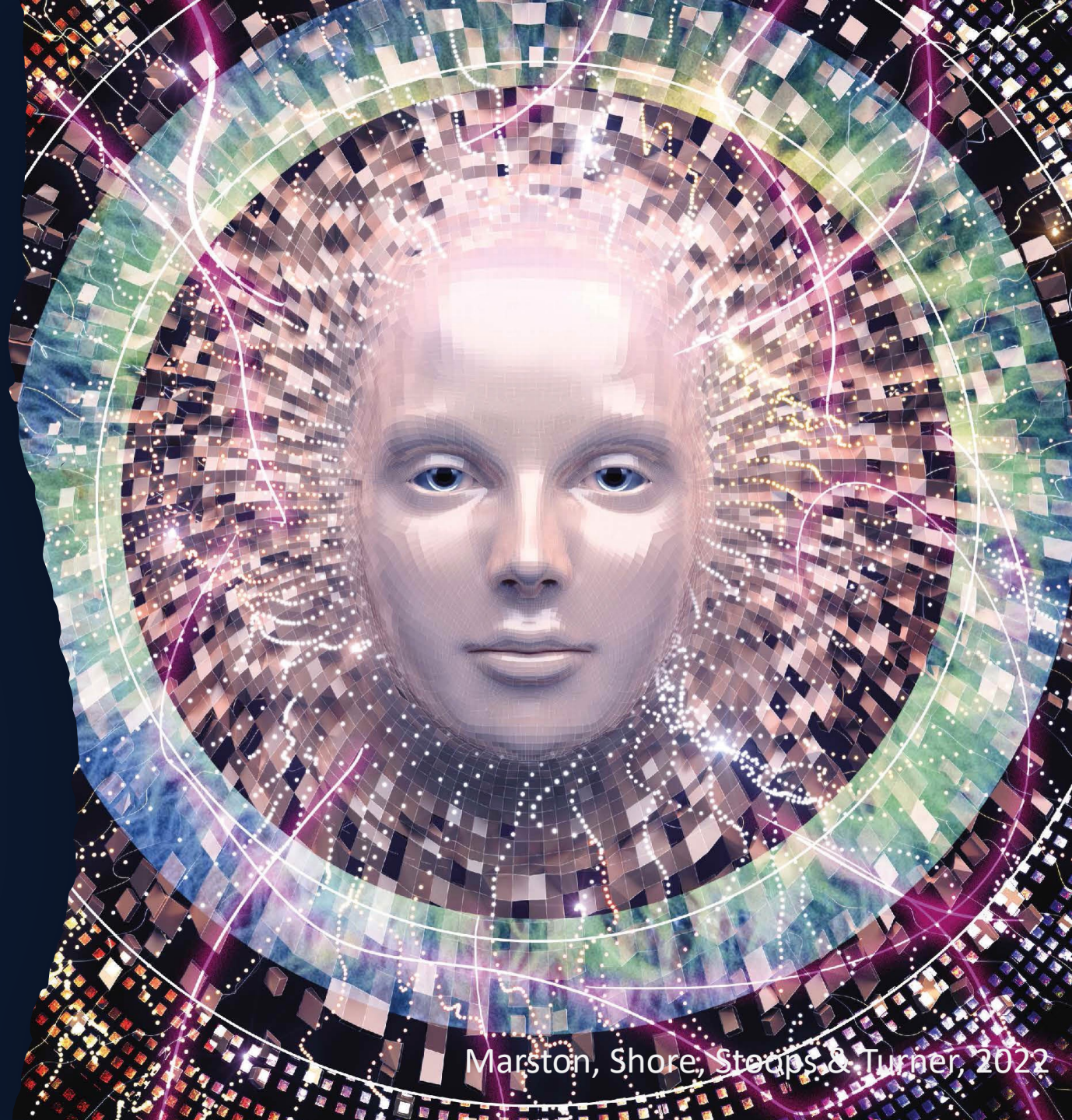
9) We believe cognitive and physical limitations can be supported, and dignity is always offered and placed central to the person.

10) To reflect on digital legacies, emerging and future technologies should not harm or injure and should obey the instruction as directed by the human.

11) At all times the intervention of future technologies should not place any person in a position of feeling stigmatised or excluded by society.

12) The data that effectively is created and stored by actors (e.g., stakeholders) will be done collectively and offers the person (including guardian, next of kin) autonomy in voicing their agreement or dissatisfaction to this activity.

Signed.....Hannah R. Marston, Linda Shore, Laura Stoops, Robbie S. Turner I 2022 ©



Marston, Shore, Stoops & Turner, 2022

Technology Acceptance

Relates to a persons' acceptance and continued use of technology

Tools that can optimise and predict users' acceptance are known as TAM – Technology Acceptance Model (Davis, 1985)

Theoretical approaches that to describe factors that affect user acceptance of technologies

They can also be used to describe factors that explain users' intentions to use a device

Shore, 2018

Technology Abandonment

Describes reasons why a person may no longer engage with or use an assistive device

Failures of providers to pay attention to UX and needs requirements

Easy to procure devices or technology

Poor performance

Changes in needs or priorities

Exoscore – A design tool to evaluate factors associated with technology acceptance Of soft lower limb exosuits by older adults

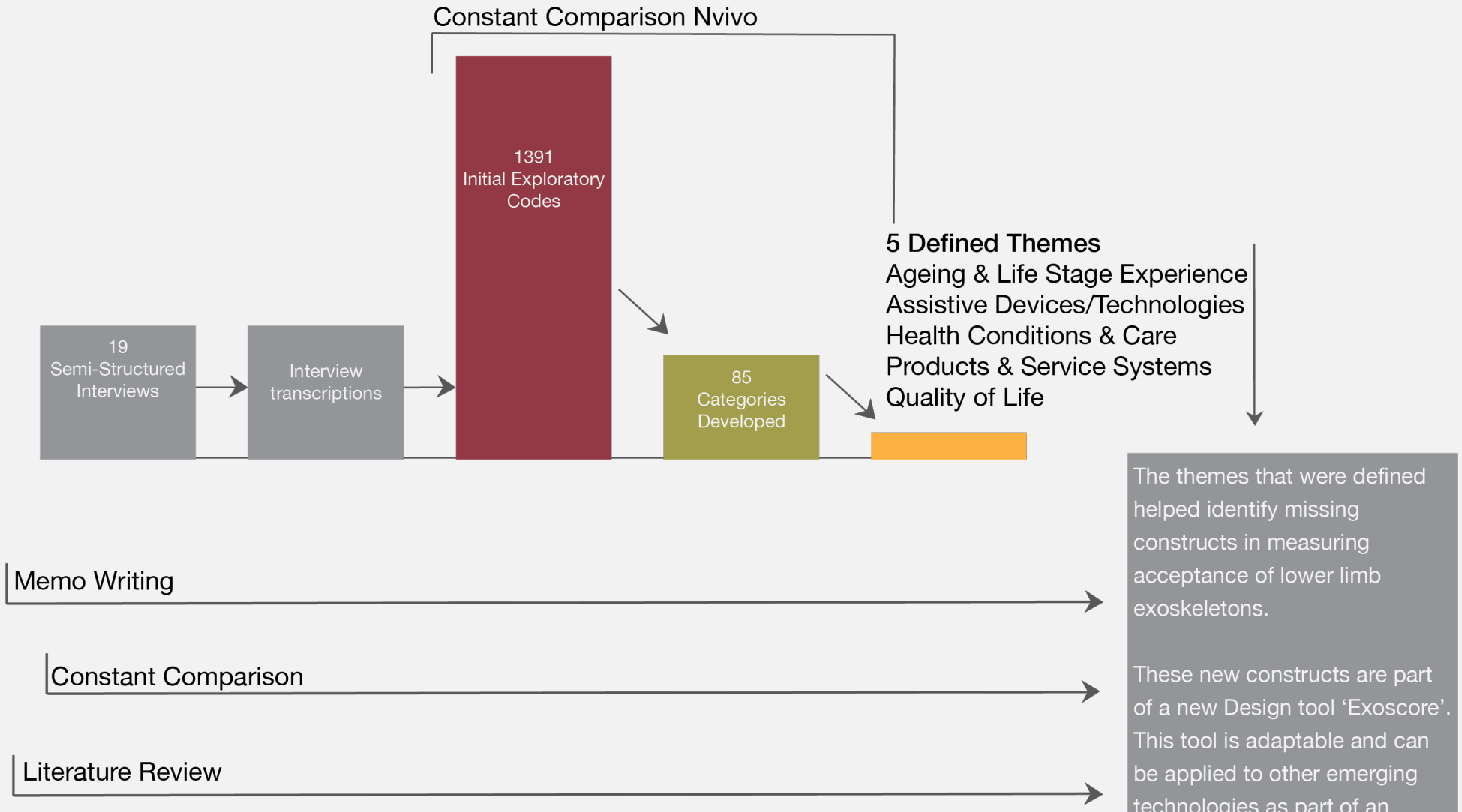
Shore, et al., 2020

Introduction

Exoskeletons and exosuits are types of robotic mobility assistive devices that have the potential to assist a person's mobility in numerous settings (Borisoff et al. 2017).

There is increased focus on exoskeletons as mobility aids for specific cohorts, such as older adults (O'Sullivan et al. 2015).

Method: Fieldwork & Analysis



Five themes emerged from analysing and interpreting our fieldwork study.

This provided broad understanding of expression by older adults about the acceptance of lower limb exoskeletons.

Exoscore: Development

The five themes generated new knowledge as a basis for three new constructs for Exoscore, (Shore et al, 2020)

Exoscore Development

PERCEPTION

What is this...? (exo etc information)

Constructs

P.U. | Perceived Usefulness

E.E. | Effort Expectancy

Anx. | Anxiety

S.E. | Self-Efficacy

E.P | Experiential Perception

EXPERIENCE

What is this...? (Intro, tasks etc...)

Tasks

DON. | Ease/Efficiency?

S.t.S. | Ease/Efficiency?

Walk. | Ease/Distance/Time?

Stand. | Ease/Time?

DOF. | Ease/Efficiency/Time?

Charge/Store? | Ease/Effort/?

PERCEIVED IMPACT

What is this...? (Summarise, self-contextualise)

Constructs

A.T.T. | Attitude towards Technology

Anx. | Anxiety

S.E. | Self-Efficacy

B.I. | Behavioural Intention

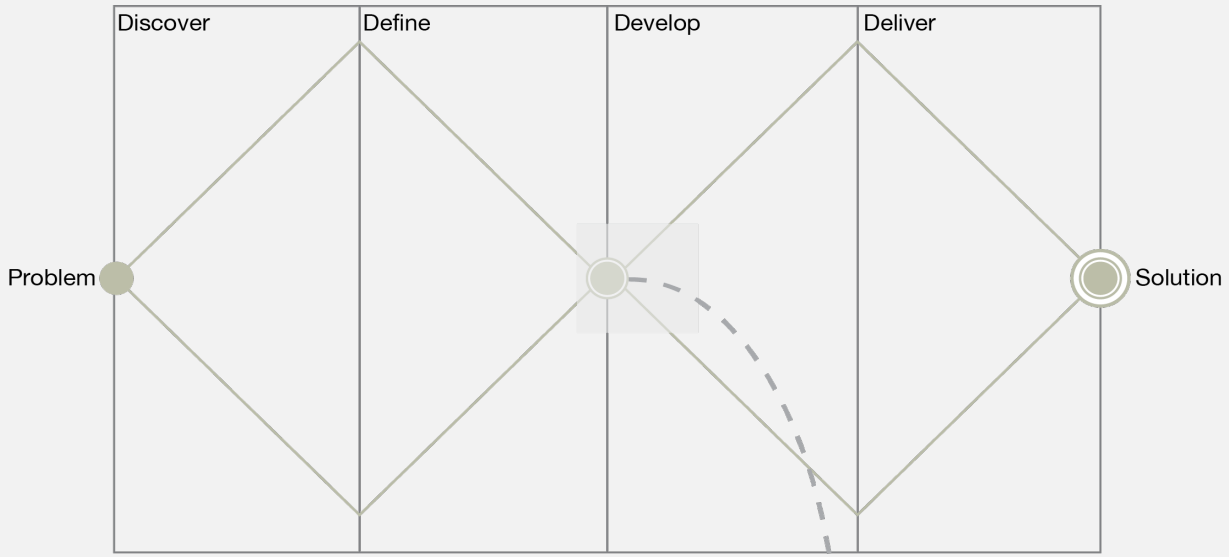
P.Ad | Perceived Adaptiveness

S.I. | Social Influence

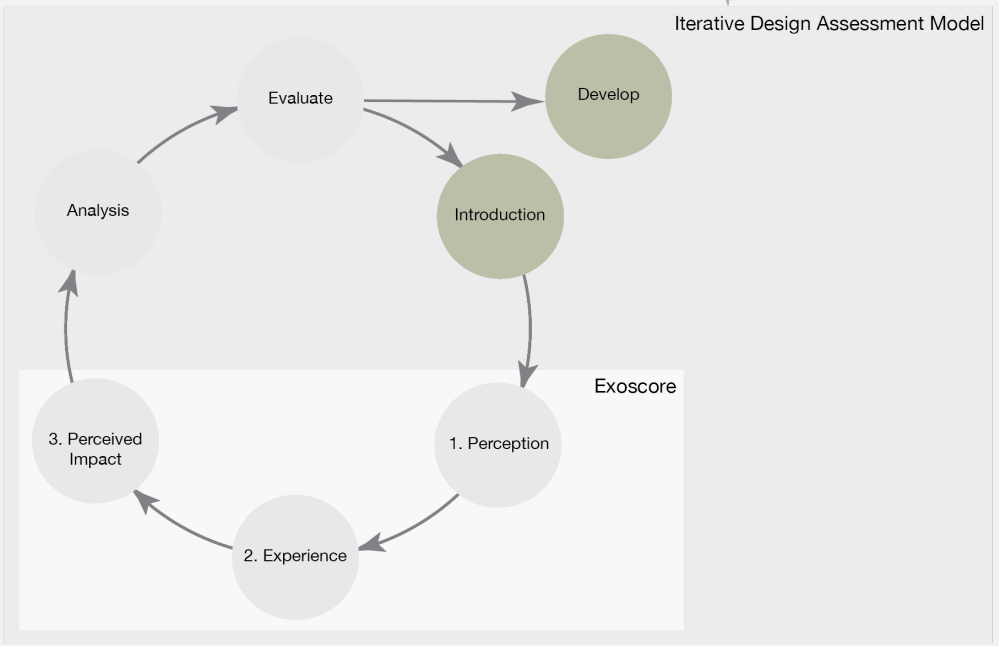
S.L | Self-Liberty

QoL.E | Quality of Life Enhancement

Trust | Trust



Placement of IDAM within the Double Diamond (Design Council 2014) process.



Iterative Design Assessment Model (IDAM) work phases

Exoscore is embedded within an Iterative Design Assessment Model (IDAM) (Shore, et. al., 2020)

Pilot Study

We conducted a study to pilot test the initial version of Exoscore.

This was performed by applying the three elements of Exoscore during design concept testing of a soft lower limb exosuit for older adults as part of the EU project XoSoft (XoSoft, 2016).

Pilot Study: Participant Information

All of the participants had Functional Ambulation Category (FAC) scores of between four and five (Holden, et al., 1986).

Participant	1	2	3	4	5	6	7	8	9	10	11
Gender	M	M	M	F	M	F	F	F	F	F	M
Age	69	79	72	52	58	48	85	68	82	54	76
Diagnosis	Stroke	Hereditary spastic spinal paresis	Incomplete spinal cord injury	Incomplete spinal cord injury	Stroke	Incomplete spinal cord injury	Gait impairment, falls	Post-polio syndrome	Spinal stenosis	Myasthenia gravis	Spinal stenosis
FAC	4	4	4	4	4	4	5	5	5	5	5

Pilot Study: Descriptive statistics

The participants could perceive the exoskeleton to be useful.

The results for the ANX construct both during Perception and Perceived Impact Phases, would indicate it as an important one to capture a sense of confidence, or not by an older adult while being assisted by the exoskeleton.

An item within the EP construct concerning the ‘look’ of the exosuit appeared to have a lower result which could be down to the aesthetics of the exoskeleton, or other factors not yet defined.

The ‘look’ of the exoskeleton may be a critical measure to evaluate acceptance or not of the exoskeleton.

Pilot Study: Feedback

Exoscore was described as ‘easy to use’.

It could be improved by revising some of the terminology and improving the introduction phase.

The Perceived Impact Phase questionnaire made more sense to the participants, following the experience of the exoskeleton.

Exoscore is further developed to include a version for testing user experience of exosuits in home settings.

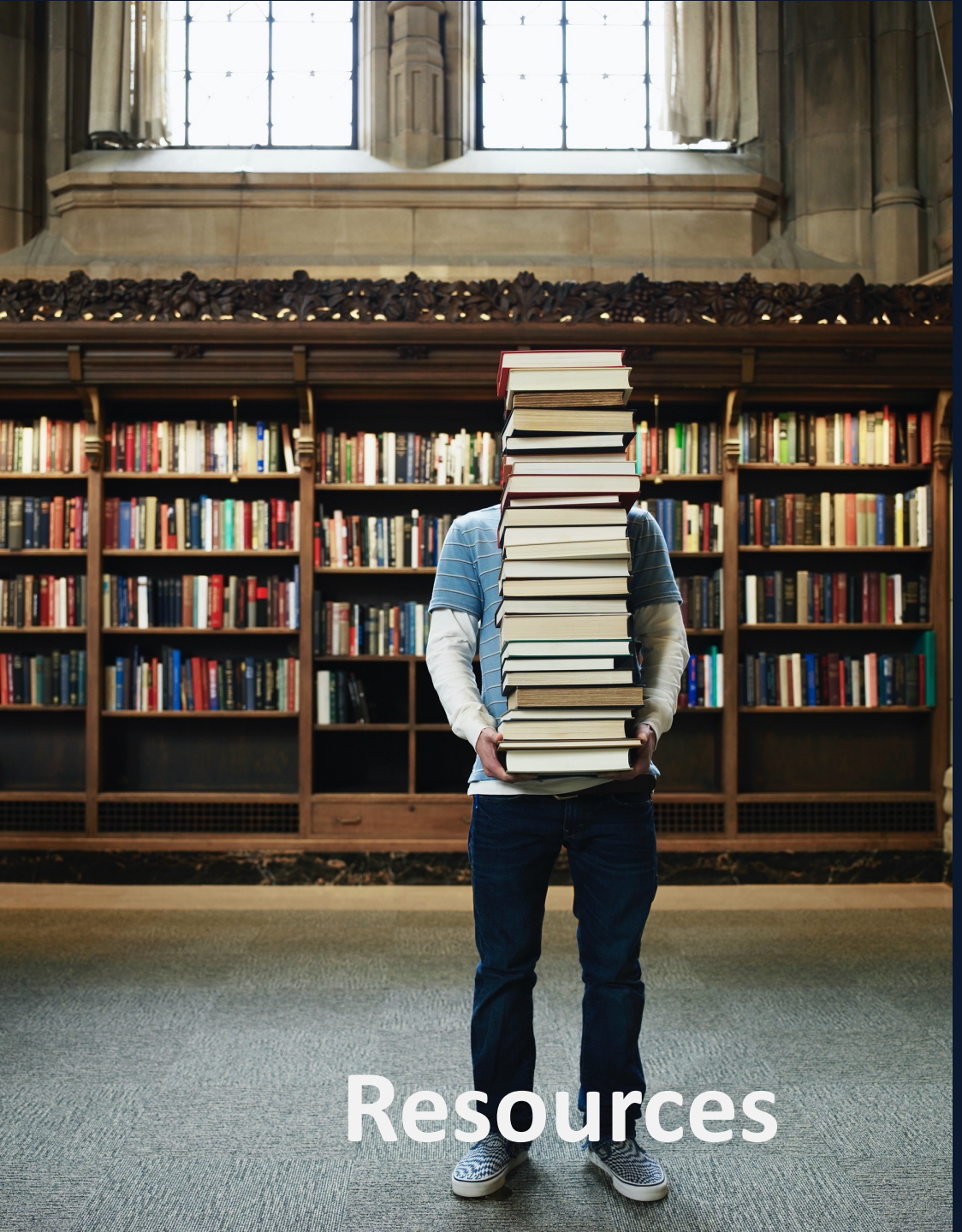
Consideration towards length of testing time and validation of questionnaire completion (e.g. hurriedness, fatigue).

Key Points

- Reduced mobility can lead to a reduction in independence and autonomy when conducting daily activities; this, in turn can affect quality of life.

- Exoscore facilitates phases of evaluation and assessment of perceptions to lower limb exoskeletons & exosuits by older adults.

- IDAM and Exoscore offer opportunity for interaction between design teams and participants as a means to optimize acceptance of exosuits and improve quality of life.



Resources

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Thank You

Questions?