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Virtual Taste and Smell Technologies for Multisensory Internet and Virtual Reality

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*This book is dedicated to my wonderful
daughter Kotoko. I love you infinity percent.*

Adrian David Cheok

*To my beautiful family (Rusandu & Kishori)
and loving parents (Chandrapala &
Chandrawathie).*

Kasun Karunanayaka

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I am deeply grateful for the great work of each researcher who helped carry out research, and also for the help writing the chapters. Apart from my co-author Kasun Karunanayaka, each researcher, who contributed to the project, is listed in Table 1.

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Iskandar Puteri, Malaysia
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(continued)

Table 1 (continued)

Author name	Contributed chapters	Nationality	Photo
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Acronyms

AC	Alternating Current
ADP	Adenosine Di-phosphate
AMP	Adenosine Monophosphate
AOS	Accessory Olfactory System
ATP	Adenosine Triphosphate
ATS	Analysis of Variance-Type Statistic
cAMP	Cyclic Adenosine Monophosphate
CO ₂	Carbon Dioxide
DC	Direct Current
DNA	Deoxyribonucleic Acid
DRD2	Dopamine D2 Receptor
ENaC	Epithelial Sodium Channel
FTDI	Future Technology Devices International
GERD	Gastroesophageal Reflux
GLUT2	Glucose Transporter 2
GMP	Guanosine Monophosphate
GNAT3	Gustducin Alpha-3
GND	Ground
HCI	Human Computer Interaction
HCl	Hydrochloric Acid
IC	Integrated Circuit
IMP	Inosine Monophosphate
KCl	Potassium Chloride
LED	Light-Emitting Diode
M	Mean
mGluR1	Metabotropic Glutamate Receptors 1
mGluR4	Metabotropic Glutamate Receptor 4
MSG	Monosodium Glutamate
MOB	Mammalian Olfactory Bulb
NaCl	Sodium Chloride

NO	Nitric Oxide
NPN	Negative Positive Negative
OS	Olfactory System
OSN	Olfactory Sensory Neurons
ORN	Olfactory Receptor Neurons
PC	Personal Computer
PCB	Printed Circuit Board
PG	Periglomerular Cells
PID	Proportional Integral Derivative
PKD	Polycystic Kidney Disease
PROP	Propylthiouracil
PTC	Phenylthiocarbamide
PWM	Pulse Width Modulation
QTL	Quantitative Trait Loci
SD	Standard Deviation
SMS	Short Message Service
SNPs	Single Nucleotide Polymorphisms
SOA	Sucrose Octaacetate
TR	Taste Receptors
TRC	Taste Receptor Cells
TRP	Transient Receptor Potential
TT	Thermal Tasters
TRPM5	Transient Receptor Potential Cation Channel Subfamily M Member 5
T&T	Toyoda and Takagi's perfumist's strip method
USB	Universal Serial Bus
3D	3-Dimensional

Prologue: The Mouth's Glasses

It is interesting to see how glasses are part of our reality. We internalise them as part of our face once we wear them. I believe that when glasses were first invented in the fourteenth century, it did not cease to cause surprise to the human body. It was an addition that served to mitigate our defects or increase our capabilities. I am sure that many were opposed to it and looked at those who wore them with surprise. Human beings tend to notice differences before similarities. They tend to differentiate the new as foreign. This mechanism is no more than part of a survival system; to approach people we resemble both socially and emotionally in order to preserve our genes.

From the moment humanity started to invent, it created tools to improve its life. Among these tools, they emphasised on those that enhanced our sensory capacities. Is it not the invention of better eating utensils, that became the tools that increase our sense of taste? Over the years and with the eruption of newly formed ICT tools, they became, often invisible, digital devices. Augmented reality is a fact, and we forget that it has been with us for a long time, transforming our lives by leaps and bounds. Those who are opposed to it are opposed to a vector of our historical development. Remember, nevertheless, that all great advances always have great detractors. And just like a person with glasses, we will end up assuming it as something normal.

There exist theories about the transhumanism where we are evolving as a species: a technological evolution that will allow us to acquire or improve our genetic abilities, thanks to artificial complements. At the philosophical level, this can be very interesting since it forces us to consider the limits that may stop human beings. However, without becoming dystopian, we may already be at the hinge of this paradigmatic shift. Do we not already use our smartphones as an extension of our memory and our cognitive skills? Every day, we automate processes, thanks to the same device. We get up due to an alarm clock; it reminds us of an automated agenda that tells us what we have to do. If we arrive late to work, we will look for an alternative route, or it will indicate us what we should or should not read according to our tastes. In a few years, the smartphone will probably be already implanted in some way under our skin. In this world of the near future, we must understand that these increases will improve our capabilities and make us live longer, if not better.

Glasses for the mouth are only a concept. With age, human beings are losing their sense of taste and smell often causing less hedonic pleasure. Amongst the elderly, this causes many people to begin to eat less than one needs with the consequent loss of nutrients that derives in diseases. It can also be worrisome when one sees reputable chefs complain that a product does not taste the same as when they first started cooking. However, they have not realised that perhaps what may have changed is not the world, but oneself. To have the possibility of not only being able to alleviate our gustatory decadence but also to increase our capacities is something that is discussed in this book. We have seen the horizon, and I am sure that this will soon go further.

Adrian is not only a brilliant engineer, but he is a dreamer. He likes to reach out where no one has arrived yet, and he moves along the path of the dream, devising and solving problems that have not yet been raised. The more I know him, the more I am surprised, and I think that more projects like the Imagineering Institute should exist in order to reexamine humanity in post-material times.



(Credits of the picture: Alex Iturralde)



Errenteria, Gipuzkoa, Spain
December 2017

Chef Andoni Luis Aduriz
Mugaritz

Biography of Chef Andoni Luis Aduriz

What does luxury mean? Do we eat to satisfy our hunger? How are cultural identities built? Is flavour the only important thing in gastronomy? Which is the real distance between global and local? Andoni Luis Aduriz (San Sebastián, 1971) is undoubtedly one of the most influential chefs of our times. He has led since 1998 Mugaritz, a project that he defines as a creative ecosystem that allows the freedom to create without chains and to constantly ask new questions. Throughout his career, he has prioritised both culinary evolution and an interdisciplinary approach. This has allowed him to cross the established borders, and to become a rebel in the kitchen. His lectures in places such as Harvard University or the Massachusetts Institute of Technology (MIT), his articles in *El País* newspaper and his membership to the Basque Culinary Center Foundations patronage or to the Tufts Nutrition Council from TUFTS University (a group of international leaders from diverse backgrounds who share a passion for nutrition and health), and his books are powerful tools to share all the knowledge that Mugaritz has acquired about creativity in organisations, health, perceptions or the gastronomy of the future. His versatility and creativity always raging the predefined limits open windows to many new worlds. This pioneering attitude gives rise to theatre performances with *La Fura dels Baus* and to the promotion of diverse documentaries such as *Mugaritz BSO* and *OFF-ROAD*. Aduriz aims to seduce us with a multisensory experience. During his professional life, he has earned prizes such as the Spanish National Gastronomy Prize, the St. Pellegrino Chefs Choice Award from St. Pellegrino and the Eckart Witzigmann Prize.