INTRODUCTION

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INTRODUCTION

The fundamental objective of this book is to explore the role that inventiveness plays across all fields. It is customarily believed that invention is only applicable to a few fields such as medicine, engineering and the physical sciences. This belief unfortunately is evident across the higher education sector, government agencies, and other institutions, reflecting a general perception that invention originates from scientific discovery alone. Critically then this book describes the articulation of inventive capacities across disciplines with sensitivity to the personal capacities and social, spatial and network configurations that drive people to produce inventions.

What exactly then is inventiveness? This question goes back all the way to Plato's problem: How can we appear to have a body of knowledge more expansive than what we are exposed to through perception and action in the physical world? This is the central issue of invention. The traditional path to invention is purportedly independent investigation and discovery. Such assumptions demand serious scrutiny for many reasons, not the least of which is that they often become embodied into law and social policy. The contributions in this volume will show the shallow foundations of this and other key assumptions underlying invention. More so, the contributions address how to foster inventiveness within our own academic community of diverse scholars, artists, architects, designers, historians, engineers, doctors, physicists, chemists, lawyers and economists. The contributors to this volume grapple with this critical issue in our globalised world of media communications, geo-political, demographic, technological and pedagogic complexities and shifts on a basic level, amongst other related salient factors, to ponder the intricate reciprocal interaction of artistic practices and technological and scientific developments.

Simply put, is an artist, architect, or designer an inventor? For us to scrutinise how inventiveness cuts across the entire domain of disciplines within a university—as this book clearly attempts to demonstrate—is to examine the elaborate connections between art, design, architecture, science and engineering and not to argue that it is only located within the traditional cluster of the physical and natural sciences.

Specifically then, the book articulates inventive capacities across disciplines with a sensitivity to the social, spatial and network configurations within which

each of the inventors who contribute to this book are embodied, and describes ecological connections across these scales, which would otherwise be invisible. Therefore, inventiveness is a multi-scale issue, containing 'components' from the micro- (personal capacities), the meso- (social), and the macro- (spatial and network) scales. This view of inventiveness across scales is what differentiates our book. Although the contexts of invention described in this book vary significantly, we believe that the invention of a new style of poetry and the invention of a new consumer service, to name two inventions at opposite ends of the spectrum, share regularities in terms of process and cultural production.

Some of the key questions that this book addresses include: What critical patterns and regularities recur in inventors' capacities? What architectural, social and spatial configurations foster invention? What behaviours and forms do online and physical networks of invention actually take? What important factors reliably predict rates of inventiveness?

These research questions are of broad importance across disciplines beyond those represented in the book. Economists model inventiveness as an 'absorptive capacity', a firm's ability to assimilate and exploit external knowledge as a precursor to innovation in new ideas.[1] In neuroscience, inventiveness is seen as a byproduct of the network architecture of the human brain, which allows the activation of mental representations that are not part of ambient reality.[2] Finally, anthropologists study the evolution of humans through a comparative analysis of artifacts created by early humans and our closest species relatives, the great apes, to theorise about the evolution of cognitive abilities for inventiveness.[3] Ultimately, if we are to understand intelligence in humans and what constitutes personhood, we need to consider how it is that humans produce culture, which Holloway[4] defined as the imposition of arbitrary form on the environment. This imposition of arbitrary form can only happen through the invention of instruments to inscribe our identities.

Hitherto, inventiveness has received limited attention as an object of study. Whereas researchers across the academy could easily describe their research methods, and research methods are intensively documented and subjected to scrutiny, the act of invention is largely treated as indescribable or taken for granted as miraculous moments of serendipity that elude codification. This is academically problematic given that research discoveries and inventions are largely the same; research discoveries bring advances of a conceptual nature whereas inventions bring advances of an applied nature.[5]

Unfortunately, economic rationalist and intellectual property motives have burdened discourse around invention, leading many researchers whose intellectual tradition is based on inventiveness to retreat to the concepts of creativity and innovation. Basically neither of these concepts is particularly helpful when trying to describe the relatively known intellectual traditions of invention. Neither of these concepts adequately

characterises the intellectual tradition of invention. Inventiveness subsumes creativity and demands cumulative knowledge-building across intellectual fields. It is also fundamentally the precursor to innovation.

Ecologies of Invention is the first edited collection of essays that brings together writers, several of whom are scholars of international standing, and a number of current academics and graduates of the University of Sydney to focus on and examine how invention is impacting on and changing our culture and society. With our selection of contributors we have decided that there should be a clear balance between the conceptual and methodological, and the empirical chapters. We have chosen a number of scholars who are widely acknowledged for their national and international standing in their respective fields. The book's concept of invention extends beyond the essays to the cover image and its design demonstrating the depth of inventiveness across the University.

Consequently, in order to do justice to such a significant topic, it is imperative that we discuss a wide array of different creative, intellectual and scientific approaches, and, in so doing, appreciate how some of these approaches in themselves may be contradictory but essentially are equally necessary, possible and legitimate. Invention in itself is a very multifaceted phenomenon that encapsulates, at any given historical moment of critical reflection, many different diverse theoretical approaches, intellectual traditions, and methodologies. However, what animates this book's underlying conceptual architecture is the salient belief that invention itself embodies a number of disparate factors that must come together in order for it to exist. Whatever the discipline, for invention to take place, it must be located in the mutating complex interrelationship of culture, technology and science. Within this important axis of human creativity, curiosity, scientific, and technological pursuit, the arts do play a role of considerable importance. Invention, contrary to public perception, does figure in the humanities and the creative arts as much as it does elsewhere in the sciences. This is becoming clearer by the day.

The late US mathematician Norbert Wiener, one of the first to contribute to this particular view of invention, emphasised how certain factors must surface first and collide to produce invention. Wiener's Promethean intellect and existential wisdom always underscored the role that individuality plays in invention: 'Thus one of the purposes of the present book is to make a proper assessment of the individual element in invention and discovery and of the cultural element.'[6] This perspective of invention is so often forgotten in a university's foundational pedagogic ecology and research praxis, and needs to be cogently foregrounded in any present and future discussion of such a topic. Too much is at stake otherwise.

The importance of inventiveness to Australia, which along with many other Western nations is facing a declining or exhausted manufacturing base, has become urgent. This has created a situation where countries are scrambling to maintain an edge in the global economy through the production of new knowledge and invention. In the US, inventiveness—though the term 'innovation' is generally used when discussing these issues—is widely considered to be the product of science, technology, engineering and maths and is known by the acronym STEM.

However, Rhode Island School of Design (RISD) president John Maeda and other academics at RISD have led the way with a groundbreaking initiative that places art and design at the centre of the equation transforming STEM into STEM + Art = STEAM. According to Maeda, STEAM 'addresses creative problem solving, the translation of complex data for broad audiences through visualisation, and how to bring ideas to market through design'.[7]

In many ways this book attempts to explore Maeda's concept of STEAM by contesting the prevailing hegemonic and distorted belief that invention can only take place in the sciences and not in any other discipline as such. This is lamentably unhelpful if we wish for universities to adequately realise their innovation potential in terms of creative industries, economy, productivity, and research and development. Further, and critically, not only would such a more democratic, empirically realistic and pragmatic view of invention advance knowledge, government innovation policies and technology, it would also considerably enhance cultural, economic and social benefits and outcomes of our national creative sector.

In a critical sense, this book wishes to bring to light the 'hidden' potential of invention and innovation that resides in those disciplines outside the customary ones of science, medicine, engineering and technology. In other words, it is quite timely now to suggest that the creative arts, humanities and social sciences are (when it comes to invention) more than just the tokenistic contributors they are often regarded as. In fact, when one examines the subject more critically from an informed position sceptically— and adopting a global reflexive approach to its theoretical, cultural, empirical and methodological complexities and realities—then one realises how prominent these disciplines really are.

It is more than 50 years ago that the novelist and scientist C. P. Snow coined the influential term 'two cultures' to describe the different world views of understanding reality by scientists and the artistically creative.[8] Snow famously spoke of a hostile dislike between the literary intellectuals and scientists of his time. In fact, since Snow's time, the idea of innovation has become categorically aligned with modern science. This problematic view is still unfortunately evident as the totemic norm in a university's disciplinary ecology and governance. Therefore, it is crucial at this historical juncture to deploy a more inclusive multifaceted framework and appreciation of the subject, illustrating the value and role that the creative arts, humanities and social sciences play. As media and communications theorist Stuart Cunningham has recently persuasively argued, following Ian Miles and Lawrence Green's 2008 study of Britain's innovative enterprises of advertising, independent broadcasting, games and product design, the innovation of the creative industries including the 'new' humanities disciplines like media, cultural and communication studies, including the creative arts, is 'hidden' in contemporary academic, cultural and social life.[9]

There needs to be more elaborate thinking about invention, universities, and government innovation policy. As Cunningham rightly argues, and as this book rigorously seeks to address, we need to think that invention and innovation are 'far more than white-lab-coat science, and high-value service industries, as are found in the creative sector, are where a large proportion of incremental and process innovation happens'.[10] What is required now more than ever is the recognition that, since Snow's 1959 *Two Cultures* debate, what we are encountering today is that the

traditional dualistic split between the arts and the sciences has been transformed into an elaborate and subtle open-ended spectrum of aesthetic, cultural, theoretical and technological ideas that cut across disciplines when it comes to invention. This is something that the literary historian and critic Stefan Collini minimally refers to in his 1998 introduction to Snow's benchmark publication when he acknowledges the 'Rubik's-cube' recombinant shadings of this spectrum:

> Reflection on this point should do more than simply soften Snow's original polarity into a more continuous spectrum … We need, rather, something like multidimensional graph paper in which all the complex parameters which describe the interconnections and contrasts can be plotted simultaneously.[11]

Cunningham argues therefore that, when discussing innovation in the context of industry, policy and the creative sector, what is urgently needed is to recalibrate our thinking concerning the creative industries in a non-totalising, non-dualistic fashion by being aware of how much of contemporary life in all of its spheres is shaped by the new proliferation of digital and virtual technologies. Furthermore, we need to ask ourselves (theoretically and empirically) who benefits from a university's ecology of disciplines that adheres to a more traditional definition of invention located only in the sciences?

As media theorists Dieter Daniels and Barbara U. Schmidt rightly point out in their probing analysis of the artist as inventor and vice versa, Wiener's groundbreaking theory of cybernetics introduces to us a much more critically poetic, sceptical and sophisticated understanding of the role that the creative intellect plays in combination with a whole cluster of different variables such as the cultural context, techniques, materials, social class, economics and politics.[12] Wiener, who profoundly understood the dialectical complexities and tension between the arts and science, invented the concept of cybernetics, which, in its subsequent popularised manifestation as the 'third culture', critically corresponded, in Daniels' and Schmidt's words, 'today to the widespread propagation of digital phenomena in the culture of everyday life'.[13] This propagation, as these two authors opine, gave rise to a pervasive proliferation of aesthetic and technical hybridisation shaping our creative work processes and cultural practices across the whole spectrum of disciplines when it comes to a fundamental understanding of invention in and outside the academy.

Ecologies of Invention consists of seven chapters that discuss, in their respective transdisciplinary theoretical and methodological voices, various concepts, contexts and research strategies dealing with the complexities of invention in terms of knowledge production, experimentation and research-praxis as encountered mostly across the disciplinary spectrum at the University of Sydney. At all times, there is a critical consensual effort amongst the various contributors to try to carefully analyse the many shifting intricacies of invention as they are encountered by the various contributors in their specific disciplines of research, teaching and technologies. Invention is, at all times, carefully differentiated from creativity and innovation.

Each book chapter is divided into two parts which essentially are dialogic and interrelated to each other concerning invention in terms of its different critical capacities, sensibilities and social, cultural and spatial configurations in a particular discipline. This approach has been used to describe the aesthetic, cultural, experimental, theoretical, spatial, and technological complexities of invention as it applies to that particular discipline in question. Thus, the first part is an introductory theoretical essay that contextualises the following part, which in effect is a case study of invention at work in the University and beyond.

One of the most important editorial strategies of this approach is to present to the reader an enormous breadth, complexity, multidimensionality, and transdisciplinary nature of invention that characterises the University's creative, intellectual, pedagogic and technological ecology. This is crucially unprecedented as the book globally showcases invention across the University. In so doing, *Ecologies of Invention* strives to bridge together all the so far disparate contexts, elements, disciplines and technologies of invention as a continuing dialogue of possibilities and new 'grammars of creation'.[14]

In chapter one, Andy Dong's multifaceted contextualising essay 'Discourses of Intervention: A Language of Invention' deftly and succinctly maps out some of the more current vital and compelling views relating to the emerging unexplored surface contact between the disciplines in certain situations of invention. Dong argues by analogy borrowed from psychotherapy—the concept of 'intervention' in particular— that in architecture and engineering it signifies the act of reinventing space and form by rejecting bonds to the history of space and place. Thus in invention what we have is, in fact, an 'intervention' that in various fields of knowledge unmaps and destabilises official knowledge so that notions of canonical definitions, specialised methods and established identities representing a field of knowledge are eschewed in favour of uncircum-scribed potentials.

Dong's guiding expertise in design studies, specifically on what constitutes design knowledge and relatedly the causal significance of the processes and structures of design knowledge production on design-led innovation, primarily has shaped (in conjunction with Brad Buckley, an artist, urbanist and polemicist, renowned for his 'post-medium' expertise in installation, theatre and performance) the book's characteristic conceptual, formal and thematic concerns.

Grounded in social realism and Basil Bernstein's theories of vertical and horizontal discourses, Dong's illuminating essay addresses the structural properties and principles of language in ways of speaking that open potentials for the creation of new realities.

Dong's essay focuses on how 'art-science' or 'art-technology' collaborations between artists and scientists need to, in order to produce new hybridised spaces of knowledge transmission and meaning-production that are central to the exigencies of the creative practice, break out of their own disciplinary boundaries and fixations. In short, as collaborators between disparate disciplines, for invention to take place they need, according to Bernstein's code theory, to conceptually, dialogically and performatively engage in constructing the new object they are creating. When there is a clash of disciplinary codes happening, then collaborators in their discourses of invention are essentially able to weaken disciplinary boundaries and control of permissible knowledge and introduce the necessary horizontal structures of knowledge that are mandatory for a new specialised language of new questions, new claims and voices to surface.

This is followed by Petra Gemeinboeck and Rob Saunder's contribution 'Inventing Cultural Machines', which adroitly investigates the inventive processes of their art and technology collaboration that are particularly situated between the fields of artificial creativity and experimental art. And in so doing they perfectly illustrate the main critical points of Dong's interdisciplinary design-oriented thesis using Bernstein's code theory of 'discourses of invention' to account for the creative, intellectual, performative and technological complexities of invention through collaboration between the arts and sciences.

For Gemeinboeck and Saunders, artistic inventiveness does not principally only concern the production of an original 'artefact', nor is it the outcome of the experimental technical development in their collaborative work. But rather they see it as a strategic intervention into cultural and social discourse, whereas the artwork is its aesthetic materialisation and the technology is at once the medium for intervention and a complicated actor.

In relation to their robotic artwork *Zwischenräume* (2010–12), the authors have attempted to tease out the composite nature of inventiveness in the dynamic interplay of several contexts and positions, including the cultural, social and technological context of their art-making and the artwork itself. Also, invention for them indubitably is not only a matter of the dialectical concerns, methods and tensions of interdisciplinary collaboration but inevitably also of a collision of world views that Dong himself spoke of in his preceding contribution. It is also equally a matter of constructing new knowledge production and utilising multiple (human and non-human) actors salient to their art–technology collaborations. Finally, invention for Gemeinboeck and Saunders involves other indispensable factors such as machine autonomy and the role of the inventor and public exhibitions as testing grounds.

Dan Lovallo's succinct contribution 'The "Character" and the "Algorithm": An Essay on Technology and Art' is primarily an overview of four important new works by several artists and researchers working at the University of Sydney. Its main critical focus is, however, on two new installations recently exhibited at Artspace Visual Art Centre in Sydney in May of 2013.

The first installation is Mari Velonaki's *The Woman and the Snowman,* which is comprised of two video projections. The first one is of a female android robot, Repliee Q2, dressed in a fine red gown located next to a tall wispy tree in the snow, by the renowned Japanese roboticist Professor Hiroshi Ishiguro from Osaka University. The second is of a snowman located in his natural environment, while there is a third non-anthropomorphic robot that more accurately represents a kinetic sculpture that moves in unison with a haunting score devised by composer Nikolas Doukas. This kinetic sculpture is also rotating and changing speed on several different levels to the score itself. It needs to be said that the sculpture also contains a few screens, which display scenes from a 1970s Greek television show and also a winter scene.

In Lovallo's estimation, the installation is in his words 'a sublime contemporary masterpiece', indicating Velonaki's diverse interests in Japanese cinema, performance art, robotics, kinetic sculpture, poetry, etc., and how the installation's defining inventiveness has been shaped by Velonaki's persuasive ability to engage high-calibre skilled colleagues.

The artists Petra Gemeinboeck and Rob Saunders, collectively known as 'robococo', collaborated on the work *Accomplice*. This exhibit consisted of four robots located on the gallery's walls communicating to each other both audibly and visually. But obviously these robots would also communicate with the participants in the gallery but not necessarily understanding what they were saying to each other. Each robot would communicate their presence by banging on their respective wall with an implement producing a hole in the wall. As the walls came apart, it was a case of seeing how these robots would behave in their unpredictable ways. This is essentially a performance installation using non-humanoid-shaped robots and, as an emergent system, the artists were concerned with experimenting with these robots so they could experiment with and imagine the future. In a certain sense, *Accomplice* evoked Jean Tinguely's famous self-destructing 1960 work *Homage to New York*.

Lovallo believes that one of the more interesting inventive attributes of robococo's work is their multifaceted capacity to utilise algorithms in such a new fascinating way by creating human characteristics such as curiosity in their robots. Fundamentally Saunders is breaking new ground by modelling curiosity algorithmically.

The author himself has in two recent algorithmic works, *Eucalyptus salmonophilia murray darling* and *Constellation 3—Exploded Julius 2013,* experimented innovatively with algorithms in order to produce witty, imaginative and compelling works. With the former, Lovallo used a branching algorithm to combine the branching of a tree and river basin. Significantly, the author used a 3D printer to create this work. As 3D printing costs fall, many more artists and technologists will be using this new revolutionary process of design and manufacturing. In fact, as the author reminds his readers, Boeing is already embarking on 'printing' their planes. And with the latter work Lovallo used an algorithm for the purpose of structuring simple materials like bottles, wires and coloured water into complex processes that would not have been achievable without the algorithm.

David Rye and Mari Velonaki's stimulating account of their cross-disciplinary collaboration as roboticists 'Art and Robotics—A Brief Account of Eleven Years of Cross-Disciplinary Invention', concisely delineates the aesthetic, disciplinary and technological complexities of creating works that speak of human–robot interaction deploying a basic interest in novel human–machine interfaces as well. Velonaki's specific starting point of interest was in the production of haptic interfaces that explored different new models of interaction between the participant and an interactive kinetic object such as a robot. And for Velonaki's collaborators like Rye and Steve Scheding and Stefan Williams, all three roboticists, the direct challenge was to create a robot located in a public gallery space. Thus for Velonaki and her collaborators the inventiveness of their collaboration was to make a robot that was technologically intuitive in terms of its human–machine interface with the added challenge of ensuing that the robotic interactive artwork itself was also robust to unforeseen events in the gallery space.

The earlier stages of their collaboration were predicated on a cluster of issues concerning building bridges between different disciplines stemming from both shared and individual goals, trust as equal partners in the creative process, and the common realisation that, whatever one's disciplinary concerns and methodologies may be, there needs to be a fundamental acknowledgment that because of different educational and biographical circumstances wide cultural gaps are perhaps inevitable in such collaborative projects.

The authors' contribution engagingly describes the various challenging aesthetic and behavioural decisions that were made through their influential cross-disciplinary projects. *Fish-Bird, Fragile Balances, Diamandini* and *The Woman and the Snowman* are highly indicative of how the authors self-reflexively proceeded in their robotic and responsive artworks in relation to the complex human–machine interfaces deployed and the related bidirectional communication between gallery participants and the artwork in question and, in the case of female humanoid robot *Diamandini,* the haptic one-to-one human/robot interaction.

Their contribution clearly suggest the central importance in any cross-disciplinary collaboration of capitalising on the relevant individual and shared strengths of the participating artists, composers, roboticists and cinematographers, as in the case of their most recent multimedia/robotic work *The Woman and the Snowman.* Invention, for them, critically resides in clearly defining the effectiveness and experience of diverse interactions between gallery interactors and technological others. Invention in this situation, the authors argue, depended on their challenging mutual project creating new environments and experimental interfaces that would elicit new behaviours and new aesthetic experiences.

Kit Messham-Muir's chapter 'Melting into the Texture of Everyday Life' examines John Tonkin's acclaimed video installations of the last decade or so, in terms of how in our present digital and networked culture these works embody a new approach to interactivity that centres around ideas in keeping with contemporary social media and technological connectivity. Regarding such inventive works by Tonkin as *Selective Attention* and *Nervous System,* both of 2011, Messham-Muir

clearly argues the case that this artist's works effectively question the more traditional 'keyboard and mouse' passive view of interactivity by inviting his audiences to be more participatory and collaborative in their encounters with his works. Interactive media art, for Tonkin, becomes emphatically more a process that is not interested in informational retrieval but one more of a creative and improvisational process.

In other words, the author posits the view that Tonkin's recent oeuvre, influenced to a considerable degree by a 2001 kinetic multimedia work *Welcome Space* at the new National Museum of Australia concerning Aboriginal and Torres Strait Islander cultures, is significantly socialised and 'mutualised' in its thinking about connectivity which is critically empathetic, culturally and socially, in its orientation. Given the huge impact that Web 2.0 technologies are having on our everyday life in changing knowledge ecologies from the old Gutenberg transmission mode of mediated knowledge to one of knowledge as a social participatory networking process of creative commons sharing, Tonkin's work is imaginatively and technologically inventive as it significantly facilitates a phenomenological person-to-person connectivism.

As John Tonkin clearly explains in his absorbing contribution 'On Building a Perceptual Apparatus—Experiments in Proximity', the author created a series of responsive video artworks collectively known as *Experiments in Proximity* which represent his most recent research as a notable media artist concerned with what he calls 'meta meta-cognition'. These simply designed and inventive artworks are central to the author's practice-research project, which falls under the more general rubric of embodied cognition and, as such, these works can be considered as 'enactive machines'.

These enactive machines, in their specific contexts and concerns, explore, for the author, the important concepts of structural coupling, enaction and sensorimotor contingencies, ideas that typically emanate from wide-ranging fields, from philosophy to cognitive science to media arts. The two most critical effects for Tonkin are that ideas allow him to create mechanisms for thinking about thinking (cognitive science), and, most significantly, for thinking about thinking about thinking as he has impressively accomplished in his own artworks. Ultimately, Tonkin believes that invention takes place in a non-linear fashion that highlights a co-emergence of theory and praxis grounded in the actual physical process of making.

The chapter by Brad Buckley and John Conomos, 'The Artist-run Initiative: An Agent That Blurs the Studio, Laboratory and Exhibition Space, Creating a Site for Inventiveness', underlines how invention within these unique artists' exhibition spaces, is integrally unique to contemporary art and how because of their unregulated nature and concerns are not saddled with the crushing ascendancy of corporate managerialism that is normative in the established global art world. Their historical origins emanate from the collectives of artists in the 1960s that were interested in working with experimental ideas and forms and operating in fringe spaces outside the mainstream gallery and museum system.

Essentially, artist-run initiatives (ARIs), such as in the accompanying case study by Alex Gawronski, a founding member of the Institute of Contemporary Art Newtown (ICAN), unequivocally demonstrate how inventive they are as an expression of aesthetic cosmopolitanism and experimental hybridism and as public spheres of artistic creativity and knowledge production that effectively critique the characteristic ideological aspects of Fordism, neo-liberalism and the culture industry as Enlightenment as mass deception.[15]

Buckley and Conomos maintain that ARIs are innovative, questioning and reflexive spaces of post-Fordist production and they insist on the deconstruction of the state-sponsored audit culture of the visual and creative arts, media institutions and critical reception.

Gawronski's informative case study, 'ICAN: Reinventing the Autonomy of the Artist-run Initiative', shows how in 2007 it was first instigated as a project by the author himself in association with fellow artists Carla Cescon and Scott Donovan, and also initially by the late Sydney artist Stephen Birch (1961–2007), who was a critical force behind the project. What Gawronski highlights in his carefully considered analysis of ICAN's

importance as an ARI is how its very inventiveness as an experimental space is predicated on its evolving project to become an autonomous critical laboratory. As such ICAN over the past few years has been concerned with generating an ethos in Sydney where artists and academics in their respective shared histories and networks are mutually involved with 'reframing contemporary art as a visual form of non-instrumental *thinking*'. Further, another innovative attribute of ICAN has been its focus on presenting the works of already established and mid-career artists rather than the obligatory emerging artists who tend to be more representative of such spaces.

In essence, Gawronski clearly shows how ICAN has always in their multi-tiered approaches to contemporary art been committed to the continuing questioning of the neo-liberal commercialisation of the art world and its attendant culture of high spectacle. Salient to its wider climate of inventiveness as an ARI is ICAN's dedication to politically independent creative activity where knowledge is constantly foregrounded in non-commodity terms.

Chris Smith's chapter 'Fit to Burst: Bodies, Organs and Complex Corporealities' is an insightful, elaborate examination of Dagmar Reinhardt's and Lian Loke's 2012 imaginative and speculative work *Black Spring* which was exhibited at the University's Tin Sheds Gallery (a venue that has played an enormous role, historically speaking, in advocating contemporary art in Australia). Smith's equally speculative analysis of Reinhardt and Loke's work focuses on a Deleuzean approach to the seminal architectural question of thinking through the formation and life of space that is quintessentially central to how architects and artists work creatively.

The bold inventiveness of Reinhardt and Loke's interactive *Black Spring* resides precisely not in being traditionally an installation as such but rather best regarded—conceptually and performatively—as a sensate machine. This means that the work's multiple dancing bodies, contexts, processes and ideas are primarily concerned with uniting, in Smith's words, 'the corporeality of the sensate and the incorporeality of the machine'. The work involves bodies dancing, responding with each other, constantly changing through an infinite, complex structure of processes that happen inside and outside of the bodies themselves.

Reinhardt and Loke's work implicitly concerns itself with Deleuzean ideas of 'becoming', 'machine' and 'sensation' in its effective multifaceted project to transcend a disciplinary boundary of architecture by exteriorising depth from it, coercing forces from its inside.

Dagmar Reinhardt and Lian Loke's engaging contribution 'Entangled: Complex Bodies and Sensate Machines', is enlightening for its lucid exposition of their original design research activities as embodied in their three interactive spatial installations *The Black Project: Black Spring* and *Black Shroud*, collectively entitled *The Black Project* and *GOLD (Monstrous Geographies)*. All three works can be seen to be laboratories built over a design, construction and experiential period situated within an exhibition context and through the constant exposure of an unversed audience. All three installations critically represent an interdisciplinary conversational arena constituting a matrix of relationships fluctuating between several interlocking conceptual clusters of intriguing ideas of interdisciplinary design processes as re-invention, complex corporealities, inexactitude and excess, and sensate machines.

For Reinhardt and Loke, design research is a verb in that it incorporates speculative creative acts developing dialogue, doing, multi-direction and related processes of investigation that valorise alternative, devious and sideways results. Thus, their intriguing, fertile and expressive installations cogently demonstrate the authors' design research philosophy to represent explorations spanning 'body, space, code, and materiality in excess of architectural practice's privileging of form, function, economics'. Invention for them is constitutive of their creative and scholarly endeavours in the very act of unveiling important narratives, conceptual and semantic layers, and plateaus within a given potential work bridging architecture, choreography, engineering, interaction design and programming.

Sean Lowry's conceptually nimble and informative chapter 'Inventions Are Networks: Fostering the Liminal Play of Ideas' discusses how inventiveness is based on pre-existing networks of different contextual relations. Lowry persuasively makes the case for how the collaborative spirit of human activity favours the pliable capacity to recombine and

repurpose existing ideas and objects in new unpredictable and challenging ways. This is especially the situation, Lowry argues, with the presiding ethos of our digital age. Hence, global networks are liminally enhancing and re-choreographing tensions between different individual and collective contexts and interests that underline cultural change, thereby fuelling invention.

The author provides numerous telling insights into how, through the Internet, it is critical to acknowledge that invention takes place when the lateral connectivity of digital social networks in association with the cross-disciplinary potential of open source digital databases directly produce new fields of innovation. He also contends that the broader the network of collective consideration that a creative work enters into, the more unlikely it is to be deemed critical in terms of its interdisciplinary significance.

Inventiveness, in its broadest sense, is therefore multi-scaled and dynamically responsive at micro, meso, and macro levels. The case study of Sydney composer Ivan Zavada that follows is a perfect instance of Lowry's argument that networked musical collaborations, across space and time, like Zavada's work, dramatically redefine relationships between performer and music, producing new forms of musical expression. The challenge is, according to Lowry, that one can't predict how new technologies and new markets will create invention, but it remains for all of us to locate new ways of fostering free, open global forms of experimentation.

Zavada, therefore, in his accessible analysis of his own recent network musical collaborations 'Expanding Sonic Space: An Antipodean Approach to Telematic Music' demonstrates how boundaries of conventional performance and creative practice in our society can be extended given our present mutating techno-culture. Composition is often regarded as an individual activity, but with the internet and new communication methods, Zavada shows us how the creative potential for a given composer transforms his role to one of being more of a coordinator of musical events over space and time. Depending on the network technology used, this will facilitate the coordination of different real-time musical events or pre-composed musical pieces being simultaneously performed in totally different places.

In such key works as *Jasmine* and *Antipode*, undertaken at the Sydney Conservatorium of Music, numerous participants in different locations (China, Canada, Australia) were engaged in different modes of interactivity and networked collaborations creating entirely new models of musical creativity. By amalgamating existing electronic music and different audiovisual processing techniques to increase the aesthetic concerns and boundaries of network musical performance, sonic space itself is creatively expanded.

Leading artist and media researcher Bill Seaman and equally renowned chaos physicist Otto E. Rössler, following their recent cutting-edge book *Neosentience* (2011) which espouses a new branch of scientific inquiry into artificial intelligence, have contributed the chapter 'Inventions and Recombinant Poetry' which appropriately enough closes the book. Their book chapter, which can be considered as an 'after-poem' to their book, is a highly inventive, playful and interdisciplinary exploration of creativity, complexity, connectivity, mind maps, robotics, memory, how we interface and interpret the world, and what it means to be human in our present globalised world.

It is a speculative, free-wheeling, poetic meditation on invention in the context of complexities of the arts and the sciences that ranges across many different disciplines such as psychology, computing, physics, cybernetics, logic, genetics, evolution, literature, art, architecture, neuroscience and linguistics. In its sprawling collage structure and trans-disciplinary concerns, theirs is a most vital and fitting 'book-end' chapter in that it encapsulates in its own inventive mode of writing the dynamic porous character of invention itself. In a critical sense, Seaman and Rössler's invaluable contribution is reminiscent of composer John Cage's mesostic poetry.

Think of 'inventor' or 'invention' and the images that come to mind might include Thomas Edison and Johannes Gutenberg, the polymer banknote or Wi-Fi, but probably not Buckminster Fuller and Picasso, the Torrens Title and the method of collage. All of these examples are inventors and inventions, as are the contributors to this volume and their works.

This volume contributes to a burgeoning body of evidence that broadens the view on invention from its narrow base of scientific, legalistic and economic understandings. Theories of collective intelligence (Pierre Levy), hyperintelligence (Mark Pesce) and cognitive surplus (Clay Shirky) all describe the ways ideas and knowledge circulate amongst global networks and thereby galvanise invention. Invention is also retrofitting, modification and hacking. As science fiction writer William Gibson famously commented in his short story *Burning Chrome*, 'the street finds its own uses for things' as user inventiveness leads to new uses and further inventions. In his book *Where Good Ideas Come From,* Steven Johnson describes this process of adapting existing components and re-purposing them as 'Exaption'. The contributions to this volume produce a new language by which to declare the value of a mulitiplicity of inventive approaches.

ENDNOTES

1   Wesley M. Cohen and Daniel A. Levinthal, 'Innovation and Learning: The Two Faces of R&D', *The Economic Journal* 99, no. 397 (1989).

2   M. Marsel Mesulam, 'From Sensation to Cognition', *Brain* 121, no. 6 (1998).

3   John A. J. Gowlett, 'Artefacts of Apes, Humans, and Others: Towards Comparative Assessment and Analysis', *Journal of Human Evolution* 57, no. 4 (2009).

4   Ralph L. Holloway, Jr., 'Culture: A Human Domain', *Current Anthropology* 10, no. 4 (1969).

5   Lewis. H. Sarrett, 'Research and Invention', *Proceedings of the National Academy of Sciences* 80, no. 14 (1983).

6   Norbert Wiener, *Invention: The Care and Feeding of Ideas* (Cambridge: MIT Press, 1993), 6.

7   To read John Maeda's comments in full on STEAM, see www.risd.edu/About/STEM_to_STEAM/, retrieved on 13 July 2013.

8   Charles Percy Snow, *The Two Cultures* (London: Cambridge University Press, 1998).

9   Stuart Cunningham, *Hidden Innovation: Policy, Industry and the Creative Sector* (Brisbane: The University of Queensland Press, 2013).

10   Cunningham, *Hidden Innovation,* 12.

11   Stefan Collini, introduction to *The Two Cultures* (London: Cambridge University Press, 1998), iv.

12   Dieter Daniels and Barbara U. Schmidt, introduction to *Artists as Inventors, Inventors as Artists,* ed. Dieter Daniels and Barbara U. Schmidt (Ostfildern: Hatje Cantz, 2008).

13   Daniels and Schmidt, *Artists as Inventors,* 10.

14   George Steiner, *Grammars of Creation* (New Haven: Yale University Press, 2002).

15   Max Horkheimer and Theodor W. Adorno. 1972. *Dialectic of Enlightenment.* (London: Allen Lane, 1944).