Harnessing non-modernity: A case study in Artificial Life

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Declaration

I, Christine Aicardi, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Abstract

Artificial Life is a research field which has developed around the use of synthetic artificial systems, mostly robotic and virtual, to investigate the supposed characteristic features of life. The thesis presents a case study of Artificial Life, with the overall objective of understanding some of the cultural, disciplinary and epistemological developments that may be distinctive of research communities who ground their work on a collaborative involvement with non-human simulation models. The study examines the cultural identity of the Artificial Life research community and its knowledge-making practices, as well as its sustainability strategies into existing institutional contexts. The study aims at being neither an over-localized laboratory micro-study nor an over general macro-study, but tries to situate itself in the mid-range by combining both approaches. It has been conducted through a combination of ethnographical fieldwork and of bibliographical analysis, and places a special focus on the Artificial Life research group at University of Sussex, which has been selected for its centrality in the global Artificial Life landscape.

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Chapter 1: Introduction

1. SETTING UP THE STAGE

1.1 TOPIC

The main motivation of this thesis is to capture some of the more subtle yet possibly profound ways in which the elusive and much canvassed 'information revolution' may influence research cultures and knowledge production. It rests on the working assumptions that in order to do so, then (1) a study of research practices and communities that have developed over time will yield elements of answers that a history of innovation, from which the complex time-dependent co-adaptation of users, usages and tools is absent, will not; (2) there are privileged sites for studying these effects; (3) research fields that have grown out of informatics,[1] and are at its forefront in terms of skilled mastery, are such privileged sites; (4) Artificial Life is one such research field. I trust that the thesis will prove in due course that these working assumptions are justified.

As a preamble, let me say that for the sake of convenience, under the name 'science and technology studies', STS for short, I will subsume throughout the present thesis the various fields of history of science, history of technology, philosophy of science, philosophy of technology, sociology of science, sociology of technology, anthropology of science, science policy studies, etc, alongside, of course, the 'genuine' STS work that sits across and fits into none of these specialist categories. My contention is that for STS at large, there are invaluable insights to gain in studying Artificial Life from a broad discipline-building perspective (its culture, its sustainability strategies, its

[1] I use the term informatics to encompass, as in the French 'informatique', information science and technology.

knowledge-producing practices, the institutional environments that best allow for its development). In the light of my main motivation, a major goal will be to uncover distinctive traits of Artificial Life at the cultural, institutional and epistemological levels, which relate to the centrality of informatics for the field.

1.2 ARGUMENT

In the present thesis, I will be defending the following main points:

- Artificial Life, which aims at understanding characteristic features of life by synthesizing artificial systems, is a field of research that is largely born from its practitioners' familiarity with, and skilled mastery of, informatics. It is held together by a culture of simulation, and more precisely, of agency-imbued computerized synthetic simulation. Drawing on Andrew Pickering, I will argue that some Artificial Life practitioners (or ALifers, as they often call themselves and as I will call them thereon) do not place themselves into the modern dualist ontology prevailing in the sciences, but are opting for a non-modern antidualist ontological attitude, by deliberately engaging into an open-ended 'dance of agency' with the systems that they design.

- The practice of computerized synthetic simulation, which is the cultural 'glue' holding Artificial Life together, is also, paradoxically, its major source of disciplinary instability, as it is at the root both of the uncertain epistemic status of its research and of its unsettled institutional positioning. Building on Peter Galison's concept of the 'trading zone', I will propose that Artificial Life is best conceptualized as an extended trading zone, which locally bridges different contexts of use (comprised of skills, practices, cultural values, theoretical frameworks) ranging across the full disciplinary spectrum. By focusing on the nonhuman element of Pickering's human-nonhuman 'dance of agency', here Artificial Life simulations, the 'extended trading zone' makes it possible to study the ‘quality’ and ‘quantity’ of agency effectively belonging to the nonhuman.

- The research community in Artificial Life who has so consistently thrived that it has come to dominate the field is also one who, through its moral economy, its ethos of interdisciplinarity and its interdisciplinary practices – through its overall form of life – is ‘harnessing non-modernity’, where harnessing corresponds to a letting-go-of-control form of management. Moreover, it is a form of life that is strongly localised, historically and geographically, in a particular institutional context. To argue this last point, I will again borrow consistently from Pickering. The study of interdisciplinary practices itself will draw heavily on the results of the project “Interdisciplinarity and Society: A Critical Comparative Study”, led by Andrew Barry, Georgina Born and Marilyn Strathern between 2004 and 2006 as part of the British ESRC ‘Science in Society’ programme. [2]

1.3 ANATOMY OF THE THESIS

The overall approach is hybrid, combining the micro-level perspective of an in-depth local case study to a macro-level investigation of the global Artificial Life phenomenon. The macro-study part of my thesis is comprised of chapters 2 and 3, while chapters 4 and 5, dedicated to the case study of what I will define as the ‘Sussex neighbourhood’ and its interdisciplinary practices, constitute the micro-study part. The macro- and micro- studies are not independent. Instead, the latter follows from the former, as the macro-study leads to the conclusions, first, that the use of computerized synthetic simulation, central to Artificial Life research, confers on the field a propensity for interdisciplinary hybridization at multiple levels (skills, cultures, epistemologies,

[2] The meaning of key terms such as ‘synthetic’, ‘computerized’ and especially ‘simulation’ is clarified at the beginning of chapter 2.

research methods) worth investigating; second, that due to the scattered nature of the global Artificial Life community and the strongly differing influence of local factors, an inquiry at field level is not appropriate to get a consistent insight into Artificial Life's most distinct interdisciplinary practices and into the form of community life that can sustain them; third, once it is recognised that a localised micro-study is preferable, that the locale retained is a healthily resilient research group occupying a central place in the Artificial Life landscape.

Chapter 2 addresses a first set of questions, preliminary yet fundamental in a discipline-building perspective, which springs from the observation that Artificial Life does not in fact exist as a discipline in academic institutions, but manifests itself mostly through specialist conferences and journals. How is such a research field to be apprehended? Does it exhibit a recognizable disciplinary-like form of identity? What is the 'glue' holding it together? As part of a formal disciplinary approach, different metrics are tried in order to circumscribe the global Artificial Life phenomenon. The quantitative markers show that, since Artificial Life came into official existence in 1987, its centre of gravity has moved frankly from the United States towards Europe, most especially the United Kingdom; they also show that the Centre for Computational Neurosciences and Robotics (CCNR) at the University of Sussex is by far the leading centre for Artificial Life research in the world. These are surprising and valuable results: first, they refute the generally accepted view that Artificial Life is quintessentially a North American phenomenon, which in turn casts serious doubts on the applicability of general conclusions drawn from US-centred studies of Artificial Life; second, they reveal the unambiguous centrality of CCNR, flagging it as the best potential candidate for an in-depth case study.

In terms of direct answers to the questions I am asking, the quantitative approach proves a good starting point in that it provides an overall map of the field. It shows that Artificial Life is found predominantly in academic departments of computer science and computer engineering; that it is a highly scattered population, small and rather stable in number; and that there is a small cluster of healthy research groups, a majority of which located in the United Kingdom. Yet it does not give any purchase on what is holding the global community together. Neither do the couple of routinely used qualitative disciplinary markers that I try beside the quantitative ones: Artificial Life is no more held together by a consensus around a well-defined research agenda than by a shared theoretical framework.

It is a cultural approach that eventually yields some answers, which I refine through the successive application of different cultural filters: predominant academic affiliation; researchers' background and training; Sherry Turkle's 'hard mastery' and 'soft mastery' programming styles, which lead her to characterize in broad terms the 'culture of simulation'; hobbies; types of simulation models used; relationship to simulation models and their products. It leads me to conclude that the Artificial Life research community shares a culture of simulation, and more precisely, a culture of 'agency-rich' simulation. Their defining cultural trait, their cultural 'glue', is the conviction that synthetic systems, which design involves computer simulations, is relevant to understanding life and its distinctive characteristics. Further, I show that the resulting Artificial Life systems are expected to display agency in a strong sense; that human authors wilfully engage their empowered nonhuman creations into collaborative play, into an open-ended and performative 'dance of agency'.

Chapter 3 takes a view of Artificial Life that is orthogonal to that of chapter 2. The latter is a frozen, historically-flat snapshot of the research community. By contrast, chapter 3 adopts a time-thick perspective, apt at capturing the dynamics of Artificial Life viewed as a social organization. Starting from the same observation as chapter 2, that Artificial Life is not an established discipline in academic institutions, the main question it attempts to answer is why. Why, over twenty years after its official inception, has Artificial Life not achieved a more stable disciplinary existence? Taking inspiration in the body of STS scholarship dedicated to the study of scientific controversies, which has shown that controversies have much to tell us about the peculiarities of the scientific communities involved, I scrutinize the recurring introspective debates that have been agitating the life of the global Artificial Life research community, in the hope that they may provide clues about possible structural causes (if such causes exist) of its disciplinary instability.

Two major themes are uncovered and analysed, which have been driving the Artificial Life community's ongoing introspection over the years: the (uncertain) epistemic status of its research, and its (unsettled) institutional positioning. Besides confirming that these two issues are closely interrelated, my inquiry further demonstrates that both have roots in the computerized synthetic simulations which are at the heart of Artificial Life research, and of which chapter 2 shows that they act as cultural 'glue' for the global community. Not only does simulation as a scientific practice fail to constitute an epistemologically sound conceptual core for Artificial Life, it also appears to stimulate an unsettlingly broad interdisciplinarity. Hence paradoxically, the cohesive force holding the field of Artificial Life together is also its major source of instability.

From there, the question that chapter 3 tries to answer next is, why is it so? Is there something intrinsic about the agency-rich computerized synthetic systems favoured by Artificial Life research, and the computer simulations that they involve, which would make them a fundamental cause of structural instability for Artificial Life, at both the epistemic and the institutional levels? My study leads me to conclude that in a worldview where, according to Bruno Latour, the purified categories imposed by the modern science ideal and by its consort epistemology strongly predominate – or, following Andrew Pickering, where a modern dualist ontology is hegemonic – the agency-potent simulation models of Artificial Life are serial boundary-crossers, 'messiness engines' that power and keep propelling into light an entire ecology of non-modern hybrids, the kind of which the modern work of purification aims at hiding. Through their resistance to categorization, through the relentless crossbreeding that they facilitate and the contamination thus produced, they are a major obstacle to the stabilization of Artificial Life into the predominantly modern epistemic and institutional matrix of academic disciplines. Building on Peter Galison's concept of the 'trading zone', I propose that the entire field of Artificial Life is best construed as an instance of extended trading zone, which locally bridges different contexts of use (comprised of skills, practices, cultural values, theoretical frameworks) ranging across the full disciplinary spectrum.

With regard to the collaborative human – nonhuman 'dance of agency' between Artificial Life researchers and their computerized synthetic systems, which chapter 2 brings to light, conceptualizing Artificial Life as an extended trading zone emphasizes the multi-dimensional hybridization that this open-ended engagement facilitates; it draws special attention to the nature and the amount of agency that the nonhuman part of the collaboration can display, thus giving more substance to the claim that in Artificial Life there is a balance to the human – nonhuman relation. This balanced human – nonhuman relation, that many ALifers appear to enjoy and explore, comes in striking contrast to the kind of asymmetric human-controlled dualism characteristic of the modern stance.[3] Following Latour and Pickering, it leads me to argue that the ontological vision which most agrees – resonates really – with the idea of the extended trading zone, is the non-modern one.

The next stage of my research is to investigate what may be going on in the extended trading zone, still through the specific instance of Artificial Life. What may be distinctive about its native research communities, preferably those who appear to thrive? What may be distinctive about the research they produce? These are the two questions that, respectively, chapters 4 and 5 set out to address empirically, through a micro-study of one such native research community, the 'Sussex neighbourhood'.

The macro-study part of my work shows that CCNR at the University of Sussex is by far the leading centre for Artificial Life research in the world. Its centrality in the Artificial Life landscape flags it as the best candidate for an in-depth case study. The first task of chapter 4 is to argue that the actual contours of the Sussex Artificial Life community, of the cultural place that it defines, is wider than the academic space, the physical shell, occupied by CCNR at Sussex University. I use various qualitative indicators (field observations, individual researchers' experiences of different research centres, interest of ex-Sussex members in the group's gossip, will to keep track and re-unite) to show that the Sussex Artificial Life community is a group of researchers who are held together by interpersonal ties that outgrow shared academic affiliation and joint research projects. This drives me to develop the idea of 'neighbourhood' in order to better delimit the contours of the locale that is to be the object of my case study. It proves an apt metaphor for capturing the nature of the relationships that ex-members of the Artificial Life research group at Sussex University entertain with CCNR, the centre of gravity of the community. It also retains the distinctly British anchorage of the

[3] Pickering (2009: 199-200).

community. Lastly, by significantly enlarging the perimeter of the sole CCNR, it helps highlighting just how central this research community has become to the global Artificial Life phenomenon.

The second task of chapter 4 is to contribute some empirical answers to what may be distinctive about native research communities in the extended trading zone, based on the specific case of Artificial Life at the University of Sussex. Following my characterization of this community as a neighbourhood, its case now begs the question, how does a research group grow into, and maintain its cohesiveness as, a healthy and successful neighbourhood? Considering that the Sussex neighbourhood does not fit the mould of professionalization into a properly delineated and respectable scientific discipline, what are the mechanisms underlying its construction and maintenance? My study demonstrates that adherence to a set of virtues and values, constitutive of a distinct moral economy, informally regulates the functioning and organization of the Sussex neighbourhood. It sheds light on the mechanisms through which the Sussex neighbourhood reproduces itself and maintains the integrity of its moral economy: elitist enrolment, which discriminates in favour of certain personality profiles, and the mentor-protégé model, which acts as vector for transmitting the cardinal virtue of loyalty – loyalty to individuals that easily translates into loyalty to the group and its moral economy. My study also characterises the ethos of interdisciplinarity that prevails in the Sussex neighbourhood. Finally, it firmly situates the moral economy and the ethos of interdisciplinarity propagated by CCNR in the historical fabric of the University of Sussex, as they reveal a strong lineage running all the way back to the blueprints for the new university set down by its founders in the early 1960s – thus showing that Real Life localisation does matter even for social groups for whom cyberspace is a natural habitat, and that notwithstanding funding factors, some institutional contexts can be more favourable than others to the development of research communities native to the extended trading zone.

Following on the conclusions of chapter 4, chapter 5 aims at understanding some of what may be distinctive about interdisciplinary research in the extended trading zone, on the basis, again, of the specific case of Artificial Life at Sussex. The chapter's focus is an empirical investigation into the Sussex neighbourhood's interdisciplinary practices that straddle the 'two cultures' divide. I deliberately target forms of research that cross over the sciences, arts and humanities, including traditionally separate schools of thought, because such practices are more especially illustrative of the hybridizing power that I claim for the extended trading zone. My investigation retains three areas of interest, as the most visible manifestations, in the Sussex neighbourhood, of the kind of interdisciplinarity I am targeting: (1) the strong continental philosophy streak, (2) the reclaiming of hybrid historical roots, (3) the art-science connection. To help filter, interpret and organize the material, both fieldwork and bibliographic, that I have accumulated in the three areas of interest, I use the thought-provoking typology of interdisciplinarity that resulted from the project "Interdisciplinarity and Society: A Critical Comparative Study", led by Andrew Barry, Georgina Born and Marilyn Strathern, which was concluded in 2006 while my own research was still under way. In the process, I evaluate whether my own results support or contradict theirs.

My study of the Sussex neighbourhood's interdisciplinary practices in the three areas selected shows that despite their diversity, these practices are, according to Barry et al.'s typology, highly consistent in their type of interdisciplinarity: the dominant mode of interdisciplinarity is agonistic-antagonistic, and the privileged logic of interdisciplinarity, that of ontology. This in itself is already a valuable result. Recognizing and identifying what they have come to term 'the agonistic-antagonistic mode' of interdisciplinarity and 'the logic of ontology' have been major original results of Barry et al.'s research – dimensions of interdisciplinarity that previous policy and theoretical approaches, and previous accounts of interdisciplinarity, had overlooked.[4] My own study confirms the pertinence of isolating these particular dimensions of interdisciplinarity.

In addition, my conclusions closely match those reached by Barry et al. in relation to the agonistic-antagonistic mode and to the logic of ontology. To start with, they support their finding, that the agonistic-antagonistic mode is the only one coming in association with the logic of ontology. My results are congruent with theirs on the main aspects of interdisciplinary practices in the logic of ontology (interlanguage development, training requirements, inadequacy of research evaluation and assessment). I enrich their results along different axis. Most notably, I highlight that the 'voluntary hybrid' profile (which I define as characteristic of individuals who possess hybrid interests and skills and are keen to integrate them – individuals who display an 'inner' interdisciplinarity) fits with interdisciplinarity in the agonistic-antagonistic mode and in the logic of ontology, and that individuals in the 'voluntary hybrid' profile may actually embrace this particular type of interdisciplinarity as a form of life. I also show that, in the face of the precariousness of this type of interdisciplinarity, largely due to the lack of recognition that follows from the inadequacy of research evaluation and assessment procedures, the kind of moral economy propagated by the Sussex Artificial Life community may not just be favourable to the growth of such interdisciplinary practices but may well be essential to their sustenance. Finally, I confirm that historicizing interdisciplinarity, situating interdisciplinary practices in time and space, helps dispel

[4] Barry (2007: 26).

the charge of internalism that analysing them in the logic of ontology may otherwise incur.

Chapter 6, the concluding chapter, brings together results from former chapters so as to emphasize the common thread that binds them. Drawing heavily on Latour and Pickering, I develop the argument, after which my thesis is entitled, that the Sussex neighbourhood is ‘harnessing non-modernity’. The remainder of the chapter establishes the scholarly contribution that my thesis brings to science and technology studies, before discussing the weaknesses that I perceive in my work and the avenues for new research that remedying them may open.

2. METHODOLOGY

In this section I will address the topic of methodology from the broad perspective of the research project’s overall methodological frame. Finer points of methodology will be introduced and discussed as the need arises, while the thesis progresses in its development. Similarly, because the research draws from a wide range of literature, and an even wider range of sources (literature, fieldwork material, web material), there is little sense in making a global literature review. Instead I will make ‘local’ thematic literature reviews in relation to specific points of my development.

2.1 A HYBRID APPROACH

From the start of the project, I had to face a thorny problem of scale, quite common in the social sciences and no less in STS. I was set on doing a detailed empirical study, much in the ethno-methodological tradition of STS laboratory studies, rather than a broad survey type of inquiry. I was (am) not so much interested in skimming the surface of things as in digging into their flesh. But the problem one faces when opting for a micro-study, is of course the problem of scaling it up – of situating it into a larger mapping so that it is possible to assess, and eventually validate, its wider relevance. Here, I had to accommodate the hard fact that I was venturing into mostly unchartered territory. Little had been done to investigate the interactive relationship between informatics – the science and technology of information – and research cultures and practices; while due to the exponential ubiquity, affordability and versatility of information and communication technologies (ICTs), their uses and users presented an enormous diversity. Hence there was not much in the way of scholarship that I could anchor a micro-study to, in order to tie it up to the main goal I was pursuing; while if I left it standing on its own, it would be comparable to the study of a single pebble randomly picked out from a heap of pebbles of unknown quantity and quality: irrelevant and anecdotal.

I have not tried to theorise the scale problem in any way, only to deal with it pragmatically. It meant that whatever the approach I adopted, I would have to justify, first, that Artificial Life was indeed a field, which study was relevant to capturing some of the deeper ways in which informatics interacted with research cultures and knowledge production practices; and second, that the locale I retained for an in-depth case study was a pertinent choice. I have thus adopted a hybrid approach, combining the micro-level perspective of a detailed local case study to a macro-study at the research field level. I will not assert that, when complemented by a macro-study at field level of Artificial Life, a micro-study of the 'Sussex neighbourhood', who is but a particular research community in a particular and rather confidential research field, can yield conclusions that are universally, or even widely, valid about the ways in which ICTs are both shaping, and being shaped by, research cultures and knowledge production practices. But the hybrid approach makes it possible, on the one hand, to investigate in depth, at ground level, a tiny area of the overall landscape; and on the other hand, to ensure that this micro-study is not an anecdotal blip but is indeed relevant to the domain of study.

2.2 PRIMARY MATERIAL: ISSUES AND CHOICES

I will approach the topic of primary material (collection, reliability, data protection) through the fieldwork angle.

The research project accounted for in the present thesis was, from the start, overwhelmingly empirical. It was targeting Artificial Life, a research field whose inception has been recent enough for some of its founders to still be actively practicing; and it was, broadly, taking a time-thick discipline-building perspective. This implied that I needed to collect elements of an oral history of the field, if I hoped to understand some of the community's social dynamics and cultural mores.

I will not enter into a review of ethno-methodology, participant observation, and their different variants; there is a massive scholarly literature available on these topics. This discussion is practice-oriented rather than theory-oriented. I will simply say that ethno-methodology inspired my approach to fieldwork, for its focus on how people understand their everyday activities, on how people use routine social interaction to make sense of their world and construct their reality. With regard to participant observation, to take a point of reference in STS, I fully follow Harry Collins when he argues that under the form of 'participant comprehension' in the phenomenological tradition (as opposed to 'unobstrusive observation' in the positivist tradition of social sciences), it enables the sociologist to acquire the understanding of what counts as an account – correct or false alike, a false account being meaningful in its own right as it reveals the kind of lies one can get away with within the culture under investigation – and that in the process, the sociologist collects an oral history of the studied field.[5]

Fieldwork was an essential element of the research design, in order to take part in some of the daily life and social exchanges of ALifers. Followed the problem of entering the field. In the early stages of my research, I was aware, through Helmreich's ethnography of Artificial Life at the Santa Fe Institute (SFI),[6] and more generally through the popular science literature on Artificial Life, that SFI was in the 1990s a major centre for Artificial Life research in the world; yet going through their website and publications a decade later, it did not appear to be the case anymore. I was also aware, through Risan's ethnography of Artificial Life at University of Sussex,[7] that in the mid-1990s there was an active group of ALifers over there; but due to its organisational opacity (see chapter 4) it was hard to figure out outright whether it was still much active, and what was its relative importance in the field. So, although it was easy enough to meet and interview individual ALifers in order to get a first dim picture of the field, where could I find groups of ALifers whose social life I could hopefully partake in, and who would be representative of the overall community? Artificial Life is not an academic discipline in the traditional sense. There are no departments of Artificial Life in universities. It mostly exists through conferences and journals. The obvious answer was to attend some of its specialist conferences.

In total, I have attended four week-long conferences, including workshops. Three were dedicated Artificial Life conferences (ALIFE X in 2006 in Bloomington, Indiana (USA), ECAL 2007 in Lisbon (Portugal), ALIFE XI in 2008 in Winchester (UK)); one was the major conference in the field of evolutionary computation, which included an Artificial Life track (GECCO 2007 in London (UK)). Conferences have

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[5] Collins (1983: 69-73).
[6] Helmreich (1998).
[7] Risan (1997a).

proven excellent sites for doing fieldwork in Artificial Life. The field is widely scattered, and many ALifers feel quite isolated as they work in departments where they are in stark minority and face much incomprehension from their colleagues. The yearly specialist conferences are thus very special events for the social bonding of the community. Moreover, I have found that the threshold to gain acceptance was lower in the conference context. In a conference, being a new face does not tag you as an outsider; participants assume that if you are there, attending plenary talks, workshops and roundtables, then you somewhat belong.

About a year in the project, I had assembled enough elements to choose the 'Sussex neighbourhood' for an in-depth case study. Gaining access was fairly easy. This is in part because my personal background (my initial training was in applied mathematics, theoretical mechanics and computer science; I worked for ten years in the computing and telecommunication industry, six of which in the field of graphic simulation software, first as analyst-programmer then as sales engineer; my hobbies involve gaming, fantasy and sci-fi; and I am a 'voluntary hybrid') matched that of many ALifers. I shared with them number of cultural references and my scientific grounding gave me a basic grasp of their research, which made me someone they easily talked to. This is also in part because the Sussex group is an especially open-minded and reflexive set who welcome pluralism – a characteristic of their ethos of inter-disciplinarity. I was never confronted to 'studying up' issues in the Sussex neighbourhood. The most difficult part was not to go fully native, and retain a healthy level of critical awareness. Here, not spending an extended period of time in full field immersion turned to my advantage, as it helped me retain some 'otherness'. Returning to my university environment where the part of me that felt at home with ALifers felt quite alien among my colleagues, has kept me reflexive on my 'native' side. Plus I should add, as my small empirical contribution to the question of compromising between the states of 'native' and 'other', that being close to Sussex ALifers in many respects, made me acutely aware of what we did *not* have in common.

Over 2007 and 2008, I regularly 'went down' to Sussex from London (for a few months about once a week) to talk to people informally, attend social events, make occasional interviews. I also spent a lot of time hanging around with the Sussex community at the later conferences, during and after hours. The after-hours sessions were especially fruitful for material collection. They involved convivial dinners often, alcoholic beverages always (the Sussex community partakes actively of the British 'pub culture'). Provided I kept a clear enough head, it was the best time to get behind-the-scene comments, ask more personal questions, and glean gossip. I knew I had reached the stage of being accepted as participant rather than as observer when I became 'one of the crowd' – when my otherness became invisible, even momentarily.

I would like to clarify my position on the question of interviews. I started on the project thinking that I would collect a lot of primary material through semi-structured interviews, in the oral history tradition. When I attended my first Artificial Life conference, I had pre-arranged interviews through emails, with individuals whom I had identified as possible gatekeepers to the community. Interviews did bring me valuable material. But I soon found that the formality of their setting, involving digital recorder, copyright assignment and consent form, made them somewhat methodologically inconsistent with my idea of participant observation: if anything, it turned me into a threatening 'other'. Plus some interviewees who were familiar with the exercise tended to revert to well-rehearsed answers, which to my ex-sales person ear sounded a lot like a sales pitch, and I had to work hard to disrupt their routine. After ALIFE X, I still made a few interviews of the 'old' ALifers with the explicit aim of collecting their memories, but I seldom used the digital recorder anymore. Instead I reverted to the well-honed skill I had developed during my years in sales, of taking a few unobstrusive notes during the interview while committing as much as possible to memory, and sitting down in a quiet place immediately after to jot it all down or dictate it. This is, more generally, the data collection technique that I have used throughout my fieldwork. I may have developed it as a skilled practice in the context of my professional experience in sales, but it is classic anthropology field technique

I also gave up entirely on the copyright assignment and consent form (except for the first few I had obtained). This, along with the 'covert' manner in which I collected field material, had implications for data protection and ethics in the restitution of field and interview material. The policy I have adopted is straightforward: I have anonymized the data, using vague terms as 'a researcher', 'one of the group leaders', etc, save for the few interviews for which the copyright assignment and consent forms had been signed, and for the reporting of public events (roundtables, keynote lectures, paper presentations, organized debates, performances).

The major drawback of so anonymizing my field sources is that the trustworthiness of the reporting relies almost entirely on my word for it. Its reliability, as well as the validity of its results, thus increased the already strong need to bolster it by other means. I have used what in qualitative research is commonly called triangulation. For qualitative casework, it is an alternative to justification, "generally considered a process of using multiple perceptions to clarify meaning, verifying the repeatability of an observation or interpretation. But acknowledging that no observations or interpretations are perfectly repeatable, triangulation serves also to clarify meaning by identifying different ways the case is being seen."[8] I have used

[8] Denzin & Lincoln (2005: 5-6); Stake (2005: 453-454).

triangulation extensively throughout the thesis, in the macro- as the micro-study parts, in both the roles identified in this extract. It is ubiquitous in my work and easily recognizable. For instance, at the most rudimentary level, I have sifted my material for recurring and preferably independent occurrences of themes. I have also used quantitative data to complement my predominantly qualitative material. More importantly, after writing up the drafts, first of the macro-study, later of the micro-study, I had some of my informants review them and/or I discussed my main findings (observations I found of interest and the interpretations I proposed) with them. The later conferences have been especially good for this.

The search for different perceptions to triangulate my field material with has had a broadening and diversifying impact on the range of primary sources I have drawn from. I have used primary bibliographic material extensively (mostly books, papers published in peer-reviewed journals and conference proceedings) especially after I realised that bibliographic analysis and fieldwork complemented each other in ways I had not fully anticipated. Reading Artificial Life scholarship, especially by ALifers I planned to meet, was good preparation to making contact, and conversely, participant observation gave me a better grasp on the literature, but these were expected reciprocal benefits. More unexpectedly, I have found over time that remarks I may initially have overlooked in my sources' writings as seemingly un-noteworthy could take on a new meaning in the light of the 'participant comprehension' I had developed, and I have read and re-read much Artificial Life literature looking out for hidden gems that would help in my triangulation work.

Beside traditional primary bibliographic material, Risan's and Helmreich's accounts of Artificial Life were in a category of their own. They are technically secondary sources (and good pointers towards primary bibliographic sources). But as ethnographies, they included plenty primary field material which, although filtered by each anthropologist's interpretative lens, was still useful as point of comparison for my own field findings. They were part of the different perceptions required in triangulation.

Finally, I have used much web material. The topic of web material as primary source would deserve an extended discussion in its own right, but in the constrained context of the thesis I cannot devote it more than a very sketchy and partial treatment. The web was an invaluable source of original material, especially in the domain of Artificial Life art. Announcements of social events, performances and talks were unavailable by any other means, as were artists' portfolios. Well knowing that the reliability of web material was questionable, I have paid special attention to this particular issue. First, I have given careful consideration to provenance. For webpages, those I have retained all originated from institutional websites (universities, research councils, conferences), and from websites (including blogs and wikis) of individuals or associations (like the Institute of Unnecessary Research, Brighton Robotics, the Blip forum, etc) that I had become acquainted with through fieldwork. Beside webpages, I have used material collected through mailing lists I adhered to, and through messages sent by Facebook groups I became member of, but again, it was never anonymous material and I was acquainted with administrators and/or authors. Second, I have treated this web material just as another mode of discourse (originating from a certain source, targeted at a certain audience, meant to achieve certain goals) and I have triangulated it in much the same way as the field material. This is an important point I think. In my experience, the process of triangulation through a widened spectrum of primary material can become a self-reinforcing mechanism – disparate bits and pieces can resonate and mesh together into a whole of greater credibility than the sum of its parts.

Chapter 2: Artificial Life, a culture of simulation

1. INTRODUCTION

The present chapter addresses the main issue that arose when I first tried approaching Artificial Life from the disciplinary angle. Although officially named for just over twenty years, it did not exist as a discipline in academic institutions. Its heterogeneity and elusiveness presented a number of puzzles in terms of its research agenda and its perimeter, notably its intersections with Artificial Intelligence and cognitive science. This raised a number of questions: How was such a research field to be apprehended? Did it exhibit a recognizable disciplinary-like form of identity? What was the ‘glue’ holding it together?

Answering these questions called for revisiting notions of disciplinary identity in the STS tradition. In section 3, different metrics are tried out, first quantitative then qualitative, as part of a formal disciplinary approach which starts from the observation that to the outside, Artificial Life manifests its existence mostly through specialist conferences and journals. The quantitative markers prove a good starting point for the geographical and institutional mapping of the field, yet the formal disciplinary approach fails to capture what holds the Artificial Life community together. Sections 4 and 5 turn to a cultural approach, and refine it through the successive application of different cultural filters. Finally, drawing on Pickering, section 6 argues that the cultural ‘glue’ of Artificial Life is a source of manifest non-modernity.

But first, as an overdue preamble to the entire thesis, section 2 clarifies what is Artificial Life and the meaning of a few key terms besides, in particular ‘simulation’.

2. PRELIMINARY DEFINITIONS

Chris Langton's 1987 much quoted provocative founding manifesto for the newly branded field of Artificial Life defined it thus:

> "[Artificial Life] complements the traditional biological sciences […] by attempting to *synthetize* life-like behaviors within computers and other artificial media. By extending the empirical foundation upon which biology is based beyond the carbon-chain life that has evolved on Earth, Artificial Life can contribute to theoretical biology by locating *life-as-we-know-it* within the larger picture of *life-as-it-could-be*."[9]

Indeed, a broad definition of Artificial Life on which I have found general agreement among ALifers is that it aims at understanding characteristic features of life by synthesizing artificial systems. In line with the general meaning of the term in system theory, which informs much work in Artificial Life, 'system' is to be understood as a set of interdependent and interacting elements forming a complex whole. The 'understanding characteristic features of life' part of the definition will be discussed in the next chapter. For now, the focus is on 'synthesizing artificial systems'.

In complexity sciences, a common understanding of synthetic processes is that they are interacting processes, inspired by natural phenomena, which from sets of finite and deterministic rules and parameters synthesize non-deterministic and infinite behaviour possibilities. Artificial Life is a subset of complexity sciences whose inspiration comes primarily from biological systems – biological in the broad sense of 'based in the organisation of life': this is the perspective from which Artificial Life approaches cognition, immunology, linguistics, sociality, etc.

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[9] Langton (1989a: 1-2); italics are Langton's.

The definition of Artificial Life systems as life-inspired synthetic artificial systems anchors Artificial Life in complexity sciences. From the arts comes an alternative to the term 'synthetic'. Artificial Life art is firmly located within the wider and older domain of generative art, and thus from an artistic perspective Artificial Life systems are life-inspired generative systems. In the remainder of the thesis, the term 'generative' appears in some quotations and I may use it occasionally, mostly in relation to Artificial Life art. I will no more discuss generative art than I have complexity sciences; they both fall outside the scope of the thesis. I would simply highlight that the concurrence between 'synthetic' and 'generative' points at multiple and heterogeneous historical genealogies in Artificial Life, a topic I will explore in chapter 5.

Artificial Life systems are designed using various types of processes (genetic algorithms, cellular automata, Lindenmayer systems, etc); some are autonomous agents and other multi-agents systems; they can take different forms (virtual, robotic, chemical even). Yet I will generally refer to the products of Artificial Life research as 'computerized'. Why 'computerized', when these products comprise the material artefacts of robotic and chemical Artificial Life? For me, systems qualify as 'computerized' when their design involves the running of simulation models on computers, and in that sense the overwhelming majority of Artificial Life systems, including embodied robotic and wet-lab chemical systems, are computerized, and this whether or not the corresponding biological systems are actually thought to be computational. Let me insist that biological systems need not be computational (or viewed as such), i.e. computing their moment-to-moment states, to be modelled, however imperfectly, by artificial computerized systems.[10]

[10] Wheeler (2005: 101).

Here I must clarify my understanding of the term 'simulation', as it somewhat departs from that which is usual in Artificial Life.[11] For ALifers, the virtual ('soft') Artificial Life realisations usually count as simulations, although some may argue that computer models are not necessarily simulation models; but chemical ('wet') Artificial Life, and robotic ('hard') Artificial Life – especially of the kind that does not involve software-driven controllers but relies entirely on physical components like reconfigurable hardware – do not count as simulation. Luc Steels, who has tried to articulate the synthetic method, explains that it goes further than computer simulation because in simulation the 'real world' is absent; what differentiates computer simulations from chemical and robotic artificial systems is the absence of physical interfaces to the 'real world': "The goal is to build an artificial system that can function instead of the natural system in the same context setting […]."[12]

One of my interlocutors suggested that I found a more encompassing term than simulation if I wanted to embrace the diversity of Artificial Life within a single category, 'replication' for example. Taking his point on board, I will nonetheless go on using the term 'simulation' to qualify the various forms taken by Artificial Life realisations, even those that interface to the 'real world' and eventually the (very) few that do not involve computers in their design. I will use it with a meaning that pertains more to the specialist repertoire of the humanities than of computer science, as befits my own academic allegiance. A simulation aims at imitating an appearance, a character, a behaviour. In that sense, when an ALifer lets loose a model with an in-built capacity to evolve, or to mutate, or to replicate, or to reconfigure itself, etc, with the aim of replicating characteristics of biological organisms, then whether the model is analogical, computational or chemical, whether its design has involved the use of a computer or not

[11] I am indebted to Tom Froese who has rightfully pointed this divergence to me and helped me refine my thinking about 'simulation'.
[12] Steels (1994: 8-12).

(although this is overwhelmingly the case), and whichever medium the letting loose occurs in, for me the said ALifer runs a simulation, a 'what if?' scenario in which the 'if' is predicated on the attributes built into the model. In this view, synthetic systems that interact with their environment are not 'more' than simulation, they are a new stage in simulation.

Clearly this general definition of simulation does not agree with the more restricted one of ALifers, which is largely borrowed from computer science. Yet it has other benefits than opportunistically regrouping all forms of Artificial Life under a single heading. I have stated that most Artificial Life systems are computerized to some degree. Indeed, most of the research in chemical and robotic (software-free or not) Artificial Life involves computer-run simulations as timesaving and cost-efficient designing tools. For instance, the parameters defining the initial state of a robotic agent or a chemical soup are experimented with virtually beforehand; or when a controller is part of an evolutionary robotic system, the software running the controller is evolved on the computer before being downloaded into the controller; in physical robotic projects, the evolutionary timescale may likewise be accelerated without the intermediary of software, by working directly on programmable electronic circuits, which are equivalent to basic computer parts; a robotic agent will have its interfaces tested through a computer model of the agent situated in a microworld, which is itself a computer simulation of a physical context.[13]

Another benefit of describing indifferently the virtual and physical products of the synthetic method as advanced simulation is that simulation now comprises analogue as well as digital realisations. This helps bringing out the commonalities existing

[13] For instance, Steels (1994: 12), Jacobi, Husbands, & Harvey (1995), Thompson (1995).

between some contemporary Artificial Life, and mid-20th century cybernetics such as Grey Walter's tortoises, Ross Ashby's homeostat, or Gordon Pask's ear.

Moreover, many ALifers who are currently the proponents of physical robotics and web-lab realisations have in earlier days built fully virtual Artificial Life systems, so that their later strands of research should not be understood as utterly unrelated to computer simulation, but rather as defining themselves against it, as a move away from it – a divorce which is still very much a relationship although antagonistic. Thus widening the simulation perimeter will make sense when looking for the cultural glue holding together the Artificial Life research community.

To conclude on terminology, I realise that the partis pris I have just taken in defining certain terms may appear arbitrary at this point, but this is because they rely on the research project as a whole and thus on the content of later chapters. I ask the reader to bear with me and trust that the rest of the thesis will vindicate my choices.

3. A FORMAL DISCIPLINARY APPROACH

The existing literature on Artificial Life has not addressed the disciplinary question as such. Two previous anthropological studies of specific groups inside the Artificial Life community have given it a partial treatment: Stefan Helmreich's ethnography of Artificial Life at the Santa Fe Institute, and Lars Risan's ethnography of Artificial Life at the University of Sussex, both in the early to mid 1990s.[14] Their studies have provided me with invaluable material. Despite the gap in time between their work and mine, many of their informants were still active members of the Artificial Life community. Moreover, because of the highly networked and distributed nature of the community, both Helmreich and Risan had to situate the groups they spent

[14] Helmreich (1998), Risan (1997a).

time with in a wider context. Yet because they were not looking explicitly for the common denominators of the global Artificial Life community, they did not have to tackle the thorny issue of delimiting the field.

From the onset, a disciplinary approach to Artificial Life has to adapt to the basic fact that Artificial Life does not exist as a traditional discipline in academic institutions. Contrary to its close neighbour Artificial Intelligence, Artificial Life has no dedicated departments or undergraduate degree, and very few taught masters degrees are directly relevant. Looking for the presence of Artificial Life in academia on a smaller scale than that of university departments, one finds that the overwhelming majority of research centres doing Artificial Life research do not have Artificial Life in their names,[15] and Artificial Life often accounts for only a minor part of their research activities. The lack of institutional structure has consequences that I had to take on board from early on in my fieldwork. For example, a majority of the participants whom I talked to at the first Artificial Life conference that I attended (ALIFE X, the 10th International Conference on the Simulation and Synthesis of Living Systems, hosted by Indiana University at Bloomington, Indiana, in June 2006) would not qualify themselves as really doing Artificial Life. They tended to present their research activities under a different heading than Artificial Life, one that would get recognition in the academic entities they belonged to. At ALIFE XI, the first keynote speaker of the conference, a long-time ALifer, observed that when people in the field were asked whether they were doing Artificial Life, and even when they asked themselves "Am I doing Artificial Life?", the answer was more often than not "I don't know."[16]

I have adopted a pragmatic approach to this problem. Since the existence of Artificial Life relies to a large extent on conferences and publications, in addition to the

[15] Tables 2 and 3 below.
[16] Fieldnotes, 05/08/2008.

researchers who straightforwardly acknowledged that they were doing Artificial Life, I have tagged as Artificial Life practitioners the individuals who attend Artificial Life conferences or publish into Artificial Life journals and monographs – my rationale is that overall, barring a few discrepancies, they are likely to have vested interests in Artificial Life-related research. I am fully aware that this method of delimitation has shortcomings. For example, I get included in the perimeter of Artificial Life; get also included the few individuals coming from diverse horizons, who attend mostly out of curiosity, in the hope of shopping for ideas. Yet it may not be such a shortcoming. As I will show in due course, there is more to the capacity of the Artificial Life community, and the willingness of some of its members, to attract odd ones out, than just being a source of anomaly in its headcount. It may well be a distinct feature of the Artificial Life phenomenon.

3.1 THE CONFERENCES

As a first approximation of the Artificial Life community, let us examine the main conferences they attend and the main journals into which they publish. Although there are many, and increasingly more, Artificial Life tracks at different conferences, as well as workshops, summer schools, etc, historically, there are two major series of conferences dedicated to Artificial Life. The ALIFE conferences, International Conferences on the Simulation and Synthesis of Living Systems, have been running since the first international workshop held at Los Alamos in 1987. Since ALIFE II in 1990, they have been held every other year. The ALIFE conference series is US-based, although it has moved out of the US three times, once in Japan in 1996, once in Australia in 2002, and once in the United Kingdom in 2008. In June 2006 I attended ALIFE X, organised at Bloomington (United States) by the School of Informatics of the

University of Indiana; and in August 2008 I went to ALIFE XI, which was organised in Winchester (United Kingdom) by University of Southampton SENSe (Science and Engineering of Natural Systems Group). The second series of conferences, ECAL (European Conferences on Artificial Life), have been held on odd years since 1991. In September 2007, I attended the 10th ECAL in Lisbon (Portugal), chaired and co-organised by the Centre for Computational Neuroscience and Robotics (CCNR) of University of Sussex (United Kingdom).

The number of registrations at ALIFE X and ECAL 2007 were consistent – 240 at ALIFE X and 230 at ECAL 2007. They were significantly higher at ALIFE XI, around 300 – and higher than expected: the conference chair stressed that although he was delighted about it, the venue was stretched to its maximum, calling for patience and discipline in the audience. According to the participants whom I talked to, it seems that these figures are overall in line with those of previous conferences. Regarding the ALIFE series, at ALIFE I in 1987 the attendance was apparently already around 150,[17] and numbers seem to have soared for a while, with around 500 participants reported for ALIFE III in 1992,[18] before diminishing to around 200. In comparison, let us consider the International Genetic and Evolutionary Computation Conferences (GECCO). The comparison is significant because genetic and evolutionary computation methods are, along with cellular automata, fundamental tools for building Artificial Life simulations. The Artificial Life community contributes to their development and a good number of ALifers attend conferences in that area. Indeed, GECCO 2007, held at and co-organised by UCL in London (with notorious ALifers on its organising committee)[19], offered an Artificial Life and Evolutionary Robotics track. GECCO has been held yearly since

[17] Waldrop (1992: 238).
[18] Helmreich (1998: 55); also mentioned in the blurb on the last of cover of ALIFE III proceedings, published by the Santa Fe Institute.
[19] Peter Bentley, head of the Digital Biology interest group at UCL; Hod Lipson, head of the Computational Synthesis Lab at Cornell University.

2000, initially as a recombination of the International Conferences on Genetic Algorithms (running since 1985) and the Genetic Programming Conferences (running since 1996). GECCO 2007 included 14 separate and independent tracks, whereas both ALIFE X and ECAL 2007 were single track conferences; 266 full papers and 210 posters were presented, against 35 full papers / 48 posters at ALIFE X and 38 papers / 82 posters at ECAL 2007; and there were about 700 people attending the conference. According to these figures, the Artificial Life community appears to have remained stable over time and quite small compared to the soaring numbers of the evolutionary and genetic computation crowd. As for the higher attendance of ALIFE XI, the organisers may have been pleasantly surprised, especially as the conference took place early August and they had some uncertainties with regard to the 'summer vacation' factor; yet it is neither a real surprise nor a discrepancy, if we consider that the conference was taking place in the United Kingdom which (as the figures below will clearly demonstrate) is largely predominant on the international Artificial Life scene.

Keeping in mind the number of participants at ALIFE X, ECAL 2007 and ALIFE XI, most of whom were presenting papers or posters (as it is the usual requirement, in academic institutions, to obtain funds for attending a conference), if we look now at the provenance of the papers being presented, around 100 institutional entities[20] for 17 countries were represented at ALIFE X, about 90 institutional entities for 27 countries at ECAL 2007, and 115 institutional entities for 26 countries at ALIFE XI. These additional figures show that in addition to having remained quite stable and small in number over the years, the Artificial Life community appears to be scattered both institutionally and geographically.

[20] By which I intend academic departments, schools, institutes or research groups, as well as private research facilities.

	ALIFE I	ALIFE X	ECAL 07**	ALIFE XI
Austria	-	-	-	3
Australia	-	3	6	7
Belgium	-	7	12	3
Brazil	-	-	1	-
Canada	1	5	4	6
Chile	-	-	1	2
China	-	-	2	1
Colombia	-	-	1	1
Czech Republic	-	-	2	-
Denmark	2	-	-	1
France	1	3	1	5
Germany	-	12	7	11
Hungary	-	3	1	3
India	-	1	-	-
Ireland	-	-	3	6
Italy	-	6	8	8
Japan	-	17	16	15
Lithuania	-	-	1	-
Mexico	-	-	1	-
Netherlands	2	3	5	8
New Zealand	-	5	-	1
Norway	-	-	-	2
Poland	-	-	1	1
Portugal	-	3	6	6
Romania	-	-	2	1
Russia	-	-	1	2
South Korea	-	-	1	-
Spain	-	4	3	5
Sweden	-	1	2	1
Switzerland	-	11	4	4
Thailand	-	1	-	-
UK	1	39	39	111
US	26	65	10	22
Total Europe	6	92	98	181
Total	33	189*	141*	236*

Table 1: Papers by country at ALIFE I, ALIFE X, ECAL 07 & ALIFE XI
Shows by country: (1) number of papers to which an institutional entity collaborated for ALIFE I, (2) number of papers (inc. workshops) to which an institutional entity collaborated for ALIFE X, (3) number of papers (inc. presentations for which only an abstract has been published in the proceedings) to which an institutional entity collaborated for ECAL 07, (4) number of papers to which an institutional entity collaborated for ALIFE XI

* These totals are much higher than the number of papers presented, most of them being collaborative involve more than one institution

** ECAL 2007 workshop papers are not included; to give an indication of the way in which their inclusion might have affected the results, out of 7 workshops the UK organised 5, Switzerland 1, Italy / Netherlands 1

Table 1 gives the figures regarding the repartition by countries of the papers presented, showing by country the number of papers to which institutional entities have collaborated for ALIFE X, ECAL 2007 and ALIFE XI, to be compared with the numbers for ALIFE I.

Table 1 does not go down to the level of individual institutional entities, but its coarse-grained filter should be well adapted to the detection of broad geographical trends. It immediately reveals a couple of distorting factors which must be taken into account before we venture any further in the interpretation of its content. It appears that the choice of the country where a conference is held has an impact on the number of individual contributions by institutional entities of this country; but the impact proves to be even stronger for the country to which belongs the institution organising the conference. The US was much more strongly represented at ALIFE X than at ECAL 2007 and even at ALIFE XI (the ALIFE series being the one traditionally located in the US, we could have expected ALIFE XI to be well attended by US ALifers even if it was held outside of the United States): out of a total of 189 individual contributions by institutional entities in the case of ALIFE X, 34% originated from the US; it was down to 7% at ECAL 2007 and 9% at ALIFE XI (it had been 79% at ALIFE I). The level of representation of Portugal was the highest at ECAL 2007 which was located in Lisbon, but not very much so: 1.5% at ALIFE X, 4% at ECAL 2007 and 2.5% at ALIFE XI. As for the UK, the figure was higher in the case of ECAL 2007, which was organised by a British institution although it took place in Portugal, than in that of ALIFE X; it was much higher still in the case of ALIFE XI, both located in the UK and organised by a British institution: 20.5% at ALIFE X, 27.5% at ECAL 2007 and 47% at ALIFE XI. These results are displayed in figure 1.

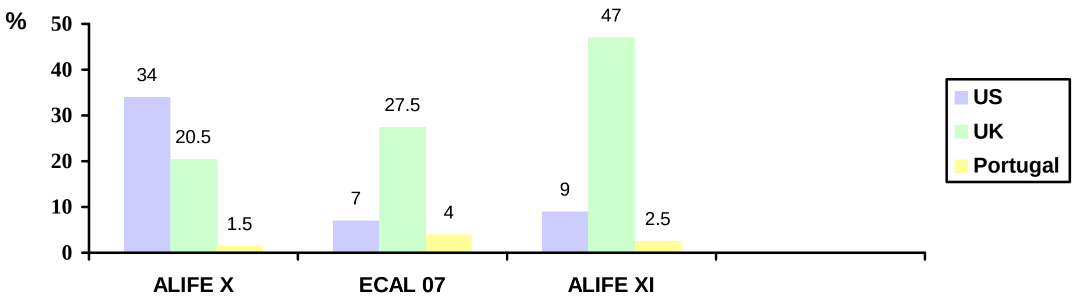

Figure 1: % of total papers by country for host countries of ALIFE X, ECAL 07 & ALIFE XI
Shows for the US, the UK and Portugal (the 3 countries which between themselves organised and hosted ALIFE X, ECAL 2007 and ALIFE XI), their respective weights as percentage of the overall number of individual contributions to conference papers by institutional entities for these 3 conferences

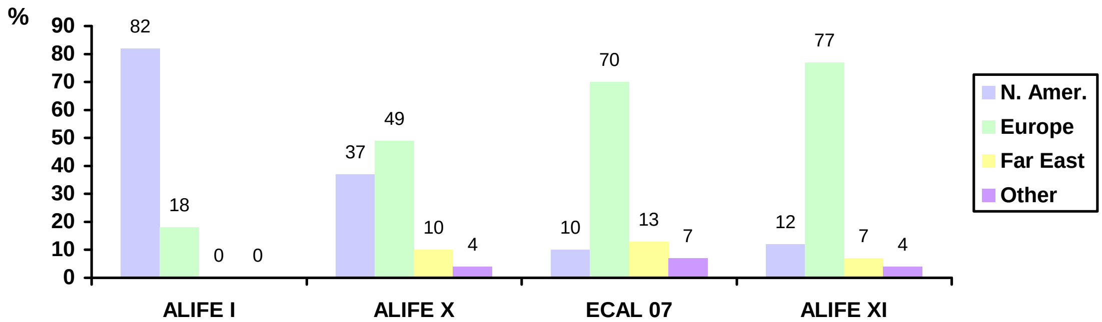

Figure 2: % of total papers by region for ALIFE I, ALIFE X, ECAL 07 & ALIFE XI
Shows for ALIFE I, ALIFE X, ECAL 2007 and ALIFE XI, the respective weights as percentage of the overall number of individual contributions to conference papers by institutional entities, for North America, Europe, Far East and Other

The chart in figure 2 derives also from Table 1. It displays the weight of North America, Europe, the Far East and South America respectively in the overall individual contributions to conference papers by institutional entities, for ALIFE I (as initial referent), ALIFE X, ECAL 2007 and ALIFE XI. Figure 2 confirms that the Artificial Life community is mostly based in Western contries. I have not included the share of Oceania although it is higher than that of South America, hovering around 5%. This is because the contributions all come from either Australia- or New Zealand-based researchers, of whom we can assume that despite some local specificities they fit the Western developed country model. Together, the charts in figures 1 and 2 reveal that notwithstanding the distortions introduced by where the conferences took place and who organised them, there has been an unambiguous displacement towards Europe of the Artificial Life community centre of gravity since 1987. This finding refutes the commonly accepted view that Artificial Life is overwhelmingly a North American phenomenon. Further, it casts serious doubts on the validity of generalisations which can be made (have been made) about Artificial Life, based on US-centred studies.

Compounded with table 1 that breaks the European figures by country, figures 1 and 2 show the overly dominant position achieved by the UK. Here we can look at the distorting effect of where the conferences took place and who organised them from a different perspective: the fact that ECAL 2007 has been organised by a UK institution and that ALIFE XI has been both organised by a UK institution and held in the UK may not be just circumstantial coincidence, but partly the consequence of the current UK dominance in Artificial Life research. The grapevine gossip at ALIFE XI about why it had been decided to take it outside the US was that it had been impossible to find a US institution interested in hosting it. It seems that the UK was the most obvious place to look once it had been decided to have it in Europe.

	ALIFE X	ECAL 07*	ALIFE XI
Auckland Univ. (New Zealand), Dept of Computer Science	5	-	-
Basque Country Univ. (Spain), Dept Logic & Philosophy of Sc.**	2	1	4
Birmingham Univ. (UK), School of Computer Science	**3**	**2**	**2**
Birmingham Univ. (UK), Systems Biology Centre**	**-**	**1**	**4**
Brussels Free University (Belgium), IRIDIA	4	9	2
Brussels Free University (Belgium), AI Lab & SWITCH Lab	3	3	1
Budapest Collegium (Hungary), Inst. for Advanced Studies**[21]	2	1	3
Cornell Univ. (US), Computational Synthesis Lab	4	-	1
CSIRO[22] (Australia), Information & Communication Tech. Centre	1	3	3
East Anglia Univ. (UK), School of Environmental Sciences**	**2**	**1**	**2**
Hertfordshire Univ. (UK), Dept of Computer Science	**8**	**3**	**8**
Indiana University (US), School of Informatics & Cognitive Sc.	14	3	6
Istituto di Scienze e Tecnologie della Cognizione (Italy)**	3	4	3
Lausanne Univ. (Switz.), Information Systems + Ecology Institutes	3	2	3
Leeds Univ. (UK), School of Computing	**2**	**2**	**6**
Nagoya Univ. (Japan), Grad. School of Information Sciences	3	-	2
New York State Binghamton Univ. (US), Dept of Bioengineering**	3	1	1
Notre Dame Univ. (US), Dept of Computer Sc. and Engineering	5	-	-
RIKEN Brain Institute (Japan)**	2	-	3
Southampton Univ. (UK), SENSe[23]	**4**	**4**	**20**
Sussex Univ. (UK), CCNR	**12**	**16**	**22**
Tokyo Univ. (Japan), Dept of General Systems Science**	4	3	6
York Univ. (UK), Centre for Complex Systems Analysis**	**-**	**3**	**5**
Zürich Univ. (Switzerland), AI Lab	5	-	-
Total	94	62	107

Table 2: Papers by institutional entity at ALIFE X, ECAL 07 & ALIFE XI
Shows for the institutional entities having collaborated to 5 or more papers over the 3 conferences combined: (1) number of papers (including those presented at the workshops) to which it has collaborated for ALIFE X, (2) number of papers to which it has collaborated for ECAL 2007, (3) number of papers to which it has collaborated for ALIFE XI. UK institutions are highlighted in bold.

* ECAL 2007 workshop papers are not included; to give an indication of the way in which they might affect the results, out of 7 workshops the UK organised 5, Switzerland 1, Italy / Netherlands 1

** Institutional entities do not directly depend of computer science and computer engineering schools or departments

I will now refine my analysis by going down to the level of the institutional entities. Browsing through the list which I compiled from the proceedings of ALIFE X, ECAL 2007 and ALIFE XI, I have found that despite the near-absence of Artificial Life

[21] The fellows of Budapest Collegium Institute for Advanced Studies collaborating to the papers were theoretical biologists.
[22] Commonwealth Scientific and Industrial Research Organisation.
[23] SENSe (Science and Engineering of Natural Systems), in the School of Electronics and Computer Science at Southampton University, has only been created in 2005.

structures in academic institutions, ALifers appear nonetheless to be predominantly housed in universities, all the more since the Artificial Life group at the privately funded Santa Fe Institute has been disbanded around 2000. Regarding the disciplinary affiliation of the institutional entities in Table 2, which shows which institutional entities have been most productive over the three conferences that I have attended between 2006 and 2008, one finds that out of 24, as many as 9 do not directly depend of computer science and computer engineering schools or departments. They belong instead to biology, to environmental sciences, to cognitive sciences. This nuances the view once expressed to me by a prominent member of the Artificial Life 'old boys club', when I questioned him on how he thought Artificial Life had sustained itself in academia over its twenty years or so of official existence; according to him, the few robust pockets of Artificial Life research which have developed in the academic superstructure are situated in computer science departments[24]. Here is an example of the distortions which can result from a view of Artificial Life overly slanted towards the US: the ALifer in question was American, and all the institutional entities in Table 2 which are situated in the US do indeed belong to computer science and engineering. But even though his opinion might be valid in the case of the US, it should not be readily generalised. Table 2 may reveal a greater diversity in the academic affiliation of the healthy centres of Artificial Life Research, still, the proportion of individual contributions coming from institutional entities that depend directly of computer science or computer engineering schools or departments, remains very high: 81% for ALIFE X, 76% for ECAL 2007 and 71% for ALIFE XI. Nevertheless, these figures show that it has been dropping steadily between 2006 and 2008. It would be interesting to see

[24] Interview transcript, 04/06/2006.

whether the trend towards a more diverse implantation (disciplinary-wise) of healthy Artificial Life research groups gets confirmed in the future.

Table 2 shows that only 24 main institutional entities, representing barely 10 % of an overall total of 230 for the 3 conferences, account for 50 % of the total individual contributions at ALIFE X, for 44 % at ECAL 2007 and for 45% at ALIFE XI. These figures are an indication that the number of robust Artificial Life research centres is really quite small compared to the overall number of about 230 institutional entities having contributed to papers between ALIFE X, ECAL 2007 and ALIFE XI. Moreover, out of these 24 institutional entities, a third (8) are based in the UK. Between themselves, at ALIFE X, they accounted for 33% of the main institutional entities total contributions, 13% for the sole Centre for Computational Neuroscience and Robotics (CCNR) at University of Sussex; at ECAL 2007, they represented 52% of the main institutional entities total contributions, 26 % for the sole CCNR; while at ALIFE XI, they represented 64% of the main institutional entities total contributions, with a share of 21% for CCNR. These figures confirm the strength of Artificial Life in the UK, as well as the leading role of CCNR.

3.2 THE JOURNALS

Before looking at the main journals in the field of Artificial Life, it is worth mentioning that, in keeping with the great diversity of backgrounds and research interests which is to be found in the Artificial Life community (a point to which I will return later on in the present chapter), ALifers tend to publish in a vast array of journals. There are additional reasons as to why a lot of them try to publish outside their field. First, their specialist journals have a limited reach, and Artificial Life is a very interdisciplinary project, which relies on the input of and collaboration with other fields.

Second, because of their rather low status as a scientific field, publishing in prestigious scientific journals is a way to get scientific recognition. These assertions about the interdisciplinary character and the scientific status of Artificial Life will be justified in the next chapter.

Browsing library catalogues, I found two periodicals with Artificial Life in their titles. In Artificial Life and Robotics (Springer Japan), the population of papers' authors is not at all representative of the Artificial Life crowd attending the two international conferences. Examining the issues for the years 2006 and 2007, one finds that although it is published in English, it is an overly Japan-centred journal. Of the 35 papers published in 2006, 33 come from Japan and 2 from Japan in collaboration with another country (1 Egypt, 1 Sri Lanka); while of the 45 papers published in 2007, 38 come from Japan, 4 from Japan in collaboration with another country (3 Malaysia, 1 Italy, 1 Ukraine), and 2 from other countries (1 Ireland, 1 Austria). As it is, the publishing body of Artificial Life and Robotics is the International Symposium on Artificial Life and Robotics, a Japanese organisation sponsored by the Japanese government, which yearly event has for objective the "development of the new technologies for Artificial Life and Robotics which have been born recently in Japan"[25], that is, it is very much a public relations operation to promote and export Japanese expertise. Moreover, the subjects given for the bibliographic indexing of Artificial Life and Robotics do not even include Artificial Life: Computer Science, Engineering, Artificial Intelligence (incl. Robotics), Computation by Abstract Devices, Automation and Robotics. A quick survey of the table of contents confirms the relative relevance of this journal for Artificial Life, as a majority of papers are geared towards pure computer science or industrial/business

[25] AROB Symposium, http://arob.cc.oita-u.ac.jp/, consulted 18/01/2008.

applications. For all of the above reasons, I have chosen to discard Artificial Life and Robotics from my sampling.

The second journal is Artificial Life, published by the MIT Press. It has been running since 1993, with 4 issues a year, with Mark Bedau, an influent ALife veteran, for editor in chief. It is often quoted by members of the Artificial Life community as a reliable outlet for publishing their research, and also as an asset for the field. One informant emphasized this latter aspect by saying that he thought the journal had been important in stabilizing the field[26]. Another journal often mentioned by ALifers is Adaptive Behavior, published by SAGE. It has been running since 1992 with 4 issues a year, and comes alongside the SAB (Simulation of Adaptive Behavior) workshop series, popular among ALifers, which has been held every other year since 1990, the year before the first ECAL. It is a smaller event but strongly attended by the strand of Artificial Life research concerned with embodied cognition. Artificial Life and Adaptive Behavior are the two journals that I have found tagged as "our specialists journals" under an ALifer's pen.[27] I have examined the issues of these two journals for the years 2003 to 2007, and put into a table the number of papers by contributing institutional entities, for such entities that have published over the past five years 3 papers or more in the two journals cumulated, in order to get a picture covering a longer period of time than I got with the two conferences I analysed. The results are shown in table 3.

[26] Fieldnotes, 14/09/2007.
[27] Miller (1995: 14).

	Artificial Life 2003-2007	Adaptive Beh. 2003-2007	Total
Basque Country Univ. (Spain), Dept of Logic and Phil. of Science	3	1	4
Birmingham Univ. (UK)., School of Computer Science	3	-	3
Brussels Free University (Belgium), IRIDIA	3	-	3
CalTech (US), Digital Life Lab	8	1	9
Case Western Reserve Univ. (US), Dept of Elec. Eng. and CS	1	3	4
Edinburgh Univ. (UK), Institute of Perception, Action and Behavior	-	3	3
Edinburgh Univ. (UK), Language Evolution & Computation	4	2	6
EPFL (Switzerland), Logic Sys. Lab/Information Sys. Inst./other	2	1	3
Indiana University (US), Sch. of Informatics & Cognitive Sc.	5	4	9
Leeds Univ. (UK), School of Computing	-	3	3
Monasch Univ. (Australia), Clayton School of IT	2	1	3
Queensland Univ. (Australia), School of IT and Elec. Eng.	3	-	3
RIKEN Brain Institute (Japan)	1	3	4
Roma Istituto di Scienze e Tecnologie della Cognizione (Italy)	2	2	4
Santa Fe Institute (US)	4	-	4
Sheffield Univ. (UK), Dept of Psychology	-	3	3
Southampton Univ. (UK), SENSe	4	-	4
Sussex Univ. (UK), CCNR	7	5	12
Tel-Aviv Univ. (Israel), School of Computer Science	5	-	5
Wales Univ. (UK), Dept of Computer Science	-	3	3
West England Univ. (UK), Bristol Robotics Lab	3	3	6
Zürich Univ. (Switzerland), AI Lab	4	1	5

Table 3: Published papers by institutional entity in Artificial Life and Adaptive Behavior over 2003-2007
Shows for the institutional entities having collaborated to more than 3 papers in the 2 journals combined over 2003-2007: (1) number of papers to which it has collaborated for Artificial Life between 2003 and 2007, (2) number of papers to which it has collaborated for Adaptive Behavior between 2003 and 2007; the institutional entities appearing in bold are those common to Tables 2 & 3

Table 3 contains 22 institutional entities, only 9 of which were in Table 2 as well. These figures are not as discrepant as they may seem at first. We must first remember that Table 3 covers 5 years (2003-2007) of journal issues, whereas Table 2 covers 2 years (2006 and 2007) of conferences. It tends to show that certain centres of research are more volatile than others. Looking at the level of individual researchers, one actually finds that at least for small to medium scale research groups, it seems to be people rather than places which matter: when group leaders change places, their former institutional entities often disappears under detection level. The Japanese centres do not do as well as in the conferences tables, but we must keep in mind that they benefit from Artificial Life and Robotics which publishes almost solely Japanese papers. Table 3 confirms the heavy weight presence of Europe, and also the robustness of the 9 sites which it has in common with Table 2. Regarding the situation in the UK, there are as many as 9 UK institutional entities in this second list, that is, almost half of those listed. Moreover, 4 of the 5 UK institutional entities which were present in Table 2 are also present in Table 3. The Centre for Computational Neuroscience and Robotics (CCNR) at the University of Sussex is again in pole position. Later chapters will focus on the specific case the University of Sussex CCNR and its 'neighbourhood'[28] to study how a distinct interdisciplinary culture of Artificial Life, localised historically and geographically in the fabric of Real Life[29], has successfully developed.

3.3 QUALITATIVE DISCIPLINARY METRICS

Approaching Artificial Life from a formally quantitative disciplinary approach has yielded some interesting results. It has shown that ALifers were a highly scattered population whose number has kept consistently small after an initial temporary rise, and that they are predominantly housed in computer science- and computer engineering-related academic structures although this may tend to become less the case. It has also revealed the existence of a little cluster of healthy research groups, as well as the dominant presence of the UK and the leading place that the CCNR at the University of Sussex has come to occupy. But the quantitative approach does not give any purchase on what is holding the global community together.

[28] Chapter 4 will define and explore the concept of 'neighbourhood'.
[29] Real Life (RL) is commonly used by online community members to designate the life they live offline; I do not use it to refer to some kind of objective reality, but to material localisations in time and space.

I will briefly consider another couple of routinely used disciplinary metrics, this time in the qualitative tradition, to show that they do not provide either a handle on the Artificial Life community.

A first possibility is to consider whether there is a consensus around a well-defined agenda of consistent research topics within the Artificial Life community. The answer is a resounding no. To be convinced, one simply has to look at the vast heterogeneity of the plenary sessions and workshops topics that could be encountered at the single ALIFE X conference: cognition, language, evolutionary and developmental psychology, ethics, musicology, sociality, learning, developmental biology, immunology, computational chemistry, complexity, synthetic biology, proto-cells, evolutionary models, autonomy, robotic and emergent systems art, swarms and collective behaviour, formal models, philosophy.

Another possibility is to consider whether Artificial Life is a community of ideas – whether ALifers are held together by a shared fundamental philosophical framework which drives their research. This leads to another dead end. There coexists in Artificial Life a full spectrum of sometimes antagonistic philosophical approaches to life, nature, and the status of the artificial systems produced: neo-Platonists alongside followers of Francisco Varela and Umberto Maturana’s theories of embodiment, realists alongside relativists, scientific essentialists alongside constructivists, professed moderns alongside professed postmoderns, idealists alongside phenomenologists, partisans of ‘strong Artificial Life’, who hold that Artificial Life systems are actual implementations of life principles, alongside partisans of ‘weak Artificial Life’, who hold that they are analogies.

Having failed so far to understand what binds the Artificial Life community together, my next move will be to take the cultural turn, and look for specific cultural indicators.

4. TOWARDS A CULTURAL APPROACH

4.1 THE 'COMPUTER CULTURE' APPROACH

Building on the fact that ALifers are found predominantly in computer science and computer engineering academic structures, an obvious route of investigation is from the perspective of the cultural involvement of the Artificial Life community with computers. This would follow in the tracks of The Cultures of Computing,[30] collective work edited by Susan Leigh Star, which proposes

> "[…] to explore a wide range of cultural practices associated with the design and use of computing […] Rather than ask 'what difference are computers making in the world?' or 'is there an information technology revolution?', this volume examines specific kinds of work that people do together […] with and around computers."[31]

The title The Cultures of Computing aptly pluralizes 'culture'. Any attempt at a globally valid definition of 'computer culture' in the singular would fall back into the rut of the computer revolution meta-narrative. This is the rut that Star, in the passage quoted above, avoids when she deliberately sidesteps the revolution question, and which anthropologist of computing David Hakken attacks head on when he argues that the general rhetoric hype about 'Computer Revolution' obscures what is actually taking place, that the dominant discourse has serious shortcomings in its relating computing and social change, and promotes a re-thinking of the whole idea of 'Computer

[30] Star, ed. (1995).
[31] Star (1995: 7).

Revolution' based on the use of a cyber-ethnographic method to be applied in a multiplicity of arenas.[32] Certainly, the 'computer culture' that has developed in the town of Guiyu, Southeastern China, a sprawling waste dump for obsolete electronics from the United States, Europe and Japan, where adults and children alike earn a livelihood scavenging old computers while "the technological garbage is poisoning the water and soil and raising serious health concerns"[33] – that particular 'computer culture' has strictly nothing in common with the 'computer culture' of the MIT hackers in the 1980s, for example. Although the two might fruitfully be brought together through their common hardware denominator in a study of the flows of capital, goods, and migrant populations in the mythical IT-enabled global capitalist village (today's scavenged old computer in Southeastern China might have been the then state-of-the-art machine running at MIT), any conceptual framework developed for the specific analysis of one culture would have little relevance for analysing the other.

As a consequence, any idea of 'computer culture' that I might attempt to develop in the context of Artificial Life will be localised and relative to the kind of individuals who have been likely to partake in Artificial Life research since the field was branded in the late 1980s. How far can the characterization of Artificial Life as a 'computer culture' take us in investigating the shared cultural substratum of the community?

As I have explained earlier, most if not all Artificial Life research is computerized to some degree. Computers occupy a central place in the experimental practices of the Artificial Life community. It is quite extraordinary that ALifers would hardly ever make it explicit when asked to define what is Artificial Life. After all, there are other modes of inquiry through which to investigate the essential features of life, that would not involve computers as privileged experimental tool; and although

[32] Hakken (1999).
[33] Goodman (2003).

computers are a privileged tool for the synthetic method, synthetic systems do not necessarily require computers. The role of computers goes without saying; they are tools ALifers cannot dispense with, to the point that they belong to the tacit dimension of Artificial Life research. And although a significant proportion of ALifers do not embrace a computational worldview, i.e. the idea that natural processes are computational, they still believe that making computer models of non-computational processes can help "to say something interesting and distinctive about the *inner states and processes* that guide [a] system's behavior."[34]

The role of ubiquitous and indispensable experimental tools played by computers in Artificial Life research is certainly enough to characterize Artificial Life as a computer culture, but it won't tell us whether a special interest *in* computers is part of what draws individuals to Artificial Life research, rather than to some other field of research having life for its object. This raises the question of whether it would be possible to characterize ALifers as a population comprised overwhelmingly of computer enthusiasts.

4.2 IS ARTIFICIAL LIFE A COMMUNITY OF COMPUTER ENTHUSIASTS?

In the preliminary phase of my project, before I entered the field, I formed the preconception that ALifers may fit with the general notion of computer geeks, that is, of people who entertain uncommonly strong relationships with computers, which I suspected a high proportion of ALifers did. I would like to emphasize that I am not in any way using the term 'computer geek' in a pejorative fashion, or as a means of distancing myself from the population I am studying. My personal background and some of my hobbies are such that I could be tagged a computer geek myself, although of the dilettante variety. Moreover, the 'geek' tag does not put off the ALifers, many are

[34] Wheeler (2005: 101).

quite proud to identify with it and may even use it with an affectionate undertone and as a sign of belonging. This was for example the case when a senior member of the Artificial Life research group at the University of Sussex told me that although Anna Dumitriu, the artist who had then recently joined them as artist-in-residence, was quite provocative and critical in her questioning of the scientists at CCNR, down deep she was a true geek (understood: she deserved to belong), with her handbag always filled with electronic gadgets.[35] I will add that over the years the term 'geek', which was traditionally pejorative, has become much more ambivalent, what with exemplary geeks, such a Bill Gates or Steve Jobs, achieving business and popular stardom, or with closet geeks progressively deciding to make their coming out and own their culture (such as a taste for videogames, or sci-fi / fantasy literature and movies) without shame or a sense of inferiority towards traditional 'high culture'. A tangible manifestation of the geek trendiness is the success of Wired magazine, which explicitly targets an audience of well-to-do mature (biologically at least) hi-tech geeks.

The preconception that Alifers were computer geeks was, in part, triggered by Helmreich's anthropology of Artificial Life at the Santa Fe Institute[36]. From there, while in the field or sifting through writings and interviews of ALifers, I was on the lookout for telltale signs that would bolster my conviction. Here is an anecdote that exhibits such telltale signs in archetypal fashion. It took place at ECAL 2007 in Lisbon. On the first night of the conference, after the opening ceremony and welcome cocktail, I went out with a predominantly British party for a late dinner at a riverfront restaurant. Towards the end of the wine- and beer- imbibing evening, the two ALifers who were

[35] Fieldnotes, 31/05/2007.
[36] For example, Helmreich has observed that "All the men in Artificial Life who came through Los Alamos [the core group in ALife at SFI when Helmreich did his fieldwork] have done extensive simulation work. . . . But the connection to computers is not simply institutional; computers have also figured prominently in these people's individual lives. Without exception, they bought personal computers sometime around the late 1970s or early 1980s, just as they were first becoming available." (Helmreich (1998: 49)).

sitting respectively on my left and opposite from me – both male, both in their late twenties to early thirties – started questioning people around them, me included, about the first personal computers we had owned: how old we were, which models we got, what memories we had of these machines – while sharing souvenirs of their own. Not just of games they had played on their computers, but also of the computers themselves as material objects (their look, their user-friendliness, etc). At some point, the two of them started playing some sort of game: each in turn was drawing on the tablecloth one of his old favourite personal computers, and the other had to guess the make and model. They tried to get me to play with them because, come on, I was bound to have had my favourite machines as well, and they were rather surprised to discover just how useless I was at the exercise. As for me, I would have liked dearly to keep the tablecloth as a material testimony of the hard-core computer-geekiness some my subjects could occasionally display.

Such anecdotes, alongside the fact that the natural academic habitat of Artificial Life researchers is in computer science and in computer engineering, indicate that ALifers could be a community of computer enthusiasts – of computer geeks. A further examination of who they are, in terms of backgrounds and personal trajectories, should help confirm or nuance this preliminary conclusion.

4.3 A CLOSER LOOK AT THE ARTIFICIAL LIFE POPULATION

Although the figures I have presented earlier in the chapter related not to the geographical provenance of the Alifers themselves but to their institutional localisation, we might expect to find a correlation between these two categories, as indeed there is. Alifers are in their majority anglo-saxon and Western European white males, belonging to social classes for whom a university higher education is the norm rather than the exception. My observations as to the broad social and geographical provenance of ALifers roughly concur with the detailed study conducted by Helmreich following his extensive fieldwork in the early- to mid-1990s among the then strong Artificial Life group of the Santa Fe Institute. They differ mostly in the much higher number of (Eastern and Western) Europeans and Japanese that I have encountered, with a quite diminished presence of the United States and an especially strong presence of the United Kingdom. These variations may depend in part on the difference of setting between Helmreich's fieldwork and mine. They may also depend on the significant evolution that Artificial Life has undergone in between our two studies, with the centre of gravity of Artificial Life research moving from the US to Europe, and more precisely to the UK.[37]

Looking at the educational backgrounds and personal trajectories of the Artificial Life population, I have found that in this respect, diversity rules. More precisely, my observations show that, alongside a core of individuals with a first training in computer science- or computer engineering-related subjects, or even in disciplines such as applied mathematics or complex systems which require a high level of mastery in computing, there exists another significant set of individuals which present a great diversity in their training backgrounds as well as quite idiosyncratic personal trajectories. In that second group one finds people whose first training was in philosophy (usually analytical but also continental), [38] in psychology, in anthropology, in the fine arts, in the musical arts, in conceptual art, in art theory, in musicology, in linguistics, in ethics, in medicine, in developmental as well as evolutionary biology, in physics, in chemistry – the list is not exhaustive.

[37] Helmreich (1998).
[38] This appears to be the case for a significant proportion of ALifers.

Helmreich’s experience of ALifers backgrounds reveals a far stronger core anchored in the 1970s hacker culture than my own study. But this is consistent with his US-centred versus my Europe-centred fieldwork, and with the almost fifteen years elapsed between his study and mine. He nonetheless mentions the wide variety of backgrounds he has come across, especially among the non-US ALifers of the Santa Fe Institute, and points at the idiosyncratic personal trajectories of some of his informants (which is in line with the hacker culture). [39]

My findings do not support the view that the overall Artificial Life community fits neatly the computer-enthusiast type. They would have, if I had found that ALifers had overwhelmingly trained first in computer science- or computer engineering-related subjects, but as they stand, they do not uphold the view that an especially strong interest in computers *per se* is a defining cultural trait shared by the Artificial Life community at large. Artificial Life is certainly a computer culture, but it is not one hinging on the computer as material object. A broad ‘computer culture’ approach will only take me this far. It will not help to understand a culture where the computer is a means rather than an end in itself. Looking at the use that ALifers make of computers may hold the key to grasping where precisely the cultural glue of the Artificial Life community lies.

5. A CULTURE OF SIMULATION

Earlier on, I pointed that Artificial Life research in its diverse forms, ‘soft’, ‘hard’, or ‘wet’, was overwhelmingly computerized, i.e. involved the use of computer simulation. I also pointed that ALifers shared the conviction that computerized synthetic systems could help saying something meaningful about life and its essential characteristics. Although Alifers’ interests are very diverse, and Artificial Life research

[39] Helmreich (1998: 48-55).

addresses issues in areas ranging, non exhaustively, from microbiology to psychology, to linguistics, to musicology, to ethics, to anthropology, to sociology, I have identified the practice of simulation as common denominator to Artificial Life research, dictating the fundamental role computers play in it.

I contend that regarding the cultural glue holding the Artificial Life community together, here is the defining cultural trait (other of course than investigating the essential features of life, the overall goal of the Artificial Life project) shared by the entire Artificial Life community. I will now attempt to characterize what a 'simulation culture' might be, and propose a refined grid of interpretation in which not only my results concerning ALifers' educational backgrounds and personal trajectories can be read in a more pertinent light, but also in which more of my research material can be mobilised as evidence.

5.1 HARD MASTERY AND SOFT MASTERY

Sherry Turkle's The Second Self: Computers and the Human Spirit, first published in 1984, was "a study of a [computer] culture in the making"[40] based on the extended ethnographic work she started carrying out with both children and adults shortly after she joined MIT in the late 1970s. It brought to light two major 'styles of mastery' in computer programming, expressions of more general personality styles, which Turkle contended were identifiable from childhood. She called them 'hard' and 'soft' mastery. "Hard mastery is the mastery of the planner, the engineer, soft mastery is the mastery of the artist […] Hard and soft mastery recalls anthropologist Claude Lévi-Strauss's discussion of the scientist and the *bricoleur*"[41]. Her choice of the terms 'hard' and 'soft' deliberately pointed at cultural biases woven in the contextual backdrop of

[40] Turkle (2005: 23).
[41] Turkle (2005: 101).

her research, as she related hard and soft mastery not only to the hard and soft science categories, but also to gender, girls in her study tending to be rather on the 'soft masters' side while boys were more likely to be 'hard masters'.[42]

In 1995, with Life on the Screen,[43] where Turkle "describes how a nascent culture of simulation is affecting our ideas about mind, body, self, and machine"[44], she returned to the topic of hard and soft mastery, in computer programming and personality styles, and identified soft mastery as characteristic of this culture of simulation she was investigating. She showed how strongly biased toward hard mastery computer science education in the United States in the 1970s and 1980s had been[45]:

> "In the 1970s and 1980s, computing served as an initiation into the formal values of hard mastery […] soft mastery was computing's 'different voice'. Different and in no way equal. The authorities (teachers and other experts) actively discouraged it, deeming it incorrect or improper […] the ideology that there was only one right way to 'do' computers nearly masked the diversity of styles in the computer culture."[46]

Turkle described the birth of the new form of computer culture as a move "from a modernist culture of calculation toward a postmodernist culture of simulation".[47] This new cultural form was the realm of bricolage, tinkering and 'what if?' scenarios. She recognised that individuals did not possess innate qualities that made them fall neatly into the hard and soft mastery categories but were rather influenced into these categories by their cultural context, and argued that from the late 1980s,

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[42] Turkle (2005: 105).
[43] Turkle (1995).
[44] Turkle (1995: 10).
[45] From personal experience, it was still very much the case in France as well in the late 1980s; it was most probably the general case, at least for as long as computer science was dominated by propositional procedural languages.
[46] Turkle (1995: 52-54).
[47] Turkle (1995: 20).

> “As the computer culture’s center of gravity has shifted from programming to dealing with screen simulations, the intellectual values of bricolage have become far more important [… P]laying with simulation encourages people to develop the skills of the more informal soft mastery because it is so easy to run ‘What if?’ scenarios and tinker with the outcome”.[48]

She recognised also that “[i]n the culture of simulation, bricolage can provide a competitive edge.”[49] In her extensive ethnographic work, Turkle paid special attention to the hackers’ cultural group, highlighting the virtuoso soft style mastery existing in that category of population. For her, hackers contributed to the late 1980s shift, as “[i]n the field of computing, the existence of the bricolage style at virtuoso levels challenged the idea of there being only one correct, mature approach to problem-solving.”[50]

Paradigmatic of the opposition between hard and soft styles in robotics, is a well-known story involving Hans Moravec on the ‘hard’ side, and Rodney Brooks on the ‘soft’ side, in the late 1970s when they were fellow PhD students at Stanford University. Watching the performance of Moravec’s room-crossing robot, which design followed the top-down representational approach, Brooks “figured that a cockroach could not possibly have as much computational power on board as the robot, yet it could accomplish the same task in a fraction of the time.”[51] His ‘soft style’ response was the subsumption architecture, a bottom-up design that has been widely influential in autonomous and adaptive robotics.

Similarly, in terms of hard and soft mastery, the computerized synthetic systems of Artificial Life fall on the ‘soft style’ side of the fence. The masters in Evolutionary and Adaptive Systems (EASy) at the University of Sussex, an internationally recognised

[48] Turkle (1995: 52).
[49] Turkle (1995: 61).
[50] Turkle (1995: 57).
[51] Hayles (2005b: 133).

route into Artificial Life research, particularly of the robotic kind, is thus described by a recent graduate: "It was essentially about turning nice, orderly computers into squishy, biological things."[52] Indeed, the synthetic method, independently of the analogue or digital nature of the systems synthesized and of the involvement of computers in their design, appears especially resonant with the kind of 'bricolage' referred to by Turkle in her characterisation of the culture of simulation. This is how its use as scientific method is defended by a couple of researchers from the Sussex Artificial Life group, Jon Bird and Ezequiel Di Paolo, in the context of a paper on "Gordon Pask and His Maverick Machines":

> "The construction [Pask] refers to is not that of more sophisticated artefacts for measuring natural phenomena or the construction of a device that models natural phenomena by proxy, but […] the synthesis of *a scientific problem in itself*. [… I]t seems absurd and a nonstarter, at most a recipe for useful pedagogical devices, toy problems for scientific training, but not the stuff of proper science. […] But what if the construction proceeds not by a full specification of the artefact but by the design of some broad constraints on processes that lead to increased organization, the result of which – with some good probability – is the artefact we are after? Now, if we succeed in this task, the workings of such a system are not fully known to us. It may surprise us. It may challenge our preconceptions by instantiating a new way of solving a problem. Or, more subtly, it may make us revise the meaning of our scientific terms and the coherence of our theories. Is such an underspecified synthesis possible? Yes, it is."[53]

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[52] Matthews, J., "About me", http://www.j4mie.org/about/, consulted 16/03/2010.
[53] Bird & Di Paolo (2008: 205).

The Artificial Life project appears to belong squarely with the culture of simulation described by Turkle. Yet an important number of ALifers are of an age, from mid-thirties to much older, which indicates that they were first educated at a time when hard mastery ruled over computer science teaching as the accepted norm. As children and teenagers, individuals in that age group, who would have felt more affinities with the soft mastery style, would have been put off by undergraduate studies into hard style computer science (‘hard’ sciences more generally). Others in that age group who went on to study computer science, may have been more attracted by the soft than by the hard style, but adaptive enough to mould themselves into the hard mastery requirements of computer science or computer engineering studies. They also may have grown to discover their ‘soft’ side over time.

Following this line of thought, one can read the Artificial Life population as a set of individuals who in their formative years were scattered across a wide spectrum of personality (and programming) styles ranging from hard to soft mastery, and who were seduced at some point by the soft mastery approach to investigating life of the Artificial Life project. The word is not too strong. Several ALifers have expressed to me the conviction that they would not have gone into research had they not encountered Artificial Life. For instance, one who had done his undergraduate degree in computer science and applied maths said he would probably have become an accountant; another, coming from a medical background, told me he would certainly have gone on to practice psychiatric medicine; still another, after a degree in philosophy and theology, had his life turned around when he read Hofstadter’s Gödel, Escher, Bach – which according to Paul Edwards was through the 1980s and well into the 1990s a landmark of hackers' culture;[54] quite a few worked for many years before returning to study and making new careers as Artificial Life researchers in academia.

In this perspective, which is upheld by Turkle's analysis of her own field data,[55] the diversity of educational backgrounds found in the Artificial Life community, the high proportion of hackers in the older US-trained Artificial Life population, the significant number of idiosyncratic individual trajectories, start making sense as a whole. They fit into the picture of Artificial Life as foremost a culture of simulation, such as Turkle has defined it.

5.2 SIMULATION-RELATED HOBBIES

Another possibility for broadening and enriching the interpretative grid used to profile the Artificial Life population as a culture of simulation, is to search for indirect evidence in the 'simulation-related' activities that they might enjoy. What kind of 'extra-curricular' activities, related in some way to the idea of simulation, might ALifers engage into? I will take for starting point Susan Leigh Star's characterization of the generic computer geek, as "someone who spends a great deal of time on computing and is often involved in related activities such as reading science fiction".[56]

Playing computer games of the RPG (Role Playing Game) kind, and reading science fiction, are two activities that a significant proportion of ALifers appear to engage in. Regarding games, at the time when Helmreich studied the Artificial Life population of the Santa Fe Institute, he noted that some had histories of playing Dungeons and Dragons (the paper-and-pen ancestor of medieval RPGs) and of designing their own video games, and there were "[a] few were people whose primary

[54] Edwards (1996: 170), note 36;
[55] Turkle (2005), chapters 3 and 4.
[56] Star (1995: 10).

[professional] experience was designing computer games"[57]. I will recount an event, which shows without ambiguity that over a decade later, ALifers were still no strangers to computer games of the RPG variety. At ALIFE X, during the discussion ending the strongly attended last session of a workshop on 'Evolution of Complexity' (this session had the lowest women to men ratio I witnessed throughout the conference: an all male venue, 33 men – apart from me), the participants entered into an animated debate about whether higher level complexity could evolve open-endedly in closed systems. Soon, they brought into the debate, as a possible source of empirical evidence, the case of massively multiplayer online role playing games (MMORPGs), discussing more specifically the case of World of Warcraft (another Dungeons and Dragons inspired game). The argument revolved around whether the apparition of structured guilds in WoW – the participants quickly switched to the acronym customarily used by World of Warcraft players – was an indication that higher levels of social structures could evolve in an open-ended innovative fashion in a closed system. I will not comment on the argument itself, it is not relevant for the point I wish to make. What I want to pinpoint, is that the very choice of MMORPGs as potential sources of evidence, and the knowledge of the WoW universe betrayed by the workshop participants made blatant just how familiar and up-to-date (World of Warcraft had not yet achieved stardom status) this group of male researchers was with the virtual worlds of MMORPGs, computer games which are direct heirs to the Dungeons and Dragons ancestor.

Let us briefly consider now the 'reading science fiction' activity in relation to Artificial Life. In his ethnography of Artificial Life at the Santa Fe Institute (SFI),

[57] Helmreich (1998: 51-52).

Helmreich has singled out the important place held by science fiction in the imaginary and culture of the ALifers he interacted with[58], and concluded that:

> "Science fiction was an extraordinarily rich resource for [Artificial Life] scientists' imaginings of computers as worlds. Many researchers have been avid science fiction fans and have self-consciously used the genre as a launching pad for scientific speculations. This is most true for computer scientists who came of age during or after the 1960s; older scientists at SFI have little familiarity with science fiction and . . . short patience with the notion that computers are universes."[59]

Science fiction is not a topic on which I have specifically questioned ALifers, yet in the course of my fieldwork, I have come across quite a few discussions involving sci-fi pieces, which were occasionally used as supporting material in arguments.[60] I asked once a staff member in the department of Informatics at University of Sussex, if he had a recipe for spotting, among the undergraduates who came through, those who were likely to be attracted to Artificial Life. His answer was, they are the sci-fi nutters. Some ALifers boldly assume their fantasy and sci-fi culture in the scholarly books they publish, like for example philosopher of mind / cognitive scientist (this is not incompatible with his belonging to the Artificial Life community) Mike Wheeler. In <u>Reconstructing the Cognitive World: The Next Step</u>, a deep philosophical book that explores and defends the possibility of a Heideggerian cognitive science (more on this in chapters 3 and 5), a main literary reference is <u>Harry Potter</u>. It is used not only as a

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[58] Helmreich (1998: 53, 88-92); Other authors have also spotted the science fiction connection in Artificial Life, for example Levy (1992), and Kember (2003).

[59] Helmreich (1998: 88).

[60] For example, Hans Moravec's <u>Robot: Mere Machine to Transcendent Mind</u> , Ray Kurzweil's <u>The Singularity is near: When Humans Transcend Biology</u> (although I am not sure Moravec and Kurzweil would appreciate my tagging their books as science fiction), C. J. Cherryh's <u>Cyteen</u>, , William Gibson's <u>Neuromancer</u>, Isaac Asimov's <u>I, Robot</u>.

source of quotations[61], but also as a practical source of inspiration for what Wheeler defines as the 'Muggle constraint' to characterize his own weak form of naturalism.[62] He also makes good use of Star Trek, where James T. Kirk of the starship Enterprise helps the author present a general strategy to address the frame problem in Artificial Intelligence from a Heideggerian perspective.[63]

5.3 THE 'PLAY' DIMENSION IN A CULTURE OF SIMULATION

The affinity of ALifers with computer games, especially of the role playing kind, as well as with science fiction and fantasy literature, is in my view in full agreement with the idea of Artificial Life being fundamentally a culture of simulation. Computer games (RPGs paradigmatically so), fantasy and science fiction are narrative forms of simulation, of 'What if?' scenarios. Drawing on psychoanalytic object-relations theory, Turkle has theorized computers as opaque machines that people use to reflect on the human, as psychological 'objects-to-think-with' about ourselves, about one another, about our relationship to the world[64]. In a culture of simulation, it seems that objects-to-think-with are also objects-to-play-with, in keeping with the ideas of transitional objects first developed by object-relations theorist Donald Winnicott[65].

Helmreich has discussed how science fiction literature was a rich resource on which the Artificial Life group he was studying drew to speculate about their research; and my own material, although scant, points in the same direction. This is a hint that the kind of 'what if?' scenarios played with in science fiction may be more than a 'related activity', but rather an integral part, of a culture of simulation. The computer game connection can equally go deeper than its extra-curricular recreational function, to be an

[61] Wheeler (2005: 3, 283).
[62] Wheeler (2005: 3-5); Muggles are non-magical people in Harry Potter's world.
[63] Wheeler (2005: 273-274).
[64] Turkle (2005).
[65] Winnicott (1971).

integral part of doing Artificial Life. Feminist critic and media studies scholar Sarah Kember, in Cyberfeminism and Artificial Life (2003), has shown that this was for example the case with computer games Creatures and Creatures 2 designed by British Artificial Life researcher Steve Grand.[66] Her case study highlights the dual nature of Creatures, as both research devices and entertainment devices, pointing that CyberLife (the company producing the game, co-founded by Steve Grand) was interested in more than commercial success in the computer games market, with Creatures being "perhaps simultaneously an end in itself and a means to an end of realising one of the key aims of ALife research."[67]

The play dimension is obvious in many other Artificial Life simulations, which were not commercial games, not even intended as games in the first place, such as Craig Raynold's Boids, Karl Sims' Evolved Virtual Creatures, or John Conway's Game of Life. The latter predates the official inception of Artificial Life, but it has been a major source of inspiration for the strand of Artificial Life research based on cellular automata. As it was pointed out to me, the Game of Life is not really a game as such in the sense of playing, it is rather a poetic metaphor for the struggle of life;[68] yet setting up initial conditions and watching surprising patterns unfold on a computer screen has proven enough of an attraction for many individuals to endlessly tinker with the Game of Life, with no other goal in mind than sheer entertainment.

In the context of my own fieldwork, the play dimension of Artificial Life was especially explicit during a presentation I sat on in the Artificial Life and Evolutionary Robotics track at GECCO 2007 (Genetic and Evolutionary Computation Conference). It was subtitled "Serious Playing with Toy Cars" (the paper's official title, much more

[66] Kember (2003), chapter 4.
[67] Kember (2003: 93).
[68] Dumitriu, personal communication, 18/10/2008.

serious looking, was “Nonlinear dynamics modelling for controller evolution”[69]), and the speaker’s more general argument was that computer game environments were very good spaces – microworlds in the synthetic method terminology – for doing research in evolutionary robotics, evolutive behaviour, etc. This is a clear instance of computer simulations as objects-to-think-and-play-with.

Overall, the parts played by science fiction, fantasy and computer games in the activities of the Artificial Life community reinforce the picture of Artificial Life as a culture of simulation. They highlight a different dimension of Artificial Life, akin to a form of speculative fiction of the interactive, performative kind – which agrees with the idea of Artificial Life as experimental philosophy, and of simulation as ‘thought experiment’, that I will discuss in the next chapter. They bring to the fore the play dimension of simulations, and show that it is an integral part of practices in a culture of simulation such as that of Artificial Life. Other observers of comparable cultures, particularly in the domain of the military, have reached similar conclusions.[70] This is an important point to take on board if we want to get a better understanding of cultures of simulation in the context of professional and research communities. It justifies that the body of scholarship used to address the topic of simulation in science and technology, should not be restricted to STS literature, but should be broadened by taking on board scholarship from new media studies, from literature studies, from game studies – a welcome diversification that may somewhat remedy the scarcity of simulation-related STS sources.

[69] Togelius et al. (2007).
[70] For instance, Edwards (1996), Ghamari-Tabrizzi (2000), Lenoir (2000), Lenoir (2003).

6. A FIRST GLIMPSE OF MANIFEST NON-MODERNITY

In sections 4 and 5, I have applied different cultural filters to the Artificial Life community, which have led me to characterize its culture as a culture of simulation according to Turkle's definition. To conclude, I would like to refine further this characterization. In order to do so, I now turn to the taxonomy of simulations as scientific experimental tools that Evelyn Fox Keller has proposed in 2002, in a book chapter entitled "Models, Simulations, and 'Computer Experiments'".[71]

Her proposition was to classify computer simulations, at first solely in the context of the physical sciences, according to the type of epistemic novelty they carried. She distinguished three broad stages in the evolution of simulations, whose appearance had been progressive in time. Her characterization of the three stages went as follows:

> "(1) the use of the computer to extract solutions from prespecified but mathematically intractable sets of equations by means of either conventional or novel methods of numerical analysis; (2) the use of the computer to follow the dynamics of systems of idealized particles […] in order to identify the salient features required for physically realistic approximations (or models); (3) the construction of models (theoretical and/or 'practical') of phenomena for which no general theory exists and for which only rudimentary indications of the underlying dynamics of interaction are available."[72]

I will discuss Fox Keller's proposition further in the next chapter. For now, I will accept her three stages in the evolution of simulations (an evolution that, she was keen to emphasize, was born from user practice[73]), and project them against another parameter than the epistemic novelty criterion she has used to distinguish them: the 'amount of

[71] Fox Keller (2002b).
[72] Fox Keller (2002b: 202).
[73] Fox Keller (2002b: 201).

agency' (for lack of a more appropriate term) devolved by the human simulator to the non-human simulation model. The immediate result is that, while Fox Keller's three stages are more and more loosely anchored into the theoretical structures of science, and simulate phenomena of which scientists have less and less knowledge, as a corollary, the new forms appearing in the simulation landscape display an ever-increasing amount of agency.

How is Fox Keller's taxonomy of simulation, which she elaborated with the physical sciences in mind, relevant to Artificial Life? First, although Fox Keller's concern was then restricted to the physical sciences, her exemplar for illustrating the third stage of simulation was none other than that of Cellular Automata models in Artificial Life; and second, in a more recent essay, she has gone on to assimilate Artificial Life robotic simulations to third stage simulations.[74] Categorizing Artificial Life computerized synthetic systems as third stage simulations is fully congruent with how Bird and Di Paolo have justified the use of the synthetic method in science, i.e. the synthesis of underspecified scientific problems, in the extract I quoted earlier. It follows that, not only can Artificial Life be best characterized as a culture of simulation if we want to understand what glues its research community together, but it is possible to narrow down this characterization: Artificial Life is a culture that does not hinge just on any kind of simulations; it hinges on third stage simulations according to Fox Keller's taxonomy, that is on simulations with the higher 'amount of agency'.

ALifers are indeed expecting their simulations to display agency. Because they take their inspiration from living systems of which a characteristic feature (an essential feature, according to some) appears to be unpredictable emergence, they expect their simulations to surprise them, to escape their control, to display a degree of autonomy,

[74] Fox Keller (2007).

even of creativity. In Artificial Life, the human agents deliberately engage into a form of collaboration with the nonhuman agents they design.

This is not merely my outsider's view on Artificial Life that I am articulating here. The awareness that ALifers engage their synthetic systems in a form of collaboration is no news to the community. This was already the case in 1994 when Risan did some ethnographical fieldwork among the Artificial Life group at the University of Sussex:

> "[Gregory] described his relation to his evolving robots as a *co-evolution*. His own understanding of how to make robots developed in interaction with his developing robots, just as his developing – or *evolving* – robots developed in interaction with his understanding of how to make them. . . . He developed his own *adaptive behaviour* in the context of the robot and the robot lab, and in interaction with the robot's ability to *adapt* to the presence of Gregory (and the tasks that Gregory set the robot to solve)."[75]

More recently, this view has been developed, refined, and promoted as a practice, most notably by Artificial Life artists. Ken Rinaldo, well known for his Artificial Life and emergent art installations, has extended the idea of human-nonhuman collaboration to encompass the public who come and interplay with such creations:

> "With artificial life programming techniques, for the first time interactivity may indeed come into its full splendour, as the computer and its attendant machine will be able to evolve relationships with each viewer individually, and the 'inter' part of interactivity will really acknowledge the viewer-participant. This may finally be a cybernetic ballet of experience, with

[75] Risan (1997a), chapter 3; Italics are Risan's.

> machine and human involved in a grand dance of each sensing and responding to the other."[76]

The dancing metaphor is similarly found in a 2005 conference paper entitled "Cyborg dancing: generative systems for man-machine musical improvisation", by Alice Eldridge, an Artificial Life musician who holds a PhD from CCNR at the University of Sussex. Its abstract informs us that:

> "One of the major motivating forces in generative art is the desire to explore uncharted spaces, to create artefacts that escape the designer's control: to attain emergence. This paper focuses on the design of digital systems that would be suitable partners for man-machine collaborative exploration of these spaces."[77]

The paper goes on to develop her specific approach to the problem along with a working example of her own design. Eldridge gives us a vivid appreciation of the agency with which she has tried to imbue her system, in terms that tend to anthropomorphize it:

> "The attraction of this approach within the musical domain, as in all generative art, is the prospect of creating novel musical material, of relinquishing control to a headstrong system whose outputs lead us into unimagined spaces."[78]

Like Rinaldo, she thinks of the human-machine collaboration as a dance of agency, and her conclusion takes her a bold step further, when she defends the idea that embodied artistic performance may be a valid alternative knowledge producing practice, because "[t]here are things you can only learn about someone by dancing with them."[79]

[76] Rinaldo (1998: 375).
[77] Eldridge (2005: 129).
[78] Eldridge (2005: 139).
[79] Eldridge (2005: 140).

Eldridge is in line with some, in the enactivist strand of Artificial Life (to which I will return in details in chapter 5), who defend the approach to complex systems of British 2nd-wave cyberneticist Gordon Pask with his 'maverick machines':

> "Pask proposes that we should base our understanding of a complex system on our interactions with it and the regularities that emerge from such interaction. We should approach complex systems, even those we synthesize ourselves, as a natural historian would (perhaps even as an animal trainer, a psychotherapist, or an artist would). This interactive method for understanding complex systems is still a hard pill to swallow in many areas of science."[80]

Articulating agency precisely as a scientific concept is part of the research programme of enactivism. A recent paper entitled "Defining Agency: individuality, normativity, asymmetry and spatio-temporality in action" takes issue with uses of the term that are largely intuitive, unreflexive, and that rely on scientifically loose and unspecific definitions. Incidentally, for the authors of the paper, the use of the term agency that I make throughout the present work, and more generally the use made of the term in STS, sociology, cultural studies, etc, falls no doubt into the 'too unspecific' category. Although our primary aim may not be to ground a scientific research programme on agency, we may take a cue from the enactivists and be more carefully precise in defining what we intend by agency. The paper aims at outlining open issues, and at providing a few building blocks toward a scientific definition of agency, among which a list of required conditions for agency. Although inspired by the 'living agency' of biological systems, this list does not restrict agency to living organisms. [81] Besides being less precise, how does my notion of agency compare with that developed by the

[80] Bird & Di Paolo (2008: 207).
[81] Barandiaran, Di Paolo & Rohde (2009) .

authors? They are actually quite compatible, but theirs is much stricter. This stricter definition of agency upholds my idea that Artificial Life systems fall into the 'higher agency' stage of simulation.[82]

Thus the idea of humans' intentional collaboration with agency-laden nonhumans is not a case of observer's over-interpretation, but is clearly endorsed and promoted by members of the Artificial Life community themselves. This point established, let us turn to a STS perspective. One cannot help but notice the striking parallel existing between ALifers' accounts, such as detailed above, of the cybernetic dance that can occur in Artificial Life between human researchers, who voluntarily relinquish control, and their empowered nonhuman synthetic systems – empirical accounts born from their own practice and experience – and the following extract, this time by STS scholar, Andrew Pickering:

> "In *The Mangle of Practice* (1995) I offered an ontological vision of the world and our place in it, a vision in which both the human and the nonhuman are recognised as open-endedly becoming – taking on emergent forms in an intrinsically temporal 'dance of agency'."[83]

This extract is the first sentence of "New Ontologies", opening chapter of The Mangle in Practice: Science, Society and Becoming, volume of essays edited by Andrew Pickering and Keith Guzik whose unifying thread is the connection to Pickering's concept of the 'mangle' in the analysis of scientific practice.[84] In "New Ontologies", Pickering discusses the paintings of Piet Mondrian and Willem de Kooning, who in the abstract to an earlier version of the essay he characterizes "as exemplars or icons of, respectively, a Modern dualist ontology and a non-Modern

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[82] Barandiaran, Di Paolo & Rohde (2009 : 1-2) .
[83] Pickering (2008: 1).
[84] Pickering (2008); Pickering (1995).

mangle-ish ontology."[85] He argues that the first "entails a dualism of the human and the nonhuman, a detachment from and domination of the latter by the former, and an erasure of time; the other entails an immediate symmetrical engagement between the human and the nonhuman and an intrinsically temporal becoming in that engagement."[86] Referring to Heidegger's "The Question Concerning Technology", he describes Heidegger as defending the de Kooning's line, whereas the stance humans adopt towards nature in the dangerous mode of 'enframing', characteristic of modernity according to Heidegger, would conform to the dualist Mondrian-esque style.[87] For Pickering, Heideggerian 'enframing', or Mondrian-esque modern dualist detachment – human-centred, atemporal (I would add, amnesiac) and controlling – has been the hegemonic ontological attitude since the Scientific Revolution and the Enlightenment, and its heartland is traditionally to be found in science and engineering; but if one adopts a de Kooning-like non-modern antidualist ontological attitude, which, as Heidegger proposed, embeds 'enframing' into the endlessly emergent, entangled becoming – the 'dance of agency' – of the human and the nonhuman , then "*science is itself caught up in the flow of becoming . . . science itself thus appears as a veil,* clouding our perception of how things actually are."[88] Here Pickering is close to Latour in <u>We Have Never Been Modern</u>, for whom a knowledge-making project is truly modern for as long as its practitioners subscribe to the modern critical stance, which "by 'purification' creates two entirely distinct ontological zones: that of human beings on the one hand; that of nonhumans on the other", while they dissimulate (including to themselves, I would venture) that the project is actually developed through

[85] Pickering (2006), abstract.
[86] Pickering (2008: 3).
[87] Pickering (2008: 5).
[88] Pickering (2008: 8).

unacknowledged hybrid networks, through an underground work of hybridization between humans and nonhumans.[89]

The phenomenological inspiration common to Pickering and to ALifers in the enactive strand is the source of more resonance between both notions of agency. Pickering's insistence on the intrinsic temporality of the 'dance of agency' – its Heideggerian becoming, in contrast with the atemporality of the enframing attitude – strongly echoes the view developed by the authors of "Defining Agency", that "spatiality and temporality are linked and co-emerge with agency" and that "a frozen snapshot of [a] system is nothing but a picture of a dead organization". And there is a close parallel between Pickering's concept of temporal emergence in the 'dance of agency', and Barandiaran et al.'s assertion that "[i]t is fundamentally through the spatial and temporal dimensions that agency expands in complexity."[90]

To conclude, it appears that ALifers, some of them at least, do not place themselves into the modern dualist ontology prevailing in science, but consciously, deliberately, opt for a non-modern, antidualist ontological attitude. This leads them to try harnessing the 'dance of agency' into which they engage their empowered computerized simulations. 'Harnessing' corresponds to a form of management that is entirely different from the dominating control of the Mondrian's line, one that is instead 'letting go of control'. Indeed, in the conclusion to his study of Artificial Life at Sussex, Risan has explicitly singled out this 'letting go of control' mode of relationship between ALifers and their systems.[91] I think of it as steering a sailboat in the wind, or going along with the flow, or surfing the wave. In short, 'harnessing' is trying to make the most of the collaboration between the human and the nonhuman and of its open-ended,

[89] Latour (1993: 10-11).
[90] Barandiaran, Di Paolo & Rohde (2009 : 2, 9) .
[91] Risan (1997a), chapter 7: Conclusion.

temporal emergence. If we follow Pickering and Latour, these ALifers and their knowledge-making practices are good candidates of non-modernity.

"Harnessing non-modernity" is the title I have given my dissertation. I would like to make it clear that in what follows, I will not make the case that the entire community of Artificial Life embraces an antidualist non-modern ontology. Indeed, chapter 3 will reveal that part of the community is embracing a typically modern stance, like the significant fraction who aims at professionalizing Artificial Life into a respectable scientific discipline and who tries to tame into formalized research agendas the wild work of hybridization that Artificial Life synthetic systems are prone to catalyse. Rather, through a case study of the Artificial Life research group at the University of Sussex and its offshoots (what I will define as 'the Sussex neighbourhood' in chapter 4), I intend to demonstrate that the thriving research group who has been most successful in achieving centrality in the Artificial Life landscape, is also one that has deliberately embraced the many dimensions of a non-modern ontology – one that is 'harnessing non-modernity'.

Chapter 3: 'What is it we are doing?'

1. INTRODUCTION

Starting from the observation that Artificial Life did not exist as a discipline in academic institutions but manifested itself mostly through specialist conferences and journals, chapter 2 has looked for the cultural 'glue' holding the Artificial Life research community together, through a snapshot view of the community that was historically flat. This was adapted to the goal pursued, but like Barandiaran et al. have stated in "Defining Agency", "a frozen snapshot of [a] system is nothing but a picture of a dead organization".[92] A frozen snapshot was inapt at capturing the dynamics of Artificial Life as a social organization, which are essential to understanding the life of the community – a major aspect of its culture.

From the same starting point as chapter 2, that Artificial Life was not an established discipline in academic institutions, I have adopted in chapter 3 a time-thick perspective to try uncover why, over twenty years after its official inception, Artificial Life had not achieved a more stable disciplinary existence. Taking inspiration in the body of STS scholarship dedicated to the study of scientific controversies, which has shown that controversies have much to tell us about the peculiarities of the scientific communities involved, I have scrutinized the recurring introspective debates agitating the global Artificial Life research community, in the hope that they may provide clues about the possible structural causes of its disciplinary instability.

Section 2 uncovers two major themes that have been driving the Artificial Life community's ongoing introspection over the years: the (uncertain) epistemic status of its

[92] Barandiaran, Di Paolo & Rohde (2009 : 9) .

research, and its (unsettled) institutional positioning. Their analysis reveals the close interplay existing between the epistemic and institutional dimensions of Artificial Life.

Section 3 takes up on the results of section 2 and shows that the unresolved issues and debates characterising the self-searching of the Artificial Life community all relate, in some manner, to its common cultural denominator – its cultural 'glue': the simulations at the heart of its research. I first discuss the problematic epistemological status of Artificial Life simulations, and its implications for Artificial Life research. I then examine how the practice of simulation may also contribute to the unsettled position of Artificial Life in the institutional landscape. Having thus singled out the role played by simulations in the ongoing epistemic and institutional fuzziness of Artificial Life, I then consider whether there is something intrinsic about the agency-rich, computerized synthetic systems favoured by Artificial Life research, in particular the computer simulations that they involve, which would make them a fundamental cause of structural instability for Artificial Life, at both the epistemic and the institutional levels.

Section 4 pursues this line of thought. Building on Peter Galison's concept of the 'trading zone', I propose that the entire field of Artificial Life is best construed as an instance of 'extended trading zone', which locally bridges different contexts of use – comprised of skills, practices, cultural values, theoretical frameworks – ranging across the full disciplinary spectrum. This will set the general backdrop against which I will develop, in following chapters, a case study of CCNR, the Centre for Computational Neuroscience and Robotics at the University of Sussex.

2. SELF-SEARCHING IN THE ARTIFICIAL LIFE COMMUNITY

This section analyses the self-searching that the Artificial Life community has openly engaged into over the years, as it has been publicly articulated on the occasion of formal community gatherings at dedicated conferences.

2.1 SOURCES AND THEMATIC

A working assumption was that good places to look for signs of recurring introspective debates would be conference sessions, talks, round-tables, workshops, which topics would be targeting the foundations of Artificial Life as research field. The primary material I have drawn on is diverse, comprising conference papers, published reports of workshops held during Artificial Life conferences, observations by other Artificial Life scholars, and fieldnotes from the Artificial Life conferences I have personally attended. It has certainly no claim at being exhaustive; rather, it aims at providing a patchy but meaningful trail of breadcrumbs.

At ECAL 1995, less than a decade after Artificial Life was officially named, an entire plenary session was dedicated to "Foundations and Epistemology", opened by invited speaker Howard Pattee with a talk entitled "Artificial Life Needs a Real Epistemology"[93]. There was again a full session dedicated to "Foundations and Epistemology" at ECAL 1997, in the context of which anthropologist of science and technology Lars Risan gave a paper entitled "'Why are there so few biologists here?' – Artificial Life as a theoretical biology of artistry" in which he reported that:

> "The question in the title of this paper was raised at the final discussion at the *Simulation of Adaptive Behavior `94* (SAB 94) conference and was brought up again one year later, at the *European Conference of Artificial Life `95* (ECAL 95) in Granada."[94]

[93] Moran et al. (1995).
[94] Risan (1997b); Husbands & Harvey (1997).

At ECAL 1999, a debate was organised to discuss "[h]ow can artificial life (AL) advance scientific understanding? Is AL best seen as a new discipline, or as a collection of novel computational methods that can be applied to old problems? And given that the products of AL research range from abstract existence proofs to working robots to detailed simulation models, are there standards of quality or usefulness that can be applied across the whole field?"[95] The organizers acknowledged that some of these issues had been raised before, but were keen to bring them to a wider audience. The debate resulted in a report entitled "Artificial Life: Discipline or Method? Report on a Debate Held at ECAL'99" subsequently published in the journal Artificial Life. At ALIFE VII in 2000, two papers were given ("Artificial Life as a bridge between Science and Philosophy"[96] and "Simulation Models as Opaque Thought Experiments"[97]), which again fall into the introspective category, and the conference concluded with a round table discussion, reported in the Artificial Life journal under the title "Open Problems in Artificial Life"[98], which aimed at establishing a set of challenges for the Artificial Life community, "[…] a structured list of open problems in artificial life"[99] – in short, a research agenda. The following year, a workshop was held at ECAL 2001, entitled "The View From Elsewhere: Perspectives on ALife Modelling" and reported under the same title in the Artificial Life journal, the goal of which "was to review and discuss artificial life (ALife) as it is depicted in, and as it interfaces with, adjacent disciplines" [100], namely, philosophy, biology, linguistics, and cybernetics – the latter of which Artificial Life has a historical rather than a contemporary adjacency with.

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[95] Noble, Bullock & Di Paolo (2000: 145).
[96] Moreno (2000).
[97] Di Paolo, Noble & Bullock (2000).
[98] Bedau et al. (2000).
[99] Bedau et al. (2000: 364).
[100] Wheeler et al. (2002: 87).

I will complement this conference-related material with a paper, "Artificial Life as Theoretical Biology: How to do real science with computer simulation"[101], which again intertwines some key concerns regarding both the scientific status and the institutional standing of the field. Although it was never presented at an Artificial Life conference and has supposedly reached a more confidential audience, it is referenced in four of the conference papers and reports otherwise listed.

At ALIFE X in 2006 and at ECAL 2007, there were no specific paper or session dedicated either to philosophical or to disciplinary issues, but I will draw on my field notes to show that these issues were not forgotten at both conferences.

Finally at ALIFE XI, a full-day track was dedicated to "Philosophical Issues".[102] It attracted a very strong attendance. The room where it was held was packed full, and at some point during the morning session I made a rough head-count, which came up to about 60 people sitting and 20 standing. These figures are very high, considering that the overall number of conference participants was around 300, split over 6 parallel tracks.

The question remains of whether the primary material on which my analysis is based is actually significant. Are the selected sources, mostly conference material, representative of the self-searching of the Artificial Life community? More importantly, is this introspective trend more than merely anecdotal? It was the Alifers themselves who drew my attention towards it in the first place. When explaining the reason of my presence in the field and the object of my research, I have repeatedly met with strong interest on the part of my interlocutors along the lines of 'then you might help us understand what it is we are doing and where Artificial Life is heading' (hence the title of my chapter). Part of the material above, which is documenting attempts made in

[101] Miller (1995).
[102] A multi-track format was adopted for ALIFE XI with six tracks running in parallel everyday, while the poster presentations were abandoned.

these directions by the community itself, was indicated to me by ALifers who were keen to help me explore that alley.[103] Overall, between the bibliographical resources and my own field notes, the selected material spans fifteen years (although with some gaps) in the two decades of official Artificial Life existence. It provides a general picture of the issues raised at dedicated conferences throughout the years 1994 to 2008, a picture that shows a marked continuity between the later years and the earlier ones in terms of the foundational issues under debate.

In all, the timeframe I cover averages two thirds of Artificial Life official existence (at the time if my inquiry). Over this non-negligible period, the Artificial Life community's introspection has been frequent and recurrent on the occasion of the dedicated conferences, which draw together the otherwise highly scattered Artificial Life research community. My fieldwork observations have convinced me that, for such a scattered community, these gatherings are important to maintain a sense of belonging and to give the field some kind of enduring existence. So much so in fact, that some ALifers seriously question the capacity of Artificial Life to go on the day these conferences, whose organisation is very dependent on a small number of strongly committed individuals, stop being held.[104] As for the content of the self-searching which the Artificial Life community has engaged into over that period and on these occasions, it has revolved around a remarkably consistent set of issues, broadly related to two main themes, the epistemic status and the institutional existence of Artificial Life, neatly summarized and brought together in the opening paragraph of the report "Artificial Life: Discipline or Method?", in which the authors state that they "[…] wanted to foster a constructive discussion regarding the scientific status, and future, of AL."[105]

[103] For example, fieldnotes, 29/03/2007, 07/06/2007.
[104] For example, fieldnotes, 14/09/2007.
[105] Noble, Bullock & Di Paolo (2000: 145).

2.2 EPISTEMOLOGICAL SELF-SEARCHING

2.2.1 A TECHNOLOGY-MEDIATED KIND OF PHILOSOPHY

The strong philosophical component of Artificial Life caught my attention from the start of my research project. It was not just the plenary sessions dedicated to "Foundations and Epistemology" at past Artificial Life conferences. Many ALifers have a degree in philosophy. Most of those who studied philosophy as undergraduates then turned to computer science, but part of them went on to do philosophy at postgraduate level; there are also ALifers, trained first as scientists, who studied philosophy at a later stage in their career. Some belong to departments of philosophy or hold academic positions as philosophers in interdisciplinary centres. These philosophical ALifers philosophize not as observing outsiders, which is often the rule in philosophy of science, but as insiders, whose 'thinking work' is an integral part of the research projects which they conduct or contribute to. This is the case of some well-mediated figures – like for example Chilean biologist, philosopher and neuroscientist Francisco Varela, whose 'embodied philosophy' remains hugely influential despite his untimely death; or Mark Bedau, Professor of Philosophy and Humanities at Reed College, editor-in-chief of the journal Artificial Life, co-founder and Chief Operational Officer of company Protolife[106]; or Margaret Boden, editor and author of many books in the domain of the history and philosophy of Artificial Intelligence, Artificial Life and Cognitive Sciences, founding-Dean of COGS (the School of Cognitive and Computing Sciences at University of Sussex) – and also of many other less public figures. One such is Xavier Barandiaran, who presents himself on his academic website in the following manner:

[106] Protolife is a Venice-based private company, which was member of the EU-funded Integrated Project PACE (Programmable Artificial Cell Evolution, 2004-2008) consortium.

> "I consider myself a situated and embodied philosopher, which means that I situate my philosophical practice in close interaction with scientific environments and embodied in the conceptual apparatus that emerges from this interaction. The sciences on which I feel embedded are those meeting in the multidisciplinary crossroad of cognitive sciences and artificial life […]."[107]

Artificial Life has been described to me as an "experimental philosophy", or even a "mechanical philosophy", i.e. a philosophical investigation mediated through the building of technological artifacts. The ALifer from University of Sussex who gave me this particular definition is strongly inspired by the work of late British cyberneticist Gordon Pask, who apparently described his consultancy company System Research Ltd as an epistemological laboratory.[108] Artificial Life has also been described to me as "doing philosophy with a screwdriver" – it is allegedly a charge levelled at Artificial Life by those scientists who argue that it is not a 'true' science. The graduate student in Artificial Life who reported this to me, said he was not bothered by the appellation and neither were those he worked alongside with, instead they were rather proud of it.[109]

But the view that Artificial Life is a form of philosophy is not just embraced as a positive driver by enthusiastic ALifers, or as a critique by detractors of Artificial Life. It also appears in less emotionally-charged arguments, for example under the pen of philosopher of science Daniel Dennett, who published a paper in 1994 in the journal Artificial Life, entitled "Artificial Life as Philosophy", which opens in the following manner:

> "There are two likely paths for philosophers to follow in their encounters with Artificial Life. They can see it as a new way of doing philosophy, or

[107] http://xabierbarandiaran.wordpress.com/about-me/, consulted 13/10/2009.
[108] Fieldnotes, 23/07/2007.
[109] Fieldnotes, 29/03/2007.

> simply as a new object of philosophical attention using traditional methods. Is Artificial Life best seen as a new philosophical method or a new phenomenon? There is a case to be made for each alternative, but I urge philosophers to take the leap and consider the first to be more important and promising."[110]

Dennett encourages philosophers to become active insiders of the Artificial Life movement rather than to position themselves as external observers, and argues that Artificial Life can be seen as a special kind of philosophy permitting the prosthetically-controlled design and testing of thought experiments "[…] of indefinite complexity", "[…] kept honest by requirements that could never be imposed on the naked mind of a human thinker acting alone"[111], with computers in the role of prostheses of the human mind.

The shortcomings of philosophising from an outsider vantage point were made painfully obvious at ALIFE XI in one of the "Philosophical Issues" sessions, during a talk which proposed that Artificial Life should embrace an organisation-based conception of the organism as a fruitful alternative to the dominant metaphorical conception of organism-as-machine[112]. It sounded as if the speaker, a non-ALifer philosopher of science, had missed over a decade of Artificial Life scholarship. At ALIFE XI, the idea of an organisation-based conception of organisms was rather old news. Indeed, the abstract to another presentation in the "Philosophical Issues" track, this time by an insider to the community, began with the observation that "There is a

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[110] Dennett (1995 : 291).
[111] Dennett (1995 : 291).
[112] Fieldnotes, 07/08/2008; also ALIFE XI Conference Schedule, 4th-8th August 2008, Winchester, UK, abstract for Nicholson, D., "Is the organism really a machine?": 48-49.

widespread view in the artificial life community that life is not so much about materiality but about organization."[113]

In the conference material that I have selected, "Artificial Life as a bridge between Science and Philosophy", by Alvaro Moreno Bergareche, philosopher of science in a department of Logic and Philosophy of Science, addresses the issue of the disciplinary relationships between Artificial Life, science and philosophy, again rather from the perspective of the kind of knowledge produced than from the perspective of its institutional existence. The paper defends the view that Artificial Life, thanks to a complex combination of elements, has its own proper identity as a discipline[114], "a discipline that, due to the nature of the problems it addresses, has progressively moved into an intermediate area between philosophy and science."[115] For him, "[…] AL would come to be a bridge between empirical science and philosophy of science, as each of them has been traditionally conceived. […] in AL a new way of interrelating empirical theories and meta-theories arises, a way that involves the mediation of technological devices."[116]

2.2.2 THE STRONG ARTIFICIAL LIFE LEGACY

It is unsurprising that a research community with such a strong philosophical bend, whose field is considered by some as a form of philosophy, should address the epistemic issues surrounding their research. In relation with the epistemic status of Artificial Life research, two major stances are apparent in the material I have selected. One is, in my view, the direct corollary of the strong Artificial Life position.

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[113] ALIFE XI Conference Schedule, 4th-8th August 2008, Winchester, UK, abstract for Di Paolo, E., "Life in time: the missing temporal dimension in autopoiesis": 25.
[114] Moreno Bergareche (2000: 507).
[115] Moreno Bergareche (2000: 510).
[116] Moreno Bergareche (2000: 511).

The strong Artificial Life position claims that it is, or will be, possible to build synthetic processes that are actual instantiations of life as a phenomenon. It entails that life is held to be a natural kind, and further, that a metrology of life is a highly desirable achievement in order to allow for a scientifically acceptable evaluation of aliveness. In the course of my fieldwork, I have encountered only a minority of ALifers, who were still openly defending a radical strong Artificial Life position of the type boldly articulated by Langton in 1987 in his much quoted founding manifesto for the newly branded field of Artificial Life:

> "[Artificial Life] complements the traditional biological sciences […] by attempting to *synthetize* life-like behaviors within computers and other artificial media. By extending the empirical foundation upon which biology is based beyond the carbon-chain life that has evolved on Earth, Artificial Life can contribute to theoretical biology by locating *life-as-we-know-it* within the larger picture of *life-as-it-could-be*. […] Biology is the scientific study of life – in principle anyway. In practice, biology is the scientific study of life based on carbon-chain chemistry. There is nothing in its charter that restricts biology to the study of carbon-based life; it is simply that this is the only kind of life that has been available for study."[117]

Nowadays the Artificial Life community appears quite wary of sweeping claims, like "How I created life in a virtual universe" (1993) by Thomas Ray, charismatic creator of the famous Artificial Life world Tierra. Such claims have typically attracted popular media coverage and damaged the scientific reputation of the field in academic circles.

Yet I would venture that the strong Artificial Life position has not faded, but has mutated into less radical, more scientifically-conform positions: the idea of life-as-a-

[117] Langton (1989a: 1-2); italics are Langton's.

natural-kind is routine scientific essentialism, and a (preferably quantitative) definition of aliveness was and remains part of the research agenda of Artificial Life. Philosopher Kim Sterelny has remarked that "[o]n even a cursory survey of A-Life literature, one is struck by the resuscitation of a quaintly old-fashioned project: defining life"[118]. This was already explicit at the Artificial Life II conference in 1991, and was still the case in 2007[119]. It is also apparent in the "Open Problems in Artificial Life" collaborative synthesis in 2000. After classifying the key open challenges under three main headings, "How does life arise from the nonliving?", "What are the potentials and limits of living systems?", and "How is life related to mind, machines, and culture?", the report goes on:

> "This list of challenges could be extended, of course. Some fundamental questions are missing, the most notable being the nature of life itself. This question is presupposed by a number of the problems listed, however, and answering any problem will necessarily involve resolving anything it presupposes."[120]

This passage, raising the question of the nature of life, resonates with the various attempts at a definition of life and their ensuing debates, which have paved the short history of Artificial Life. The question of the nature of life remains an unresolved issue within the community, on which there is no consensus to be found. I would like to point a number of objections to this particular strand of investigation.

First, it subsumes the epistemic status of Artificial Life synthetic simulations under a metaphysical presupposition: the 'good' ones are more than mere simulations, they are actual instantiations of life processes and belong to the natural kind of life. For

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[118] Sterelny (1997: 587).
[119] Bedau & Packard (1991: 458): "The field of artificial life is searching for a definition of life; even better would be a criterion of life – a public, empirical, repeatable, quantifiable test for whether a system (possibly artificial) is alive."; also Bedau (2007: 466-468).
[120] Bedau et al. (2000: 364-365).

those who adopt this perspective, the epistemic inquiry into what constitutes ‘good’ and ‘bad’ Artificial Life simulations *as simulations* is not considered a priority. The priority goes to the object of inquiry behind these simulations, i.e. life, and focuses Artificial Life research agenda on the production of a scientifically acceptable theory of the nature of life that will explain the hallmarks of life and the borderline cases, resolve the puzzles about life, produce testable predictions, and ultimately yield a definition of life[121]. Once this goal is achieved, criteria for assessing ‘aliveness’ will be available, and there will be *de facto* an objective means of demarcating ‘good’ from ‘bad’ Artificial Life simulations and hence assess their epistemic value. By thus concentrating the attention on the search for a scientific theory of life as a natural kind, the question of the epistemic status of Artificial Life simulations *as simulations* is entirely eluded, and severe constraints are introduced on the field’s research agenda.

This is not merely my view. Such objections have indeed been raised from inside the community, at levels pertaining to both the disciplinary and the epistemic. Philosopher of science Alvaro Moreno Bergareche has argued that “depending on the epistemological status given to computational systems, the actual research program may vary quite radically.”[122] And a constrained research agenda is not to everyone’s taste.

Even though the “Open Problems in Artificial Life” workshop at ALIFE VII in 2000 was an attempt at imposing such a research agenda on the grounds that it was consensual, there certainly had been no consensus on the matter just the year before, at ECAL 1999. Indeed, some of the opinions put forward during the “Artificial Life: Discipline or Method?” debate at ECAL 1999 make it doubtful that the research agenda defined a year later at ALIFE VII could have been widely consensual. The organizers of the debate reported that most of the discussants agreed “that AL […] had a positive

[121] Bedau (2007: 466-468).
[122] Moreno Bergareche (2000: 510).

contribution to offer to many disciplines, including philosophy, linguistics, economics, psychology, geography, archaeology, and even theology" but that "[t]here was less agreement as to whether there were […] a core of research topics unique to AL"[123]. Inman Harvey, one of the founders and leaders of the Artificial Life group at University of Sussex, reportedly pointed out that "[…] crossover between disciplines leading to 'flaky speculations and hot air' may be one of the great benefits of AL as a movement" and that "AL researchers should continue to explore crossover between disciplines and generate the 'flaky stuff' that such interdisciplinary interaction often results in".[124] Harvey belongs to those openly resisting the professionalization of Artificial Life, fiercely defending the broadest possible interdisciplinarity.[125]

Finally, some ALifers are unhappy with the strong versus weak Artificial Life debate and consider it to be a dead end distracting the Artificial Life community from the really important issues, like the problematic epistemology of simulations.

2.2.3 CONFRONTING THE SIMULATION ISSUE

The "Artificial Life: Discipline or Method?" report concluded:

> "Many of the participants at this debate […] do *not* see their work as a source of empirical data. They see it as a source of new ways of thinking, or novel intuitions; as a way of testing the coherence of theories, or of generating other nonempirical results. Is it time to forego the philosophically rather difficult notion that the systems developed by AL researchers have the same status as the natural phenomena they seek to resemble? We believe that these artificial systems are more like conventional models, built to clarify and extend theories of natural

[123] Noble, Bullock & Di Paolo (2000: 147).
[124] Noble, Bullock & Di Paolo (2000: 146-147).
[125] Fieldnotes, 21/06/2007, 29/11/2006.

> phenomena, rather than to augment natural phenomena with artificial brethren."[126]

This belief underlies the second major stance which I have identified with regard to the epistemology of Artificial Life. It leads to an inquiry into the epistemic status that simulation models *per se* may have a claim to, and of how it may be improved. In the report "The View from Elsewhere", where four cases of 'elsewhere' were each presented by a main speaker and a discussant, the discussant for philosophy explained why in his view it is problematic to consider Artificial Life as a philosophical method and urged philosophers to rather take Artificial Life simulations as objects of philosophical study – simulations which for him "are best conceived as close relations of biological mathematical models".[127] The issues raised when simulations are themselves taken as objects of study were addressed for example in "Artificial Life as Theoretical Biology: How to do real science with computer simulation"[128], in which Miller aimed at laying the first stones towards the development of a stronger methodology for Artificial Life which in his opinion did not show at this point "enough methodological sophistication to count as good theoretical biology"[129]; the paper pointed at "some methodological pitfalls arising from the computer science influence" and at the irrelevance of the strong Artificial Life debate, as major weaknesses to be remedied.[130]

More recently, these issues were addressed by the three authors of "Simulation Models as Opaque Thought Experiments", who claim that "[o]ur goal in this paper is to clearly spell out one way in which the type of systems characteristic of artificial life can

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[126] Noble, Bullock & Di Paolo (2000: 148).
[127] Wheeler et al. (2002: 89-90).
[128] Miller (1995).
[129] Miller (1995: 1).
[130] Miller (1995: 1).

make a contribution to science as simulation models"[131]. The paper, presented at ALIFE VII in 2000, builds on the questions which framed the debate that the three same researchers had organised at ECAL 1999 and had reported in "Artificial Life: Discipline or Method?"[132]. In the latter, they had been asking whether all possible positions were tenable along the continuum between Artificial Life as a collection of methods to use in different fields and Artificial Life as a discipline in itself, and how bad work was to be distinguished from good. They had showed an awareness of the interlinking between the issues of the epistemic status of Artificial Life research and of the field's institutional positioning, as they insisted that "[t]he two questions are not independent: If one sees AL research as some kind of thought experiment, one's quality criteria may well differ from those of someone who is interested in more-or-less precise models of real-world systems."[133] In "Simulation Models as Opaque Thought Experiments", Di Paolo, Noble and Bullock bring their own contribution to the debate they had set up the year before:

> "Our view, in brief, is that although simulations can never substitute for empirical data collection, they are valuable tools for re-organising and probing the internal consistency of a theoretical position."[134]

Drawing on Kuhn's "A function for thought experiments",[135] they attempt to reconcile the difference between simulation and thought experiment – the explanatory opacity of the former, born from the complexity of its internal workings – within a workable methodology. They eventually conclude that "it is reasonable to understand the use of computer simulations as a kind of thought experimentation"[136] whose distinctive

[131] Di Paolo, Noble & Bullock (2000: 497).
[132] Noble, Bullock & Di Paolo (2000).
[133] Noble, Bullock & Di Paolo (2000: 145).
[134] Di Paolo, Noble & Bullock (2000: 497).
[135] Kuhn (1977).
[136] Di Paolo, Noble & Bullock (2000: 505).

explanatory opacity, not part of traditional armchair thought experimentation, necessitates systematic inquiry into their workings.

"Simulation Models as Opaque Thought Experiments" is a significant paper in more than one respect. It is a serious attempt at strengthening the methodological grounds on which Artificial Life is built, while sidestepping the weak versus strong Artificial Life debate. It is also, I believe, an original contribution to the budding epistemology of simulations, exemplary of a category of well-informed and well-researched philosophical papers written by members of the Artificial Life community.

2.2.4 EMBODIED-EMBEDDED COGNITION, SUBJECTS & OBJECTS

What might be the most unusual aspect of the serious philosophical thinking that goes on inside Artificial Life is the presence of a robust anti-Cartesian continental current. Unusual, that is, for a field with scientific claims. By contrast, philosophy of technology and philosophy of new media art are strong on continental philosophy and anti-Cartesianism – which points towards some future conclusions about the hybrid nature of Artificial Life. This continental current does not focus on the epistemology of computational simulations but rather on metaphysical issues[137], as it aims towards the articulation of a consistent overarching philosophical framework through which to address cognitive behaviour questions, in the perspective of the embodied cognition movement in cognitive science. The embodied-embedded cognition movement, which comes in reaction, and as an alternative, to classic cognitivism and GOFAI[138], takes inspiration in phenomenological ideas developed by the likes of Heidegger, Piaget, Merleau-Ponty, Husserl or Dewey[139]. I propose to examine broadly how and where this movement fits within Artificial Life, with the view to demonstrate that its fundamental

[137] Van Inwagen (2007).
[138] GOFAI stands for Good Old Fashioned Artificial Intelligence.
[139] Cowart (2008).

anti-dualism tends to associate it with the second stance I have identified in relation to the epistemology of Artificial Life – the one that confronts the problem of the epistemic status of simulations rather than elude it. I will further discuss embodied-embedded cognitive science in chapter 5, when studying interdisciplinary practices in the Artificial Life community associated to the University of Sussex.

Before going any further, in order for my development to remain consistent, I must clarify the link between Artificial Life and cognitive science. The ALifers who appear in the present sub-section focus their research on cognition – but cognition in a very broad sense of the term, which goes far wider than a high-level human-type form of cognition, to include that of the simplest kind of animals such as *C.elegans* worms.[140] It would be a mistake to think that these researchers position the inquiry into cognition at the margins of Artificial Life, when in fact they take cognitive abilities to be a major characteristic trait of being alive, and their commitment to investigating cognition from within the field of Artificial Life springs from a radical philosophical stance regarding the very nature of life:

> "A-Lifers have to get to grips with what it means for anything to be alive - anything from a bacterium to a tree, from a human to (potentially) a robot. One theme that some of us use is to relate Life to Cognition (in a broad sense): living creatures know their world, know what has significance for them, through their interactions with it, and without a world of meaning for X, X cannot be alive."[141]

In a reversal of the classical view of the evolution of organisms on Earth, according to which cognitive abilities develop at a much later stage than life itself, this extract articulates the hypothesis that cognition may be the condition for life. At ALIFE

[140] Dictated fieldnotes, transcripts, 03/06/2006.
[141] Harvey (1997).

XI, the importance taken by the cognition question in the philosophical preoccupations of the Artificial Life community was glaring. Among the eight talks given in the "Philosophical Issues" track, five were concerned with cognitive issues (four of which by current or ex-members of the Sussex group). Some do not stop at the idea that cognition might be the condition for life, but venture further that sociality might be the condition for cognition itself. To open the panel discussion on social systems at ECAL 2007, the discussion proponent made a case for the continuity of life, mind and society, arguing that the first living creature could only have been also the first cognisant creature and the first social creature as well. He proposed that sociality was, maybe, as primarily central as cognition, and said he was tempted to take the radical view that individuality had evolved away from the collective which itself had evolved away from sociality. The afternoon keynote speaker had developed a somewhat similar perspective in a lecture entitled "Escape from pervasive individualism: Why should embodied cognition seriously study the collective dynamics of social interaction?" [142]

An important strand of the embodied-embedded cognition current of Artificial Life is inspired by the enactive approach to cognitive science initially developed by Varela, Thompson and Rosch in The Embodied Mind: Cognitive Science and Human Experience[143]. Enactivism is an anti-cartesian philosophical framework drawing on Heideggerian ideas, which is quite influential in the areas of Artificial Life research concerned with autonomous adaptive behaviour and embodiment (embodiment in robots and animats mostly)[144]. The work of Francisco Varela is an important source of inspiration in Artificial Life, and most especially in European Artificial Life. There are compounded factors of historical serendipity at work here. First, in 1986 Varela settled in Paris where he remained until his death in 2001. There he worked at the CNRS and at

[142] Fieldnotes, 13/09/2007.
[143] Varela (1991).
[144] Wheeler (1995: 65).

the Centre de Recherche en Epistémologie Appliquée (CREA)[145] of the Ecole Polytechnique, which became an important node in the early Artificial Life research network. It seems that another factor accounting for the strong influence of Varela in European Artificial Life was the presence at COGS[146] at the University of Sussex, from late 1989 / early 1990, of a postgraduate student who was a fervent disciple of Maturana (Varela's mentor, with whom he developed the notion of autopoiesis). This student was among the handful of individuals who around 1990 started ALERGIC (the Artificial LifE Reading Group in Cogs) – in effect founding the Artificial Life research group of Sussex University, which claims to be the leading Artificial Life research centre in the world[147], a claim sustained by the quantitative analysis of the previous chapter – and was responsible for first acquainting his ALERGIC fellows with the autopoietic philosophical ideas that Maturana and Varela had developed. [148] In 1991, Francisco Varela and Paul Bourgine, also a member of the CREA, organised the first ECAL conference in Paris, with a special focus on autonomous systems. The following year, Barry McMullin, who would become the founder-director of Dublin City University Artificial Life Laboratory but was at the time still working on his PhD thesis in the domain of Artificial Life, and his colleague Noel Murphy, organised a two-day workshop at Dublin City University on "Autopoiesis and Perception", with Varela as special guest. The workshop, originally envisaged to involve fifteen to twenty participants, attracted sufficient interest to be extended to somewhat more than thirty[149]. The first ECAL conference and the "Autopoiesis and Perception" workshop were two

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145 Research Centre in Applied Epistemology.
146 Centre for Research in Cognitive Science at Sussex University.
147 ALERGIC wiki, "What is ALERGIC", http://alergic.pbwiki.com/What+is+ALERGIC, consulted 21/07/2008.
148 Fieldnotes, 21/06/2007.
149 McMullin (1994: 2).

important occasions, held over a short period of time, for the budding European network of Varela's converts to coalesce and grow in strength.

In the conference literature I have studied, a paper characteristic of the anti-Cartesian school would be Michael Wheeler's "Escaping from the Cartesian Mind-Set: Heidegger and Artificial Life", given during the "Foundations and Epistemology" session at ECAL 1995. Wheeler is an academic philosopher whose primary research interests go to philosophy of science and philosophy of mind, and who describes himself as "firmly analytic" in his style of argument, yet "keen to explore philosophy at the interface between the analytic and the continental traditions."[150] His paper proposes a neo-Heideggerian framework for Artificial Life, germane to, yet somewhat different from, enactivism, with the aim to remedy to persistent problems in orthodox cognitive science – problems which, according to the author, "result from the commitment to a Cartesian subject-object divide"[151]. Wheeler's commitment to a non-Cartesian, Heideggerian framework for cognitive science has not flinched over time and his book Reconstructing the Cognitive World, published in 2005, is dedicated to this project.[152]

Anti-Cartesian ALifers who favour a holistic approach to cognition and reject dualism can be quite radical in debunking hidden subject-object and mind-body divides. This was for example the case with the speaker closing the "Morphology, Motion and Cognition" workshop organised at ALIFE X by University of Sussex CCNR, who made the point that there were two forms of dualism to be found in Descartes' writings, the best known of which – the mind-body dualism – he called ontological dualism. But there was a less well known form of Cartesian dualism, which he called explanatorial dualism, to which researchers with an otherwise holistic approach easily fell prey.

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[150] Michael Wheeler's webpage at University of Stirling, http://www.philosophy.stir.ac.uk/staff/m-wheeler/wheeler-page.php, consulted 08/10/2009.
[151] Wheeler (1995: 65).
[152] Wheeler (2005).

Explanatorial dualism implies that "to explain physical phenomena, one needs to appeal only to specifically physical entities", while to explain cognitive phenomena (involving perception or other cognitive states) one needs to appeal only to subjective states. In his view, a true morphodynamical approach to cognition required a holistic approach at the explanatory level as well as at the ontological level – a seamless language to describe both physical mechanisms and subjective states.[153]

The subject-object divide is a topic of deep ongoing interest in certain quarters of the Artificial Life community, as testified by Risan's ethnography of the Artificial Life research group at Sussex University. His fieldwork observations, which dates back to 1994, have lead him to isolate strong anti-Cartesian, relativistic, and Heidegger-inspired views among his informants – to the point that he has made the subject-object relationship the over-arching theme of his dissertation, subtitled "An Anthropology of Subjects and Objects".[154] The holistic approach of the embodied-embedded cognition current, with its utter rejection of the subject-object divide, brings a metaphysical justification to the 'active insider' philosophical stance taken by philosophers involved in doing Artificial Life, as it denies the possibility of objective, external observation in its field of inquiry:

> "As humans, as scientists, we ourselves inhabit a world of words and of theories, where through interchange of ideas we try to find a common language through which we can make sense of our fields of study […]. The language of objectivity usually implies that we can stand apart from our field of study as impartial, godlike observers, but above all here we must

[153] Dictated fieldnotes, transcript, 03/06/2006.
[154] Risan (1997a).

recognise that we ourselves, our modes of understanding, are inextricably linked with our subject matter."[155]

Moreover, the subject-object divide is not only a major issue for ALifers inspired by Continental phenomenology, it can also be a matter of interest for some in the Artificial Life community who remain fully within the analytical tradition. This is for example the case of George Kampis, of the Department of History and Philosophy of Science at Eötvös University in Budapest (Kampis is still another instance of multidisciplinary training, holding two doctorates, the first one in theoretical biology and the second one in philosophy), who by taking a different path of reasoning reaches the same kind of position as the embodied-embedded cognition proponents, in a paper entitled "The Inside and Outside Views of Artificial Life" presented at the "Foundations and Epistemology" session at ECAL 1995. Starting from the premise that the temporally coupled or detached character of the observer with regard to the system observed provides a link between observer and observed "which delimits the kinds of scientific descriptions that can be given at all by an observer"[156], he confronts "two fundamentally different forms of description, corresponding to different epistemological attitudes and different philosophies of science, called endo- and exo-physics […]"[157], as two approaches to the problems of observing. Endophysics, originating with Otto E. Rössler and David Finkelstein in the 1980s, addresses the problems of observing when the observer is enclosed within (is internal to) the observed system. In contrast, "[…] *exo*physics can be defined as an external birds-eye view of an object domain."[158] Kampis insists that in the case of Artificial Life, the endo (internal) and exo (external)

155 Harvey (1997).
156 Kampis (1995 : 95).
157 Kampis (1995 : 95).
158 Kampis (1995 : 96).

stances are not merely a matter of observer positioning, but that they correspond to epistemological commitments. He concludes his comparison in the following manner:

> "Thus, the situation is this: either we want temporal coupling, take an endo stance, and lose the direct describability of complex reality, or we drop temporal fidelity, go to the exo standpoint, impose a detached view, and this long look gives us a valid functionalist perspective. To put this even more plainly: informational detachment is only possible if accompanied with temporal (exophysical) detachment."

He then quickly goes on to outline what might be the implications of adopting an exo or endo perspective for the role of simulations in the theoretical study of life, and concludes in a rather normative fashion:

> "I would guess that the temptation to understand reality as *we* know it (in the Kantian sense of *sub specie hominis*) should bias our expressions towards the latter, internal, alternative."[159]

In conclusion, have I managed to establish a causal link between allegiance to the embodied-embedded cognition current and involvement with the epistemology of simulation? The empirical link between the two was fairly evident, considering that a large majority of the individual researchers in the latter movement are also part of the former. For example, Di Paolo is co-author of the paper "Simulations Models as Opaque Thought Experiments" and has already contributed three papers to the journal "Phenomenology and Cognitive Sciences" (in existence since 2002 only), of which Varela was founding editor; or "situated and embodied philosopher" Barandiaran proposes in his postdoctoral project to investigate both "the connection of the proposed

[159] Kampis (1995 : 101).

model with the philosophy of mind of Heidegger and Merleau-Ponty" and "the epistemological status of simulation models of complex generative organizations and the way they transform our understanding of mechanistic explanations in philosophy of science."[160]

The causal link follows from the negation by embodied philosophy of the subject-object divide. When one adopts the phenomenological foundations of embodied-embedded cognition, embedding both observer and observed into a constructivist relationship to the world, the consequence is that the realist pursuit of objective universal criteria of aliveness becomes meaningless and beside the point. Further, I have highlighted that a parallel position could be defended from a fully analytical position in philosophy, since an endo-physics type of perspective is incompatible with an informationally-detached (hence objective) observer, thus incompatible, again, with objective universal criteria of aliveness. Researchers who place themselves in these relativistic frameworks give up on the possibility of accessing such positive knowledge, and eventually deny its existence. They are rather aiming at understanding life-as-*we*-know-it (to play on both Kampis' and Langton's words). For those who place themselves in a performative phenomenological framework such as enactivism, life is experienced, and the only form of life they have access to as such is in their own, subjective and individual, experience of life. It is not external, objective criteria of aliveness that can assess the epistemic value of the relativist ALifers' simulations, determining for the quality of the knowledge they produce. It is the epistemic value of their simulations *as simulations*. They thus have a vested interest in improving the epistemological status of simulations.

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[160] Barandiaran (2008: 1, 8).

2.3 INSTITUTIONAL SELF-SEARCHING

2.3.1 INSTITUTIONAL AND EPISTEMIC INTERACTIONS

With regard to the second main theme of introspection that I have isolated – the institutional positioning, and very existence, of Artificial Life – the concerns expressed by the community have mostly been revolving around the sustainability of the field (understood, as a scientific endeavour): whether Artificial Life is (should be) a discipline in itself; what is (should be) its research agenda; what are (should be) its relationships with neighbouring disciplines. The last two questions raise implicitly a further one, that of which are (should be) the neighbouring disciplines. My adding 'should be' between parenthesis in all these questions simply highlights that in the answers proposed, what may appear on the surface as a mere description of a state of affairs, can often be decoded as quite prescriptive. Occasionally the prescriptive content is fairly transparent, like when during the "Artificial Life: Discipline or Method?" debate, Harvey "expressed the opinion that AL is not a discipline in itself, nor should it be."[161]

In order to get an insight, however reductive, into how inextricably enmeshed the construction of a sustainable institutional position for Artificial Life and the construction of its epistemology are, let us consider how the two themes may interact. As I have demonstrated earlier, the stances adopted by different factions within the Artificial Life community with regard to the epistemology of the field are related to their stances with regard to the priorities of a research agenda for the field, and even with regard to the desirability of having a research agenda, as for example the holist phenomenological approach adopted by some ALifers within the embodied cognition movement pushes them to favour the widest possible spectrum of experiential input and to oppose the professionalization of Artificial Life into a traditional discipline. In turn,

[161] Noble, Bullock & Di Paolo (2000: 146).

the content – or the absence – of a research agenda has implications for the institutional positioning of Artificial Life, as it can limit the openness of the field by freezing it into certain research programmes and by steering it towards certain neighbours rather than others – or maintain it as an adaptive entity at the margins of institutional structures. Conversely, there are other forces at work than epistemic in the debates around whether to institutionalize the field as a scientific discipline or whether to associate it more closely with certain neighbours rather than others, forces causing disciplinary shifts which cannot fail to impact both the question of the field's research agenda and the construction of an epistemology for Artificial Life. It is some of these forces that I am most particularly trying to uncover in this part of the chapter. With this goal in mind, I will start by looking at some of the arguments in favour or against the professionalization of Artificial Life as a scientific discipline, and I will then examine how the Artificial Life community behaves towards neighbouring fields.

2.3.2 TO BE OR NOT TO BE A DISCIPLINE

The "Artificial Life: Discipline or Method?" debate which was held at ECAL 1999 revolved around an explicit concern for the scientific status and the future of Artificial Life. Behind the question "Is AL best seen as a new discipline, or as a collection of novel computational methods that can be applied to old problems?"[162], which formulated in this way appeared to be asking for objective, descriptive answers, was lurking, implicit, the more prescriptive question of what was best for the field. Langton started by blurring the boundaries between method and discipline, arguing that "methods and disciplines typically overlap, and thus deciding whether AL is one or the other is a moot point."[163] This was opening the door to subjective (and from there, more

[162] Noble, Bullock & Di Paolo (2000: 145).
[163] Noble, Bullock & Di Paolo (2000: 146).

prescriptive) opinions. The threshold was certainly crossed, as I have already pointed, when Harvey "expressed the opinion that AL is not a discipline in itself, nor should it be."[164] Harvey's opinion was anchored in his belief that the exploration of disciplinary crossovers was generating the "flaky stuff" which was one of the great benefits of Artificial Life[165], expressing the worry that turning Artificial Life into a discipline would kill its source of creativity. From the reading of the report, it seems that the discussion did not pick up on that particular topic.

A year later at ALIFE VII, the debate held at the initiative of the conference organisers with the view of establishing a list of challenges for Artificial Life, synthesized in the report "Open Problems in Artificial Life", was trying to give the field a form of disciplinary anchoring. It was hoped that a list of (well chosen) open challenges would do for Artificial Life what Hilbert's set of open mathematical problems, established at the beginning of the 20th-century, had done for mathematics throughout the following century by providing it with "an extraordinarily effective guideline for mathematical research"[166]. Moreover, it was thought that it would be all the more valuable for Artificial Life, because contrary to mathematics at the time, "artificial life is quite young and essentially interdisciplinary".[167] The worry which most transpired there, in my view, was that failing to freeze a research agenda for Artificial Life and to mature around a stabilizing core, might spell the dislocation of a still fledging field which tends to be pulled apart by the mix of disciplines it is interacting with. This was best summarized in the following sentence:

> "As a second generation of scientists commences work in this field, many agreed that a publicly recorded list of grand challenges could serve both to

[164] Noble, Bullock & Di Paolo (2000: 146).
[165] Noble, Bullock & Di Paolo (2000: 145-146).
[166] Bedau et al., (2000 : 363).
[167] Bedau et al., (2000 : 363-364).

> better define the core character and objectives of this interdisciplinary activity and to provide starting points for useful new contributions."[168]

As for the list of open challenges itself, I would like to comment on the 'well chosen' which I have put into parenthesis at the beginning of the paragraph. My choice of terms was meant to highlight the degree of subjectivity and normativity inherent to such an exercise. The subjective and prescriptive nature of the list is in fact explicitly acknowledged by the conference organizers:

> "While not completely democratic, we hope our list presents a sensible compromise between representing a diversity of views and constituting a coherent and structured list of challenges."[169]

The worry that Artificial Life might dissolve because of its reaching too widely was expressed in a provocative fashion at ALIFE XI by Takashi Ikegami, the keynote speaker who gave the opening lecture. Ikegami, a scientist-artist who has been active in the field for over fifteen years, started his speech by stating that "Artificial Life is dead", adding that he had to say it before someone on the outside said it. The explanation he then gave for his bold statement sounded as if he was ringing an alarm bell: it came from the observation that people in the field were more often than not incapable of answering the question "Am I doing Artificial Life?"; that Artificial Life was such a big interdisciplinary umbrella that its first aim – understand what is life – was at risk of being forgotten and without it the whole enterprise became very vague. Nonetheless, in the remainder of his speech, Ikegami went on to argue against professionalization, as for him the obsession of professional scientists with generic properties and universality is sterile. He defended instead amateurism, which despite not

[168] Bedau et al., (2000 : 364).
[169] Bedau et al., (2000 : 364).

getting the acknowledgement it deserves, has been playing an important role in Artificial Life so far, connected to the historical rise of the personal computer.[170]

I would like to conclude this sub-section with the panel discussion closing ECAL 2007, which I also witnessed *in situ*. The keynote speaker who introduced the discussion was theoretical biologist and complexity scientist Brian Goodwin. In his talk and in the following discussion, he made an argument against modernist realism and meta-narratives, and for science as an unfolding process embedded in a context where no truth is valid for all times and places. He said that he was worried by any kind of dogma, because what dogma does is shut the door; because when there is no ambiguity, there is no place for creative science anymore. [171] Overall, his talk was pointing in the direction taken by Harvey at ECAL 1999, away from disciplinary freeze, as antidote to creativity. To this, a discussant reacted by asking, but if we open up all the time, who does the work? What should the pragmatic scientist do? Where should he stand in the spectrum between Feyerabend's 'anything goes', and Kuhn's social embeddedness which prescribes that nonetheless the good scientist must work in his paradigm? [172] In this discussant's questions, which caused a wide range of reactions in the audience, I think that the two kinds of worries I have identified so far, loss of creativity through disciplinary freeze or dislocation of the field through lack of focus, were somehow balanced against each other as two opposing forces. The question of where to place the cursor between the extremist positions was left hanging as a matter of controversy.

2.3.3 A CASE OF DESIRABLE NEIGHBOUR: BIOLOGY

The relationship to biology is the disciplinary issue most regularly brought up and thoroughly discussed at Artificial Life conferences. It is in no way surprising that it

[170] Fieldnotes, 06/08/2008.
[171] Fieldnotes, 14/09/2007 .
[172] Fieldnotes, 14/09/2007 .

should be the case, since the Artificial Life project, in both its aims and its means, entertains privileged links with biology, as it draws inspiration from biology while at the same time it tries to shed light on biological processes. But this does not take us very far in trying to understand the relationship to biology from a strictly disciplinary, or professional, perspective.

It has been a troubled one from the very start, since Langton's manifesto, which positioned Artificial Life as an extension of biology, could easily be read as a challenge to biology. And it is interesting that quite soon after Langton's address at ALIFE I, the absence of biologists became not only conspicuous but also worrisome to part of the Artificial Life community. For example, in the introduction to the proceedings of ECAL 1995, the editors state that "It is our opinion, and that of many others, that the future *survival* of ALife is highly related to the presence of *people from biology* in the field."[173] In response, Risan's paper at ECAL 1997 asked in its title, "Why are there so few biologists here? […]"[174].

At ECAL 2001 the issue of the relationship to biology was again on the agenda, as biology was one of the four "adjacent disciplines"[175] examined during the workshop which was reported in "The View From Elsewhere: Perspectives on ALife Modeling". And I was witness that it was still hotly debated at both ALIFE X and ECAL 2007. I will start with ALIFE X, where I most particularly paid attention to this aspect of things. The lack of genuine biologists was fairly obvious. Three young German researchers who were attending their first Artificial Life conference asked me one morning at breakfast if there were many biologists around who would have escaped their notice, because they had the surprised feeling that there were very few. They were thrilled nonetheless by the strong biology-inspired dimension of the research presented, because

[173] Moran & al. (1995: v).
[174] Risan (1997b).
[175] Wheeler et al. (2002: 87).

they had come to ALIFE X hoping to shop for such ideas – a confession comforting the widely held assumption that Artificial Life pillages biology without reciprocating.[176] Yet a subject of deep satisfaction and excitement for many seasoned ALifers was how, with ALIFE X, Artificial Life seemed finally in the way of closing in the gap with biology by getting quantitative, empirical results which mapped onto actual biological data.[177] One told me:

> "One of the things that was really impressive at this conference to me is the degree to which Artificial Life is starting to get back to biology, and… evolutionary biology, and… we're starting to do a lot more matching on models, to real scientific data, make predictions, that you can then perform, you know… wet biology or evolutionary biology experiments […] and tie this field back into the existing sciences, which is really a good thing."[178]

Tying the field into the existing scientific landscape was here an expected benefit of "getting back to biology". And more than closing in the gap with biology, the "getting back to biology" expressed, in my view, the feeling that Artificial Life could start repaying its debt to biology. I had already got the impression prior to ALIFE X that part of the Artificial Life community may harbour a feeling of indebtedness to biology. An ALifer at my home institution had confided to me that he thought the field was finally 'getting there' with biology, as the developments which it fosters in computer science, like ubiquitous computing, is becoming a useful asset for biologists whose need for increasing computational power cannot be answered anymore by traditional computer models.[179] This feeling of indebtedness to biology was echoed in a comment I

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[176] Fieldnotes, 05/06/2006.
[177] Interview transcript, 05/06/2006; Fieldnotes, 05/06/2006.
[178] Interview transcript, 06/06/2006.
[179] Fieldnotes, 13/02/2006.

got from philosopher of biology Evelyn Fox Keller, that Artificial Life had always had a research programme which was more about how biology could inform computer science than the reverse[180].

Yet some participants of ALIFE X were bitterly pessimistic regarding the future of the relations between Artificial Life and biology, while others were downright wary of a convergence with biology. During the round table discussion closing the conference, the format chosen was to have members of the panel put forward questions for both the panel and the audience to debate. An early question was:

> "We always want to be taken seriously by biologists, and we always seem to fail. Yet even though the field is not getting recognition, its ideas and models are propagating to biology, even though they don't call it Artificial Life. Will Artificial Life get recognition from the biologists in the future?"[181]

I had not encountered before the idea that biology had actually a debt to Artificial Life – that it was drawing upon it without ever acknowledging it. Yet it did not appear to surprise his colleagues – and it is actually quite supported by the figures for the cross-disciplinary penetration of biology by Artificial Life, obtained through the quantitative analysis of the Artificial Life specialist journals, which are presented later in the chapter.

Another panellist then pointed that if Artificial Life wants to be taken seriously by biology it should address questions which are important to biology instead of questions which are important to Artificial Life[182]. To that comment, a well-established female researcher in cognitive development replied first that she thought the kind of

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[180] Fieldnotes, 19/01/2006.
[181] Fieldnotes, 07/06/2006.
[182] Fieldnotes, 07/06/2006.

explanations, models, sets of data, which are relevant to biologists, are not much relevant for Artificial Life; and second, that:

> "The question of the origin of forms is the core question in biology, in physics, in chemistry, and certainly the core question in cognition […] and that is the question that ALife is coming to answer, and it seems to me that the mathematical computational insights into that are just going to be relevant and there's no reason that you have to sort of sell your soul [in order] to be relevant to others"[183].

The response of the conference chair was ambivalent. He expressed doubts as to whether Artificial Life should stick to its historical purpose, the quest for general principles, a question which is of no interest to biologists; or whether it should get away from it and go into specifics. He did not doubt the importance of the quest for general principles, but realised also that to be respected a scientific community needs to deliver some empirical evidence.[184] Here again, scientific respectability explicitly appears as an expected benefit of getting closer to biology.

ECAL 2007 fared better with regard to the attendance of biologists, especially on the occasion of a day-long workshop on "Extending the Darwinian framework". This was certainly due at least in part to the privileged relationship, at the University of Sussex, of COGS and the CCNR, who were organising both the conference and the workshop, with the School of Life Sciences – a privileged relationship dating back to John Maynard Smith. The theoretical biologist and his group of colleagues whom I had lunch with that day all came from Sussex. Nonetheless, mid-way through the conference, there was an end-of-day panel discussion on the theme of bio-complexity

[183] Fieldnotes, 07/06/2006.
[184] Fieldnotes, 07/06/2006.

during which the crossed relationship of Artificial Life with biology took centre stage again.

The dispirited ALifer who introduced the discussion remarked that twenty years ago when Artificial Life was named, it was accompanied by the hope that by thinking out of the box of Earth-bound biology, by challenging its dogmas, new creative insights would be gained which would then return to breathe novelty into biology; what has happened instead is that during these twenty years, there have been enormous changes and exciting discoveries in biology, and that nature has turned out to be far more imaginative than ALifers. After that the discussion mostly ignored the proposed theme of biocomplexity, and revolved entirely around the relationship of Artificial Life to biology, with participants debating once again whether biologists are not interested in Artificial Life because they have no need for it and what should be done to get them interested.[185]

2.3.4 ASPIRING TO SCIENTIFIC RESPECTABILITY

In the context of the dedicated Artificial Life conferences, debates around the sustainability of the field have focused primarily on the sustainability of the field *as a scientific endeavour*; and on its neighbourhood relationships with *scientific* disciplines, to the major exception of philosophy. The analysis of the relationship of Artificial Life to biology, the most discussed of all desirable scientific neighbours in the dedicated conferences context, has brought to light an ongoing desire on the part of Artificial Life to get recognition from biology, which some even see as necessary to the survival of the field. In contrast, I would like examine an example of undesirable neighbourhood relationship, by recounting an incident which happened at ALIFE X.

[185] Fieldnotes, 12/09/2007.

On the second night of ALIFE X a workshop took place, during which a challenge to the Artificial Life community was proposed and discussed. The challenge came from Brig Klyce, founder and sponsor of the Astrobiology Research Trust, accompanied by a $100,000 prize to be awarded to a computer model which would bring an answer to the question “Is Open-Ended Evolutionary Innovation in a Closed System Possible?”. I was unable to attend the workshop, hence my reporting of the evening events is based on secondary evidence – mostly, in-depth discussions with three participants, who independently gave me corroborating accounts. I had been somewhat surprised by the announcement that a challenge sponsored by the Astrobiology Research Trust was going to be launched at ALIFE X. The trust is generally viewed as closely associated with the panspermia hypothesis which, roughly speaking, holds that life on Earth, and maybe on other celestial bodies, originates from ‘seeds’ which are ubiquitous in the universe. This is generally considered to be crackpot science, hence certainly not the kind of research programme which I thought the Artificial Life community would want to be seen consorting with, for fear of compromising its already shaky credibility. And indeed the Evolution Prize challenge triggered hot and loud reactions to what some regarded as the impropriety of associating with the Astrobiology Research Trust. There seemed to be quite radical positions on the subject. Many of the uneasy and antagonistic reactions to the idea of getting involved with the Astrobiology Research Trust apparently came from the worry of being tainted by association with a doubtful pseudo-scientific pursuit suspected by some of having a hidden religious agenda. One participant told me that fears had been expressed of potential damage to the image of Artificial Life and its scientific legitimacy[186]. This was further confirmed

[186] Fieldnotes, 05/06/2006.

by another interviewee, who also reported career-related fears. [187] Two years on at ALIFE XI, I asked around what had become of the Evolution Prize, and it appears to have been all but buried.

I have recounted this incident with the Astrobiology Trust, in order to illustrate what kind of reactions might be expected when an extended hand comes from a discipline or field that many in the Artificial Life community may judge to be an undesirable neighbour. Moreover, the contrast between the fear of being tainted by association and of damaging the scientific reputation of Artificial Life which these reactions betray, and the desire for recognition that the community can manifest towards an established scientific discipline such as biology, confirms that part of the Artificial Life community harbours a strong aspiration to the status of respectable science – to the point that some would apparently be willing to reconsider the historical purpose of Artificial Life.

On the other hand, there is a strong suspicion that biology may be performing the same kind of distancing boundary work[188] towards Artificial Life, whose scientific status is lower than their own, that I have observed Artificial Life performing towards the Astrobiology Research Trust's panspermist research program. The unacknowledged borrowing of ideas and models would be part of it. And I have witnessed first-hand the discursive boundary work that biologists could actively engage into. On the third morning of ALIFE XI, the keynote speaker was North-American Andrew Ellington, introduced by Mark Bedau as "one of the stars of synthetic biology". He started his lecture entitled "Generating the appearance of life" by highlighting that a major problem facing researchers who, like ALifers, tackle the "What is life?" question resides in the

[187] Interview transcript, 05/06/2006.
[188] The concept of 'boundary work' was first proposed by Thomas Gieryn (Gieryn (1983)) as a constructivist mechanism used to distance – to demarcate – science from non-science; my own use of 'boundary work' is a common extension of the concept, which encompasses demarcation between science and non-science as well as demarcation between disciplines or research traditions.

term ‘life’. Discussing different, unsatisfactory, candidate definitions of life, he concluded:

> “There is a more obvious conclusion to be drawn from our failure to define life: there is no such thing as life. Life is a term for poets, not scientists. There are only replicators with different degrees of complexity. PS: many of you are closet vitalists.”[189]

Coming from a synthetic biologist, hence a branch of biology that is among the ‘closest’ to Artificial Life, this statement is a serious attempt at keeping Artificial Life at a distance, by sowing doubts as to its legitimacy as science.

Another instance of discursive boundary work, coming again from a synthetic biologist, was performed by Clyde Hutchinson III of the Venter Institute, during his keynote address at ALIFE X. He took great pain to clarify that ‘synthetic life’ meant two different things for ALifers and for synthetic biologists, and concluded by saying that in contrast to the audience who was doing ‘A-Life’, his object was ‘B-Life’, B standing for biological.[190]

I have brought to the fore that a significant part of the Artificial Life community is longing for scientific respectability, and shown this to be a force at work in the community’s debates on the issue of its institutional positioning. Remaining with the topic of ‘neighbour desirability’, I wish to give more attention to philosophy, this time as the non-scientific exception among the desirable neighbours of Artificial Life. The case of philosophy was for example examined, alongside three scientific disciplines, at the ECAL 2001 workshop reported in “The View From Elsewhere: Perspectives on ALife Modeling”. Historically, the philosophy which has developed in the English and

[189] Fieldnotes, 07/08/2008.
[190] Fieldnotes, 05/06/2006.

North-American analytical tradition has had privileged relationships with science, and the scientific status of a discipline does not get tainted by association with this kind of philosophy. It would even rather benefit from its aura of formal logic rigour. Yet in the case of Artificial Life, the relationship to philosophy, if looked at closely, might not be that helpful to the scientific standing of the field. This is due to the marked contrast between the philosophical traditions on which ALifers are drawing.

Analytical philosophy of science, the first of these traditions, is overwhelmingly prevalent in what I have called the 'Strong Artificial Life legacy' research programme. In that respect, the section treating of philosophy in "The View From Elsewhere" report deserves a few words. The main speaker for philosophy, himself both an academic philosopher in the analytic tradition and a long time ALifer, criticized Sterelny's view that Artificial Life was resuscitating "a quaintly old-fashioned project: defining life", on the grounds that the central concern of Artificial Life "is not to analyze our *concept* of life".[191] For him, "philosophy and Artificial Life are natural partners" but not in the analysis of a historically relative concept.[192] The reflexive analysis of subjectivity, which is nonetheless a topic on which we have seen Artificial Life and philosophy coming strongly together in other currents of Artificial Life, was not mentioned by the main speaker as an area of partnership between the two fields. Instead, he insisted that "[t]he question about life that interests scientists (and philosophers) concerns the natural world, not our concepts."[193] In his realist perspective, the project of Artificial Life is to investigate life as a natural kind. It puts forcefully in mind the modern project of natural philosophy in the Enlightenment, from which science and philosophy had not yet branched out.

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[191] Wheeler et al. (2002 : 88).
[192] Wheeler et al. (2002 : 88).
[193] Wheeler et al. (2002 : 88).

Analytical philosophy of science is equally strong in the rest of Artificial Life, including among the ALifers in the phenomenological approach to cognition, who draw on traditional philosophy of science to address the question of the epistemology of simulations. They are moreover attempting to reconcile analytical and continental philosophy through their phenomenology-inspired theoretical frameworks; for example, the "Phenomenology and Cognitive Sciences" journal is advertised as "an international journal that offers a forum for illuminating the intersections between phenomenology, empirical science, and analytic philosophy of mind".[194] But whereas the connection with analytic philosophy of science would rather bolster the scientific standing of Artificial Life, continental philosophy, the other philosophical tradition upon which Artificial Life is drawing, tends to drag it away from an incontrovertible grounding in philosophy of science – and, in a disciplinary perspective, away from scientific legitimization.

Philosophy is not the only non-scientific potential neighbour of Artificial Life. Contrary to the sustainability of Artificial Life as science, the sustainability of Artificial Life as artistic, entertainment or engineering endeavour, and its relationship with neighbouring disciplines in these areas, have not been open topics of discussion in the main tracks of the dedicated Artificial Life conferences. These thus appear at face value to be neither desirable neighbours nor especially undesirable ones with regard to the future of Artificial Life.

Art is a case in point in this category. I will explain briefly, later in the chapter, why Artificial Life art, a small but thriving niche, is very hard to cleanly demarcate from Artificial Life science – one reason being that it is often practised within the same projects and by the same individuals. And in chapter 5, I will discuss at length the

[194] Journal's description by Springer, http://www.springer.com/philosophy/phenomenology/journal/11097, consulted 24/07/2008.

relationship between art and science in Artificial Life interdisciplinary practices. For now, the focus remains on the disciplinary self-searching of the Artificial Life community, as it is articulated in the context of their dedicated conferences. How is the neighbouring relationship of Artificial Life to art represented in the context of these conferences?

Langton, who was the initiator of the ALIFE conference series, was reportedly extremely attached to the idea that Artificial Life should be broad enough to encompass art events as well as science,[195] and early ALIFE conferences all had exhibits on the side, with ALifers bringing in all sorts of contraptions for the show. This tradition was taken up by some organisers in the ECAL conferences series, replacing the spontaneous displays which characterized the early ALIFE conferences by properly curated art exhibits,[196] or by other artistic events like an Artificial Life music workshop and an evening concert of Artificial Life music at ECAL 2007. Artistic events disappeared for a while from the ALIFE series of conferences, but were reintroduced at ALIFE X, with the Robotic and Emergent Systems Art exhibit (RES-Art) and also the "Robotic and Emergent Systems: Artist Symposium", held one evening after hours and advertised in the program as "a rare opportunity for artists and scientists to engage in a dialog about the interplay of modern science and society"[197]. Yet a general observation regarding the various artistic events held at Artificial Life conferences, is that they have never been integrated into the main body of the conferences. They can even be so poorly advertised, like it was apparently the case at ALIFE X, that a good proportion of the conference attendants are not aware of them[198]. The dedicated Artificial Life conferences are meant to showcase Artificial Life-as-science, and even when they invite

[195] Interview transcript, 05/06/2006.
[196] This was for example the case at ECAL 1997 in Brighton.
[197] ALIFE X Program: 23.
[198] Interview transcript, 05/06/2006.

as many diverse perspectives as possible to join, like at ALIFE XI, they are still meant to be scientific conferences at heart.

This prompts me to observe that the ALifers whose papers I have surveyed, when reflecting on the epistemic status of Artificial Life, usually feel compelled to explicitly restrict the way into which they address Artificial Life: "[…] we are concerned only with artificial life research conducted in a scientific mode, and will have nothing to say about work directed towards other goals, such as engineering or education."[199], or "I will not address A-Life as engineering, entertainment, pedagogy, philosophy of biology, or runaway post-modern cult."[200] It calls forth two remarks. First, this restriction is in agreement with the widespread conviction (especially among scientists, but also I would venture among philosophers of science) that science is the one valid way of producing knowledge; in such a conception of epistemology, whose object is supposedly the nature, sources and limits of all knowledge, knowledge is in actuality equated with knowledge produced through scientific means. Second, having to articulate the restriction explicitly is in itself a sign that Artificial Life is a multi-faceted enterprise of which 'doing science' is only one facet, as the artistic appendages of the Artificial Life conferences indicate.

3. BLAME IT ALL ON COMPUTERIZED SIMULATIONS

The previous section has brought to light the introspective streak of the Artificial Life community – the recurring and consistent self-searching which started soon after the field was officially named and has been going on since then. Its analysis has isolated two broad themes – the epistemic status and the institutional positioning of Artificial Life – and revealed the close interplay existing between them. The present section starts

[199] Di Paolo, Noble & Bullock (2000: 497).
[200] Miller (1995: 2).

from the conclusions of this analysis, subjecting them to a critical examination grounded into selected scholarship from STS at large, with the aim of building and justifying a general frame of interpretation.

Regarding what I have called the epistemic self-searching of the Artificial Life community, we may wonder why ALifers have been devoting so much intellectual energy trying to anchor their scientific project in sound epistemological territory, even if it meant constructing a whole new epistemology in the process. One of my informants, who has been actively involved in Artificial Life for over fifteen years, explained to me that philosophy is essential to Artificial Life because Artificial Life greatly lacks a conceptual basis – a common conceptual core – to build upon; Artificial Life is not a scientific field of cumulative knowledge as far as core concepts go, with ALifers always tending to start back from scratch.[201] This gives a straightforward answer to my question: the effort that the Artificial Life community puts in the construction and strengthening of its epistemological substrate is justified in that it should enable them to solidify a common conceptual basis. Yet I will not stop at this answer and will urge that we now consider what is at the very core of Artificial Life research.

I have demonstrated in the previous chapter that computerized synthetic simulations were a core common cultural denominator of the Artificial Life community as well as a shared core characteristic of their research practices. And in the present chapter, my inquiry into the ongoing self-searching of the Artificial Life community has highlighted two main types of attitude with regard to the epistemic status of Artificial Life research: one settles, and eludes, the issues raised by the use of computerized simulations as epistemic objects, by naturalising them into the realm of life, taken to be a natural kind; the other tackles these issues head-on and actively contributes to the

[201] Fieldnotes, 14/09/2007.

construction of an epistemology of simulations. These two ways of addressing the issues thus raised bring to attention the problematic epistemological status of simulations for Artificial Life as a scientific project. It follows that I can now rephrase my initial question of why ALifers have been devoting so much thinking to the epistemology of their own field, and ask instead, why do computerized simulations fail to constitute an epistemologically sound basis for a common conceptual core in Artificial Life scientific research? This is the question I will address in the first part of this section.

Next, regarding the second major theme of introspection that I have explored, the institutional positioning, and very existence, of Artificial Life, we may wonder why the Artificial Life community experiences such difficulties establishing itself and getting recognition in the institutional landscape. After two decades, one would expect these difficulties to have been somewhat resolved. I have highlighted in the previous section that the Artificial Life community perceives its field as widely interdisciplinary, and that some blame this wide-ranging interdisciplinarity as an obstacle to the institutional settling of Artificial Life and to its acceptance by well-established scientific disciplines. This will lead me to examine, first, if the perceived wide-ranging interdisciplinarity of Artificial Life can be confirmed from the outside, through other sources than the community's own papers and testimonies. And second, once it is confirmed, I will consider whether simulations could play a part there – whether they could be unsettling agents of a broad interdisciplinarity.

Overall, the aim of the present section is to demonstrate that the uncertainties surrounding the epistemic status and the institutional positioning of Artificial Life, which have so far constituted the two major sources of concern behind the ongoing self-searching of the Artificial Life community, and which have not faded as we might have expected them to more than two decades after Artificial Life came into explicit existence, can all be traced down to the intrinsic messiness of computerized simulations, especially of the agency-rich synthetic variety.

3.1 INTO BADLY CHARTED EPISTEMIC TERRITORY

This sub-section attempts to understand why computerized simulations fail to constitute an epistemologically sound basis for scientific research in Artificial Life, or to put it otherwise, why does the epistemological status of simulations remain problematic? Ultimately, the goal is to figure out whether epistemological messiness is innate to computerized simulations.

The most obvious direction in which to look for an answer is towards philosophy of science. Here is not the place to make an extensive critical survey of simulation-related literature in philosophy of science. I have rather concentrated on a small selection of sources which I think are both solid insightful works relevant to my discussion, and broad enough to give a fair idea of identified key issues in relation with simulations. These papers mainly fall in the domain of philosophy of science but are in effect crossing over into history and sociology. My selection is comprised of Peter Galison's "Computer Simulations and the Trading Zone"[202]; three papers from the Summer 1999 issue of the journal <u>Science in Context</u>[203] dedicated to "Modeling and Simulation": "Experimenting on Theories" by Deborah Dowling, "Models, Simulations, and Their Objects", by Sergio Sismondo, and "Sanctioning Models: The Epistemology of Simulation" by Eric Winsberg; two chapters from <u>The Philosophy of Scientific Experimentation</u>, edited by H. Radder: "Models, Simulation, and 'Computer Experiments'" by Evelyn Fox Keller, and "Experiments without Material Intervention"

[202] Galison (1996).
[203] <u>Science in Context</u>, volume 12, issue 2 (1999).

by Mary S. Morgan[204]; and chapter 9 of Fox Keller's Making Sense of Life[205], "Synthetic Biology Redux – Computer Simulation and Artificial Life". An in-depth survey of the selected pieces has revealed a fair degree of consensus on the view that the epistemological status of simulations remains problematic, and has yielded elements of answer as to why.

The most immediate element of answer lies in the fact that, although back in 1990 philosopher of science Fritz Rohrlich was already writing that "computer simulation provides […] a qualitatively new and different methodology for the physical sciences […]. Computer simulation is consequently of considerable philosophical interest,"[206] it is a topic which to this day is still very much understudied in philosophy of science. This state of affairs is clearly reflected in the papers I have selected. Morgan explicitly deplores it[207], as well as Winsberg. Winsberg's verdict is unambiguous: "Although computers have come to play an increasingly large role in scientific research, a detailed study of their significance for the philosophy of science has yet to emerge."[208] One of the aims of Winsberg's paper is actually to find some likely explanation as to why the epistemology of computer simulation has so far attracted little attention from philosophers of science.[209] In the face of such a gross disinterest, he actually goes as far as considering whether simulation do require an epistemology; to which his answer is that "We need an epistemology of simulation because modeling is a set of scientific techniques that produces *results*. When science produces results, we would like to have standards for deciding whether or not these results have some degree of reliability."[210] Winsberg's position echoes the worries about standards of research that we have seen

[204] Fox Keller (2002b); Morgan (2002).
[205] Fox Keller (2002a).
[206] As quoted in Dowling (1999: 262).
[207] Morgan (2002: 217).
[208] Winsberg (1999: 275).
[209] Winsberg (1999: 285-287).
[210] Winsberg (1999: 276).

expressed by the Artificial Life community, and supports the idea that the need for an epistemology of simulation is driven by practice. His analysis leads him to argue that most philosophers of science base their understanding of simulation modelling on erroneous assumptions and have thus not been concerned with the key epistemological issues raised by the use of simulation;[211] he proposes that:

> "It is precisely on this point that an epistemology of simulation modeling must focus: What *are* the factors that contribute to the notion that a computational model constructed on a set of approximations and idealizations is valid?"[212]

Although the kind of computer simulations on which the remainder of his paper then concentrates is different from that generally used in Artificial Life research, the question Winsberg formulates is a general one for simulation modelling, and his analysis indirectly endorses the opinion I expressed earlier, that the paper "Simulation Models as Opaque Thought Experiment" is an original contribution to the budding epistemology of simulation, since it is precisely on the factors contributing to the quality and reliability of a simulation model that Di Paolo & al. have chosen to focus:

> "Because simulations are complex, their internal workings are opaque: it is not immediately obvious what is going on or why. This opacity means that researchers must spend some time developing and testing a theory of the simulation's operation, before relating this internal theory back to theory about the world, and, ultimately, to the world itself through empirical investigation. Links in this chain are often missing in current artificial life research."[213]

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[211] Winsberg (1999: 286).
[212] Winsberg (1999: 287).
[213] Di Paolo, Noble & Bullock (2000: 497).

To the lack of involvement of philosophers of science on the topic of simulation modelling, some ALifers respond by taking the matter of the epistemology of simulation into their own hands.

The fact that simulation is an understudied topic in philosophy of science is certainly a good reason for its epistemology to remain problematic, but it reveals a shortcoming of philosophy of science rather than a distinctive trait of simulations. More to the point, a second element of answer, which transpires from all the selected pieces, is that simulation modelling in contemporary scientific research is a complex and messy issue – and this may in turn be a good reason for computer simulation to be understudied by philosophers of science. To start with, the term 'simulation' clearly needs some serious qualifying. Even in the limited set of pieces that I have selected, and despite the common specific context into which they consider simulations – that is, their use in contemporary scientific research – the term stands for different uses and different forms of realisations. This means that careful attention must be paid to the conditions under which conclusions reached on the topic of simulation modelling may be generalised. Morgan, for example, does not restrict the understanding of the term simulation to that of computer simulations but groups under it "the various kinds of nonmaterial experiments that have now invaded scientific investigations in many fields",[214] and attempts to take a global perspective on the phenomenon. Winsberg, for his part, assumes that simulation implies the use of computers, and specifies that his paper addresses "the scientific practice of computer simulation in the study of complex physical systems".[215] Similarly, Fox Keller restricts her discussion in "Models, Simulation, and 'Computer Experiments'" to "what has come to be known as 'computer

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[214] Morgan (2002: 217).
[215] Winsberg (1999: 275).

simulation'", because, as she rightly points, "it was the introduction of the digital computer that provided the major impetus for the adoption of simulation techniques in scientific research"; she focuses "primarily on the physical sciences"[216] and refers readers to chapters 8 and 9 of her book Making Sense of Life for a discussion of the use of computer simulation in the biological sciences. Galison concentrates on a narrower range of computer simulations, that of event generators known as 'Monte Carlo', and is interested in their interdisciplinary use in a well-specified historical context.

Faced with the diverse and complex jungle of activities which fall under the heading of simulation modelling in contemporary scientific research, two of the authors have reacted in much the same way that 18th-century natural philosophers reacted when confronted to the overwhelming diversity of nature revealed by the great voyages of discovery. Fox Keller (the only one to express real concern for the promiscuous use of the term 'simulation'[217]) and Morgan both attempt to devise a classification of simulation models. Morgan categorises these "non-material experiments", as she qualifies them, according to their level of material / non-material hybridism. Her view that simulations can be material / non-material hybrids is much in agreement with my own understanding of simulation, and condones my choice of 'computerized simulations' to encompass fully virtual simulations as well as material / non-material hybrids under a single denomination. Fox Keller's proposed taxonomy, which I have already briefly presented, springs from the diagnostic that "the term 'computer simulation' covers so complex a range of activities that some sort of taxonomy would seem to be in order".[218]

Fox Keller first tentatively considers a division along disciplinary lines, but quickly dismisses it on the grounds that "proceeding with a canonical evolutionary tree

[216] Fox Keller (2002b: 199).
[217] Fox Keller (2002b: 198).
[218] Fox Keller (2002b: 199).

will clearly not serve, for such a structure misses the cross-structures needed for and resulting from ongoing hybridization."[219] Later in the chapter, I will return to the topic of interdisciplinary hybridization, to discuss how simulations might be a facilitating agent of the phenomenon; but let us note already that Fox Keller recognizes, beside the established disciplinary lines defined by "differences in aims, interests, and tradition", the existence of an "extensive cross-disciplinary traffic of technical innovations that has been so much part of this history."[220] Fox Keller's writings themselves give a glaring testimony of this hybridization, one which is moreover especially relevant to my subject matter. In the paper "Models, Simulation, and 'Computer Experiments'", whose focus is on the physical sciences, she examines the case of Cellular Automata modelling in Artificial Life as the paradigmatic example of a certain class of simulations; while in the second of the chapters to which Fox Keller refers readers for a discussion of computer simulation in the biological sciences,[221] she explores in more depth exactly the same case, hence placing Artificial Life somewhere at the intersection of the physical and biological sciences.

Pursuing her search for classification criteria, Fox Keller then turns to the question of epistemic novelty. She makes the point that "what we have now come to see as the epistemological novelty of computer simulation in fact emerged only gradually", from our exploitation of these techniques and from our growing reliance on their use.[222] In this gradual emergence of epistemic novelty, born from practice, she distinguishes "a number of several more-or-less distinct stages (or branches), each bearing its own marks of epistemological novelty and its own disturbances to traditional notions of 'theory',

[219] Fox Keller (2002b: 199).
[220] Fox Keller (2002b: 199).
[221] Fox Keller (2002a), chapters 8 and 9.
[222] Fox Keller (2002b: 201).

‘experiment’, and ‘data’.”[223] She provisionally suggests three stages, which become the three classes of her proposed taxonomy for computer simulation in the physical sciences:

> “(1) the use of the computer to extract solutions from prespecified but mathematically intractable sets of equations by means of either conventional or novel methods of numerical analysis; (2) the use of the computer to follow the dynamics of systems of idealized particles […] in order to identify the salient features required for physically realistic approximations (or models); (3) the construction of models (theoretical and/or ‘practical’) of phenomena for which no general theory exists and for which only rudimentary indications of the underlying dynamics of interaction are available.”[224]

The case of Cellular Automata modelling in Artificial Life is the one with which she exemplifies ‘third stage’ simulations.

Although Fox Keller analyses the appearance of these three stages as progressive, it must be understood that each new stage does not supersede the former one, but that it co-exists alongside those already in existence, which adds to the complexity and the diversity of the simulation landscape. Moreover, if we follow Fox Keller, there is no reason to believe that the gradual emergence of epistemic novelty has stopped with the appearance of ‘third stage’ simulations, so that we might expect further stages to emerge and enrich the realm of simulations with new classes.

Morgan’s and Fox Keller’s attempts at classifying simulation models draw attention to the complex diversity existing in the realm of simulation and underscore the idea that this diversity should be fully appreciated and inventoried as a necessary first

[223] Fox Keller (2002b: 202).
[224] Fox Keller (2002b: 202).

step in the construction of a sound epistemology of simulation. Fox Keller's categorisation in particular, which discriminates between simulations according to their level of grounding in theoretical structures, reveals that different kinds of epistemic novelty are to be expected from different classes of simulations, so that we might eventually require more than one epistemology of simulation. Also, by highlighting that the epistemic novelty of computer simulations may not be found in the immediate novelty of the techniques but as gradually emerging from their use and from reliance on their use, she points STS scholars, often keener on the study of innovation than that of use, towards a less travelled path.

For the various authors under review, Morgan excepted, simulations are virtual realisations. As I have explained earlier, in the course of my study of Artificial Life I have found that Artificial Life synthetic systems, whether 'soft', 'hard' or 'wet', were overwhelmingly computerized, i.e. that their design involved the use of computer simulations, and I have grouped them under the umbrella name 'computerized simulations'. In support of this choice over that limiting simulations to computer simulations proper, I would point that the seemingly well circumscribed (although very diverse) general category of 'computer simulation' is becoming increasingly problematic, as the current evolution of computing towards ubiquitous computing and biologically-inspired hardware ('wet' computing, self-healing hardware, etc) compromises the currently accepted conception of computers as well-identified silicon-based devices sitting on desks or in refrigerated rooms, and threatens to re-define the 'computer' category itself.[225] Tim Lenoir defends the same view in "All but War is Simulation: The Military-Entertainment Complex" (2000).[226] Moreover, while the category 'computerized simulation' broadens that of 'computer simulation' to

[225] Not for the first time in history; prior to WWII, computers were human calculators.
[226] Lenoir (2000: 291).

encompass partly material hybrids, I have argued in chapter 2 that it was possible to narrow down what goes under this label in Artificial Life. Although Fox Keller restricts her taxonomy to fully virtual computer simulations, I have categorized Artificial Life computerized synthetic systems as third stage simulations. Actually, in a more recent essay than the ones surveyed here, where she discusses specifically robotic simulations of human development in Artificial Life, Fox Keller herself recognises the strong parallel between these other materially embodied forms of simulations and 'third stage' computer simulations.[227]

Fox Keller's classification brings some useful light to the analysis of the simulation-related pieces I have selected, in that it helps evaluating their relevance to the specific kind of simulations I am concerned with. For example, Galison's 'Monte Carlo' event generators can now be identified as belonging to the first stage of computer simulation. The simulations discussed by Winsberg do not in fact cover the full spectrum of computer simulations which can be met with in the science of complex physical systems; he only examines those which "transform [existing] theoretical structures into specific concrete knowledge of physical systems."[228] – hence leaving out 'third stage' simulations. On the whole, although there are elements in all the pieces I have reviewed which are directly applicable or transposable to the case of Artificial Life simulations, none save Fox Keller's are actually discussing 'third stage' simulations. It thus appears that Artificial Life simulations may in fact belong to a type of simulation whose epistemic specificities have so far been almost entirely ignored, and which consequently has been especially neglected in the already understudied philosophy of simulation modelling. This in itself can only contribute to the lasting uncertainties surrounding the epistemic status of Artificial Life research.

[227] Fox Keller (2007: 342).
[228] Winsberg (1999: 275).

Coming back to the general question of why the epistemological status of simulations remains problematic, I would like to return to the second element of answer I have given, and dig further into what makes simulation modelling in contemporary scientific research appear as a complex and messy issue.

There is a general consensus in the literature I have selected on the difficulty to position simulations in the established categories used by philosophers of science. I have already quoted the passage where Fox Keller argues that the epistemological novelty of each of the stages she has recognised in the development of computer simulation brings "its own disturbances to traditional notions of 'theory', 'experiment', and 'data'."[229] In particular with 'third stage' simulations, "it is both the meaning and the goals of explanation that come in for transformation".[230] Sismondo expresses the view that models and simulations are boundary-crossers hovering between categories:

> "Scientific models and simulations are given the status of tools, as well as representations; they are objects, as well as ideas. They easily cross categories, such as 'theory' and 'experiment', the bounds of which are otherwise well-established." [231]

Galison, in his inquiry into the use of the 'Monte Carlo' method in the US during the late and post WWII period, explains how quite soon "debate grew about who might count as an experimenter or as a theoretician, and what would count as an experiment or theory."[232] Of course such a debate should not be reduced to its epistemological content; the epistemic and disciplinary threads are again strongly intertwined, as there are clear incentives related to both individual and disciplinary status in being categorised either

[229] Fox Keller (2002b: 202).
[230] Fox Keller (2002b: 202).
[231] Sismondo (1999: 247).
[232] Galison (1996: 137).

as experimenter or theoretician. Yet taken purely from the perspective of philosophy of science, Galison's examination reveals the blurring between the 'experiment' and 'theory' categories which arose from the sustained practice of 'Monte Carlo' simulations. The blurring between the 'theory' and 'experiment' categories is also central to Dowling's argument. Her paper, based on interviews with scientists from a wide range of fields, all of whom use computer simulation in their research,[233] focuses on trying to understand "how the scientific community constructs computer simulation as an epistemically and pragmatically useful methodology",[234] and in so doing, she shows how at multiple levels "[s]imulation is constructed as both 'theoretical' and 'experimental'."[235]

The difficulty to position simulation models within the established categories of philosophy of science clearly contributes to their problematic epistemic status. Yet we may also wonder whether this ambiguous situation does not serve other purposes, and whether it is actually meant to be resolved. There are elements in the pieces I have reviewed, which go exactly in this direction. In conclusion to her paper, Dowling introduces the idea that the resistance to categorization displayed by computer simulations may be not just a source of epistemic fuzziness but also a valuable asset when well managed:

> "The usefulness of computer simulation thus depends on the construction and maintenance of this methodological ambiguity. In their everyday interactions with the computer, and in their choice of language in varied narrative contexts, scientists strategically manage simulation's flexible position with respect to 'theory' and 'experiment'. In this way they facilitate

[233] Dowling (1999: 262).
[234] Dowling (1999: 261).
[235] Dowling (1999: 263-264).

> a significantly novel, and highly productive, mode of scientific work: creative experimentation with a mathematical model."[236]

But it is Sismondo who expresses the most daring view. He writes that models and simulations

> "are a diverse lot, and are made to do a diverse number of things. But they are necessarily so, being made to stand between worlds, and pushed one way and another. Therefore we should resist the urge to do much epistemic neatening of this messy category of models and simulations."[237]

What Sismondo recognizes here, is that the most salient characteristic of simulations, a source of both epistemic complication and valuable versatility, may be their fundamental ability to cross boundaries – their innate messiness.

I started with the question of why the epistemological status of simulations remains problematic. My survey of selected pieces in the philosophy of simulation has revealed that simulation modelling in contemporary science is both an understudied and thorny issue for philosophy of science. Two points stand out: the sprawling diversity found under the single label of simulation, and the difficulty to position simulation within the existing categories of philosophy of science. If we follow Fox Keller, sprawling diversity is a factor of epistemic messiness which is to some extent innate to computer simulation, since through ongoing use, new classes of simulation appear alongside those already in existence, each bringing its lot of epistemic novelty. The difficulty to precisely situate simulations with regard to the existing epistemological categories of philosophy of science is also a factor of epistemic messiness, and

[236] Dowling (1999: 271).
[237] Sismondo (1999: 258).

according to the view put forward by Sismondo it is a problem which cannot (and should not) be remedied, hence just as innate to simulations as their sprawling diversity.

Taking in both these factors, it is not surprising anymore that the epistemological status of simulations should remain problematic. Likewise, even though Artificial Life simulations in their scientific use can be circumscribed within the ‘third stage’ class defined by Fox Keller, the lasting uncertainties around the epistemic status of Artificial Life research are unlikely to dissipate. My initial aim was to figure out whether epistemological messiness would be innate to simulation, and I will conclude that this is so. In the next sub-section, I will assess the interdisciplinary character of Artificial Life, and go on to consider whether the innate messiness of computerized simulations may play on more levels than the epistemic one, and more precisely, whether it might promote interdisciplinarity.

3.2 INTERDISCIPLINARITY

3.2.1 HOW INTERDISCIPLINARY ARTIFICIAL LIFE REALLY IS?

I will start by assessing on the quantitative mode how interdisciplinary Artificial Life actually is, notwithstanding its practitioners’ views on the matter. I have chosen as quantitative marker of Artificial Life interdisciplinarity, the cross-disciplinary diffusion of their research, evaluated through the cross-disciplinary diffusion of their specialist journals Artificial Life and Adaptive Behavior. I have performed a sample analysis, by subject areas, of the articles referencing research published in these two periodicals, for the years 1995 and 2000. The choice of 1995 and 2000 has been arbitrary only in part, as I have been careful to select years which allowed for the published work to have had time to diffuse, and I have chosen a gap of five years between the two in order to get a picture, however rough, of a possible evolution. The results are presented in figure 3.

Although they can only provide a crude picture, there are a few noteworthy points to be made.

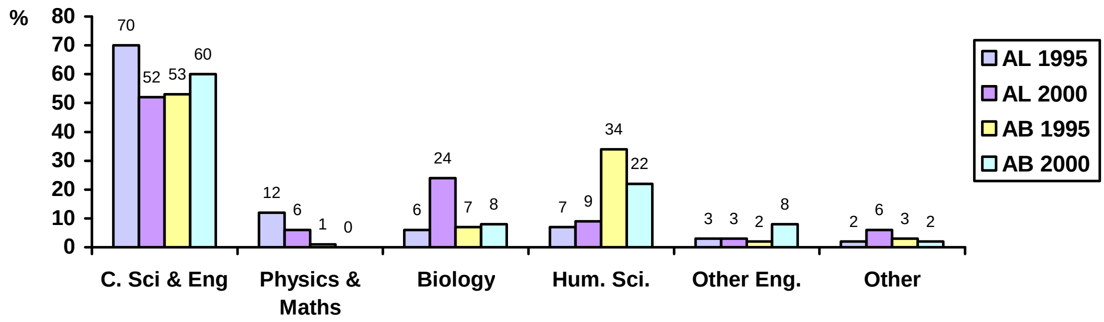

Figure 3: % of citing articles by subject area for Artificial Life and Adaptive Behavior, in 1995 and 2000

For the issues of the journals Artificial Life and Adaptive Behavior covering the years 1995 and 2000, the chart diagram shows the citing articles proportionally split into six broad categories of subject areas (a citing article can have more than one subject area); the categories retained are: Computer Science & Engineering, Physics and Mathematics, Biology, Human Sciences (to which category the main contributors are: behavioural sciences, language and linguistics, medicine, neurosciences, psychology (esp. experimental), social sciences (esp. interdisciplinary)), Other Engineering, and Other, which groups Arts, Humanities, and Multidisciplinary Sciences (Source: Web of Science, Cited Reference Search);

In the chart above, citing articles with a subject area in the computer science and engineering category account for between 50% and 70% of the total. This is a rather low ratio considering that Artificial Life affiliates predominantly under the broad umbrella of computer science and engineering, and a clear sign that Artificial Life draws interest from the outside. Looking at the Biology category, one finds that in the case of Adaptive Behavior, the proportion of citing articles with a subject area in this category does not change much between 1995 and 2000, hovering around 8%; in contrast, Artificial Life shows a massive increase in his penetration of the domain of biological periodicals, from 6% in 1995 to 24% in 2000 of citing articles having a biology-related subject area. The Human Sciences category regroups a long list of subject areas, but the main contributors are behavioural sciences, language and linguistics, medicine, neurosciences, psychology (especially experimental psychology), and social sciences (especially interdisciplinary social sciences). In this category, the ratios for Artificial Life are rather low and do not vary much between 1995 and 2000, with 7% and 9% respectively. But Adaptive Behavior, despite a decrease from an impressive 34% in 1995, still has a proportion of 22% of citing articles with a subject area falling in the category of Human Sciences for its 2000 issues.

Yet I will venture that these figures may be deceptive and that they hardly speak for themselves. To show just how important the figures for the Biology and Human Sciences categories are in effect, I will put them in parallel with the figures for the subject area of art. The figures for art have been merged into the category Other as they were too insignificant to stand on their own. The highest ratio for the entire category is for the 2000 issues of Artificial Life and amounts to a mere 6%, of which citing articles in the domain of art are only a small part (2 out of 18 occurrences of the subject areas grouped into the category Other). So at face value, it seems that Artificial Life has not diffused much into art. This is where the kind of quantitative analysis I have just performed shows its limits and must be complemented by other, more qualitative, forms of inquiry.

In reality, it is not simply that there is a diffusion of Artificial Life into art, but there actually exist a field called Artificial Life art, and another Artificial Life music, which between themselves straddle new media art, cybernetic art, conceptual art and music – as well as animation, entertainment, design and video games. For the sake of convenience and because many realisations overlap music and the visual arts, from now on, whenever I speak of Artificial Life art without further specification, it will encompass music as well.

Although Artificial Life art is certainly a narrow niche, it is quite healthy and goes back at least as far back as the scientific project of Artificial Life itself. I will not explore Artificial Life art further just now, but will limit myself to a few observations. There may not be many articles of which art is a subject area, and which are citing papers from the 1995 and 2000 issues of Artificial Life and Adaptive Behavior. Yet Leonardo, the scholarly journal of the International Society for the Arts, Sciences and Technology – which has been since 1968 a prominent international forum for professional artists with a scientific and technological bent, and eventually for scientists with an artistic bent – has devoted an entire series of articles to A-Life art spanning over six consecutive quarterly issues between 2001 and 2003. This major coordinated initiative comes on top of individual papers published now and then by Leonardo in the area of Artificial Life art. There has also been a number of scholarly books and edited volumes published in recent years, which address the subject from different perspectives, like Art in the Age of Technoscience: Genetic Engineering, Robotics, and Artificial Life in Contemporary Art, 2008, by art historian Ingeborg Reichle; Metacreation: Art and Artificial Life, 2004, by critical art theorist Mitchell Whitelaw; Evolutionary Computer Music, 2007, edited by Professor in Computer Music Eduardo Reck Miranda.

Incidentally, the latter organised a full-day workshop entitled ‘Music and Artificial Life’ as well as a MusicAL concert in the context of ECAL 2007. Here we brush upon another characteristic of the relationship between art and science in Artificial Life, to which I will return later on. Just as the same authors publish both in scientific and artistic outlets, Artificial Life conferences often accommodate artistic events beside their main scientific tracks, although as I have mentioned earlier artistic events are usually kept on the side. Some of these events are both artistic and scientific at the same time, as was the case with Miranda’s ‘Music and Artificial Life’ workshop at ECAL 2007. I sat on it throughout the morning sessions, and found that some papers presented scientific-looking results in a scientific format, while others attached to the artistic side of the research and adopted an arts-and-humanities presentation style – a confusion of the genres which was not necessarily to the taste of some of the more scientific participants. One complained to me that as the day wore on, the workshop had become increasingly arty, to the point that science had entirely disappeared.[238]

On the basis of the results for the categories of Computer Sciences and Engineering, Biology and Human Sciences as they appear in figure 3, complemented by the qualitative material brought in for the domain of art, my analysis leads me to conclude that Artificial Life presents the hallmarks of a highly interdisciplinary project.

There is another important point which I think is borne out by the results presented in figure 3. Many ALifers come originally from mathematics and theoretical physics, and this is more especially the case among the older Alifers. Typically, the older ALifers are those who, having been in the field for long, have published a lot. Yet the proportion of citing articles that cover physics- and maths-related subject areas is very low, and gets lower from 1995 to 2000. We might have expected to find a stronger crossover with physics and mathematics through the mediation of complexity sciences, all the more since a major historical cradle of Artificial Life was the Santa Fe Institute (SFI), interdisciplinary research centre dedicated to the complexity sciences founded in 1984. But based on the quantitative data at hand, there seems to be little trafficking going on here and there is nothing significant in the material accumulated throughout my project to contradict this view. Researchers who have migrated from these disciplines to Artificial Life appear to have severed former disciplinary ties.

It may also be the case that Artificial Life research is snubbed by these disciplines. This would be congruent with the fate Artificial Life seems to have met

[238] Fieldnotes, 11/09/2007.

with at SFI, which apparently has very much pulled out from the field since around 2000. I have been given differing interpretations as to why. In one version, the conjunction of funding difficulties in the late 1990s and the appointment of a new managerial head in charge of re-organising and rationalising the research being conducted at SFI, has resulted in Artificial Life being kicked out of the institute for being too borderline and unscientifically woolly, and thus unattractive to sponsors.[239] In another version, a clash of personalities and sordid rivalry politics between competing research programmes leaders ended up with Artificial Life on the losing side, and with the leader and founder of the Artificial Life research programme at SFI quitting both SFI and Artificial Life academic life.[240] These two versions of the tale are not mutually exclusive. They may just be telling the same story from different perspectives. The fact that by 2000 Artificial Life had ceased to be well-accepted at SFI, is corroborated by a source outside the community, under the form of a paper published by Helmreich in 2001 in Cultural Anthropology under the title "After Culture: Reflections on the Apparition of Anthropology in Artificial Life, a Science of Simulation". Discussing the high level of reflexivity he had met with during his anthropological work on Artificial Life at SFI in the mid-1990s, he observed:

> "But such reflexivity has not come without a price for Artificial Life scientists, who, in their attempts at self-analysis, have been seen by colleagues in the sciences of complexity as sabotaging their own project. When I returned to the Santa Fe Institute (SFI) in 1999 to give a lecture introducing my then newly published book, I found many previously sceptical researchers suddenly sympathetic to my analyses of the cultural valences of Artificial Life. But where some felt that an anthropological

[239] Fieldnotes, 29/11/2006, 31/05/2007.
[240] Fieldnotes, 31/05/2007, 08/07/2007.

> account had enriched their understanding of science as practice, others used my story to support their sense that Artificial Life had been contaminated by ‘culture’ in a way their own fields – computational mechanics, for example – had not. It seemed to me that the science wars had folded back into the sciences of complexity themselves, with Artificial Life researchers now designated as suspiciously relativist in their constructions of the categories of both ‘life’ and ‘science’.”[241]

Helmreich’s observations shed some new light on the longing for scientific respectability sometimes expressed by the Artificial Life community. They also tie up with my own analysis of the interdisciplinary character of Artificial Life, revealing an interdisciplinarity that presents the particularity of extending rather towards the soft sciences, arts and humanities, than towards the hard sciences – to the exception of biology and computer science, hardly considered to be the purest of sciences.

Before turning to my next question, as to whether computerized simulations could be a source of interdisciplinarity, I wish to touch upon a crucial issue for the institutional positioning of Artificial Life and for its interdisciplinary character, without which my analysis will be somewhat incomplete: the issue of funding. This particular issue is important in that it may be a cause of discrepancy between the ‘measurable’ and the actual level of interdisciplinarity in Artificial Life, with the latter higher than the former. Also, it may have consequences for the sustainability of the field, as well as for the geographical localisation of Artificial Life research centres and the disparities observed in their interdisciplinary practices. The issue of funding is clearly not broached in the conference literature I have examined, but people talked to me quite freely about

[241] Helmreich (2001: 622).

it during my fieldwork, even though they themselves seldom linked it explicitly with their debates on institutional positioning.

The difficulty of funding research projects is certainly not specific to Artificial Life, and is shared widely across the whole spectrum of academic disciplines so that my interlocutors did not find my questions on that topic intrusive or irrelevant. They had no qualms talking of their problems, as it made no doubt for them that my own field of STS, highly interdisciplinary as well and possibly as loosely defined as their own, could not be much better off in the funding department than Artificial Life.

The testimonies I have collected point that the funding aspect of things has been having an ongoing, strong impact on the development of Artificial Life, at several levels. First, the funding imperative possibly acts as a smoke screen dissimulating the actual degree of interdisciplinarity in Artificial Life. The difficulty of getting funding for projects crossing over art and science drives researchers to package such projects as purely scientific, in order to obtain sponsorship from scientific funding bodies.[242] Even though the situation in the United Kingdom is more favourable in that respect, some British researchers have confirmed the existence of such a 'cross dressing' strategy; as a seasoned British ALifer told me, he was not sure what Artificial Life was but it was certainly not science, except for funding purposes.[243] This particular consequence of the funding imperative indicates that the level of interdisciplinarity publicly displayed by Artificial Life may be lower than it is in actuality.

Second, by leading to the cross-dressing of research projects, the funding imperative may impact the development of Artificial Life at another level far more critical for the sustainability of the field: it could be a hindrance to the establishment of clear research evaluation criteria and to the improvement of the standards of Artificial

[242] Fieldnotes, 12/09/2007.
[243] Fieldnotes, 07/06/2007.

Life research. According to two researchers involved in art-science projects, when such projects are packaged as purely scientific for funding purposes, the works of art subsequently produced are hence not required to be evaluated on artistic grounds, while they are near impossible to evaluate on scientific grounds. Moreover, the necessity to publish on the scientific conclusions of the projects gives rise to scientifically dodgy research papers. This, in turn, affects the credibility of the field and its capacity to attract more funding.[244]

The issue of the professionally precarious situation of Artificial Life in academic institutions is a matter of concern for the community. It was raised as a problem to be addressed during a panel discussion at ECAL 2007. A panel member pointed that Artificial Life doctors and post-docs do not get jobs in Artificial Life, and that many ALifers do Artificial Life as a personal pursuit while having an unrelated day job inside or even outside academia.[245] This was typically the case of one of my interviewees, who has been in the field since the early 1990s; he explained to me that he made his money outside university, as a freelance programmer doing mostly database work in which his Artificial Life skills were useless; his part-time research fellowship in Artificial Life was no money making pursuit but "kind of a hobby"[246]. The hindrance to the improvement of standards in Artificial Life research that may result from the funding imperative, can only contribute to the shaky institutional status of Artificial Life.

Finally, at the geographical level, there are strong disparities in the availability of funding in general, and of funding for interdisciplinary projects in particular. For example, there is a consensus that Artificial Life in the United States has very nearly vanished because it is so hard to get funding over there, especially since the disengagement of SFI. On the other hand, UK-based researchers are confronted like

[244] Fieldnotes, 12/09/2007.
[245] Fieldnotes, 12/09/2007.
[246] Fieldnotes, 23/07/2007.

everyone else to difficulties in finding sources of sponsorship, yet they are clearly thought to be quite favoured by their colleagues outside the UK. The latter are envious of the kind of money that the former can obtain from British research councils for interdisciplinary research.[247] I have even heard occasionally some British researchers acknowledge their relatively privileged situation, like congratulating themselves that their own post-docs do find jobs in Artificial Life;[248] or for example when the British ALifer who had told me that Artificial Life was not a science except for funding purposes, corrected his answer by saying that in the UK it was possible to get sponsored by other sources than just the scientific funding bodies.[249]

Going back to the institutional self-searching of the Artificial Life community, the funding imperative is certainly among the forces driving part of the community to strive for scientific respectability, as respectability may be the route leading to economic sustainability. It also helps make better sense of why some members of the community would be willing to meddle with the Astrobiology Research Trust despite its doubtful scientific reputation. The Astrobiology Research Trust was bringing in an attractive funding opportunity, and as a practically-minded ALifer told me, "Money is money. […] And money has a certain anonymity when it comes to intellectual ties […]".[250]

3.2.2 AGENTS OF INTERDISCIPLINARITY

The previous sub-section has shown that Artificial Life was crisscrossing a wide variety of disciplines, resulting in a high level of interdisciplinarity. My next aim is to demonstrate (1) that the agency-rich, computerized synthetic systems favoured by

[247] Fieldnotes, 24/05/2007, 08/07/2007, 14/09/2007.
[248] Fieldnotes, 13/09/2007.
[249] Fieldnotes, 07/06/2007.
[250] Interview transcript, 05/06/2006.

Artificial Life research, and more precisely the computer simulations that they involve, are agents of extended interdisciplinarity; (2) that their capacity to promote interdisciplinarity can be traced down to their innately messy character, which plays at more levels than the epistemological one highlighted earlier.

We have already met with a first hint that computer simulations could be a factor of interdisciplinarity. In “Models, Simulation, and ‘Computer Experiments’”, Fox Keller dismissed disciplinary boundaries as discriminating factor for her taxonomy of computer simulations, on the grounds that the resulting tree structures would miss “the cross-structures needed for and resulting from ongoing hybridization”,[251] and she analyzed this hybridization as resulting from “the extensive cross-disciplinary traffic of technical innovations that has been so much part of this history [of computer simulation].”[252] This extract shows her awareness that the relatively short history of computer simulation is one of extensive boundary-crossing facilitating disciplinary hybridization.

It was a case study of interdisciplinary hybridization resulting from the use of computer simulations, which was the focus of Galison’s 1996 paper, “Computer Simulations and the Trading Zone”. The aim of Galison’s paper was to show that in “what appears at first to be a chaotic assemblage of disciplines and activities”, computer simulations constituted “a new cluster of skills [that they held] in common, a new mode of producing scientific knowledge that was rich enough to coordinate highly diverse subject matter.”[253] His study led him to coin the term ‘trading zone’: “[…] these simulations constituted what I have been calling a ‘trading zone,’ an arena in which radically different activities could be *locally*, but not globally, coordinated.”[254] Through

[251] Fox Keller (2002b: 199).
[252] Fox Keller (2002b: 199).
[253] Galison (1996 : 119).
[254] Galison, (1996 : 119).

the computer simulations constituting Galison's 'trading zone', "discrete scientific fields were linked by strategies of practice that had previously been separated by object of inquiry."[255]

I would like to comment further on Galison's paper. We have just seen that Galison defends the idea that computer simulations are the agents through which previously unrelated research fields could become locally bridged. But although he thus isolates computer simulations as a definite source of interdisciplinarity, it is a case of interdisciplinarity between research fields belonging strictly to the sciences. He does not deny that computer simulations could enable a wider kind of interdisciplinarity, it is simply not part of the scope of his paper to look beyond the realm of science, as the overall conclusion towards which his development aims is a methodological argument targeted at a restricted STS-related audience.[256] And yet, one finds in Galison's paper a thread which, if followed, might have broadened the interdisciplinary perspective of his case study to encompass extra-scientific fields. Commenting on the way in which the Monte Carlo method spread outside the realm of military secrecy in the 1950s, he writes that:

> "[…] it was a fascination so intense that it sparked warnings about overenthusiasm. Fiction writers have recognized (more clearly than philosophers or historians) the powerful and problematic temptations of this artificial reality. […] The seductiveness of cyberspace as an alternative to coping with the harsh edges of the everyday life is, and was, apparent to those who work with simulations. […] The alternative world of simulation, even in its earlier days, held enough structure on its own to captivate its

[255] Galison (1996 157).
[256] Galison (1996 : 157).

> practitioners. And in their fascination they learned a new way of work and a new set of skills which marked them for a long time to come."[257]

This passage reveals that right from the beginning, on top of being boundary-crossers between scientific disciplines, computer simulations also had the potential to cross the boundaries between Real Life and alternate imaginary worlds, enabling their practitioners themselves to crossover and blur the lines separating scientific research, where simulations were experimental tools used in the pursuit of scientific goals, from more artistic and playful endeavours, where the simulated worlds became goals in their own right. In so doing, as Galison rightfully points, computer simulations also became an object of literary inquiry. Further, the passage reveals that computer simulations were not passive tools in the hands of their practitioners but manifested their agency in the fascination they exercised on them. They captured practitioners into a spiral where skills, usage and the very nature of the computer simulations (remember Fox-Keller's three stages) co-evolved.

Although Galison is right that historians and philosophers have on the whole not clearly recognized "the powerful and problematic temptations of this artificial reality",[258] a few STS-related scholars who have researched the topic of computer simulation have nonetheless quite clearly identified its extra-scientific seductiveness and its boundary-crossing abilities. I will pass on those who have researched Artificial Life specifically, as I am rather interested in studies that will broaden the empirical basis of my findings to other fields of research than Artificial Life; I will just point that Fox Keller, Hayles, Helmreich, Kember, Risan or Whitelaw have all written on some aspect or another of the seductive power exercised by Artificial Life's simulacra of

[257] Galison (1996 : 153-154).
[258] Galison (1996: 153).

reality and its consequences.[259] I have chosen instead to examine a selection of exemplary pieces which subject matter falls outside Artificial Life, by Paul Edwards, Tim Lenoir and Sharon Ghamari-Tabrizi.

In The Closed World: Computers and the Politics of Discourse in Cold War America (1996), Paul Edwards analyzes the emergence of a specific worldview (which he labels the 'Closed World' view) from the coming together of system modelling techniques, of information technologies (especially the computer), of practices of systems simulations, of experiences of grand-scale politics "as rule-governed and manipulable"[260], of fictions, fantasies and ideologies, and of a language "of systems, gaming, and abstract communication and information".[261] Recognizing the special appeal of computer simulations, he comes close to Galison when he writes that "What gives the computer this 'holding power', and what makes it unique among formal systems, are the simulated worlds within the machine."[262] But he goes further and tries to find some explanation to their 'holding power':

> "Every microworld has a unique ontological and epistemological structure, simpler than those of the world it represents. Computer [simulation] programs are thus intellectually useful and emotionally appealing for the same reason: they create worlds without irrelevant or unwanted complexity."[263]

He thus situates the seductive appeal of computer simulation at both the intellectual and the emotional levels, hereby acknowledging the ability of computer simulations to bridge the realms of rationality and of imagination. He eventually concludes that the

[259] Fox Keller (2002a), Fox Keller (2007), Hayles (1999), Hayles (2005a), Hayles (2005b), Helmreich (1998), Risan (1997a), Whitelaw (2004).
[260] Edwards (1996: 15).
[261] Edwards (1996: 15).
[262] Edwards (1996: 171).
[263] Edwards (1996: 171).

microworld is “exceptionally interesting as an imaginative domain, a make-believe world with powers of its own.”[264] The ‘power of its own’ exhibited by computer simulation is playfully emphasized by Turkle in her recent book Simulation and its discontents,[265] whose first chapter is entitled “What does simulation want?”.

Another Science and Technology Studies scholar who has addressed computer simulation modelling is Timothy Lenoir, notably in the paper “All but War is Simulation: The Military-Entertainment Complex” (2000) and in the article “Fashioning the Military-Entertainment Complex” (2002-2003).[266] Both pieces are concerned with the economics of computer simulation, investigated through examples taken from the North American militaro-industrial complex. More specifically, they examine the activities of the Institute for Creative Technologies, created in 1999 by the University of Southern California on a $45 million five year grant from the US army “to support collaboration between the entertainment and defense industries; to apply entertainment-software technology to military simulation, training and operations; and to leverage entertainment software for military relevant academic research.”[267] According to the author, the creation of the ICT formalized “crossovers between military simulations and the entertainment industries” which until then had been unplanned and opportunistic.[268] Lenoir’s papers make the case that under the aegis of the ICT, simulation software has become a source of synergy for a heterogeneous assemblage of academic, military and industrial interests, which belonged to (until then) disjoint domains, dissolving a number of boundaries in the process. [269]

[264] Edwards (1996: 172).
[265] Turkle (2009).
[266] Lenoir (2000) ; Lenoir (2003).
[267] Lenoir (2003 : 15).
[268] Lenoir (2000 : 328).
[269] Lenoir (2000: 334): “I have attempted to show how the boundaries between exotic graphics and computer simulations for military purposes, on the one hand, and video games and entertainment graphics on the other, have dissolved into bonds of mutual cooperation symbolized powerfully by the creation of the joint military/film industry-funded Institute for Creative Technologies.” .

The last piece of work is "Simulating the Unthinkable: Gaming Future War in the 1950s and 1960s", by Sharon Ghamari-Tabrizi (2000).[270] She starts from the observation that in the 1950s in the US, young civilian defence analysts challenged the institutional dominance and the expert authority of senior military officers on the grounds that experience of conventional war was irrelevant to the planning of future wars, and replaced them with man-machine simulations and role playing war games. Her paper goes on to show that in fact, when thoroughly examined, "the terms in which they [the young civilian defence analysts] described their techniques of gaming and simulation were a modernist irrationalism that stressed the primacy of intuition, insight, discretion and artistry."[271]

Ghamari-Tabrizi focuses on the application of simulation and gaming techniques to the specific case of war planning and hence stays away from the topic of interdisciplinary hybridization, yet she nonetheless remarks that in the systems approach to complex networks promoted by the young civilian defence analysts, "it mattered little whether the system was a military unit, a commercial firm, a weapons system or even a biological organism",[272] hereby indicating some potential for hybridization. These analysts, some of whom actually belonged also to the set of individuals examined by Galison's paper, were "*virtuosi* of the techniques of Monte-Carlo, system analysis, operational war-gaming, man-machine studies, and other innovations in simulating combat operations."[273] In the development of her argument, she observes that they described their practices in terms stressing "the primacy of intuition, insight, discretion and artistry". They emphasized for example that in the search for new ideas, "role-playing games expresses the value of disinhibited play as a vehicle for creative

[270] Ghamari-Tabrizi (2000).
[271] Ghamari-Tabrizi (2000 : 163).
[272] Ghamari-Tabrizi (2000 : 165).
[273] Ghamari-Tabrizi (2000 : 164).

research".[274] They highlighted the "intuitive, artful nature of simulations".[275] In the tradition of modern science, all such justifications are most certainly scientifically invalid. As Ghamari-Tabrizi rightfully points, they rather belong to the register of aesthetics.[276]

Additionally, she brings to attention that simulations (the wargames as well as other role-playing types of simulations, of which I have shown earlier that they were a typical hobby of ALifers) can heavily tap on skills which are usually considered as belonging to artistry, in individuals who are otherwise considered as scientists or engineers. This complements Edwards' view, that computer simulations are seductive at both the intellectual and the emotional levels. It indicates that the interdisciplinarity encouraged by simulation is not a superficial assemblage of heterogeneous blocks but a phenomenon occurring at a deeper level, since it involves the hybridization of interdisciplinary skills within single individuals, and not just between collaborating individuals from different backgrounds. Such an 'inner' interdisciplinarity was implicit in my brief examination of the case of Artificial Life art, where I mentionned that some ALifers published both in scientific and artistic outlets. It is a topic on which I will return at length in the following chapters.

The pieces that I have just examined all come in support of my view, that computer simulations are agents of interdisciplinarity. The case examined by Ghamari-Tabrizi highlights that the design of simulation models can draw together heterogeneous

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[274] Ghamari-Tabrizi (2000 : 179).
[275] Ghamari-Tabrizi (2000: 188).
[276] Ghamari-Tabrizi (2000: 189): "Designing a game, simulation or model can be understood as equivalent to drafting a concrete world-picture of the Cold War. Likewise, apprehending the tangle of influence and disruption wrought by a host of incompatible variables, tendencies and interests could approximate an aesthetic appreciation of the particular intelligibility of a novel, a painting, a drama. While not every author made use of the resemblance between modeling and gaming and the fine arts, certainly within the operations research literature, the formulation of a war-game, systems analysis or simulation was regularly described as an ingenious fabrication with few leading principles.".

sets of skills in a single individual, hereby enriching our understanding of the agency of simulations in promoting interdisciplinarity. Further, the pieces show that interdisciplinarity is only one aspect of the hybridization enabled by computer simulations; in keeping with the technoscientific tradition, simulations have the potential to activate synergies across heterogeneous economic domains such as the academic, military and industrial domains.

In the first part of section 3, I have highlighted that computer simulations were epistemologically messy. It now appears that their innate messiness is multi-dimensional. Computer simulations are agents of hybridization at multiple levels. What follows is an attempt at conceptualising some of this agency.

In The Closed World . . ., Edwards' overall argument revolves on the use of discourse in linking tools and metaphors,[277] which he shows to be extensive in the case of systems simulations in the 'Closed Worlds' of Cold War America. Let us take a different angle and ask why it is in effect so easy to link the displays of computer simulations through discourse, with all sorts of metaphors. I certainly do not intend to argue that computer simulation is a value-free technique, which only gets value-laden when used towards specified goals. I am well aware that all sorts of assumptions, pre-conceptions, prejudices, social and cultural values, may enter and become black-boxed into simulation models (all the more with 'third stage' simulations, for which the deficit of theoretical structure can only lead to a greater number of assumptions and approximations) but this is not an issue I will pursue. Helmreich has already given it an extensive analysis in the case of Artificial Life at SFI.[278] Moreover, it is a problem that the reflexive community of Artificial Life tends to be aware and wary of, and even denounces. It was the case at ALIFE XI, when during a plenary session, Jordan Pollack,

[277] Edwards (1996: 27).
[278] Helmreich (1998).

a respected member of the Artificial Life 'old boys' club, made a politically charged speech entitled "Beyond Competition". He argued that after more than twenty years of Artificial Life, the use in simulation models of raw competition, of survival of the fittest as a given of nature, had amply proved that it did not lead to open-ended evolution but mostly to Nash equilibrium where evolution is halted. So why do we keep on using what is after all an unwarranted pre-conception if it is the wrong model? His answer was that we are confronted here with a typically Western cultural prejudice; we have been brainwashed by socio-political elites to believe in economic and social Darwinism, when in fact development and innovation are not sustained by 'laissez faire'. This was a striking example of reflexive examination leading a scientist to recognise that cultural prejudices may bias scientific hypotheses and thus that science is influenced by the social context it is embedded in.

The claim I wish to make is that, rather than value-free, simulation models in their 'naked' state, that is before they are wrapped into a layer of discourse (an extended type of discourse which encompasses computer graphics / audio rendition, graphs and charts, etc), have an under-determined identity, and that it is a source of innate messiness. My claim can appear as no more than a nuanced version of the value-free theory of technology, yet it is not, and it has very different implications. What do I mean by under-determined identity? Once a scenario for a simulation model has been formalized in mathematical terms, converted into a proper algorithm, turned into a piece of software (or even of hardware cabling, for that matter), it is still somewhat in limbo – in what I call its 'naked' state: first, it still needs its designer to run it in order to get a better feel for it and tweak its variables and parameters (which at this point bear no indication as to what they are meant to represent except for the researcher running the simulation); second, it needs a narrative, and accompanying visual/audio rendition, to express what it stands for. Without these, it has a deficit of meaning, it is not representing without ambiguities; there is not much to indicate whether it stands for an existing biological organism, a social phenomenon, an imaginary creature, a proto-cell, an immune system, an inter-galactic battle, etc. This is the sense in which the identity of simulation models is vastly under-determined. Their openness to parameterisation, to narrative and representational manipulation, makes them an especially malleable and versatile tool; it imbues them with a capacity to easily change clothes and travel blithely across the boundaries separating different contexts of use. In short, it makes them excellent agents of hybridization, and hence of interdisciplinarity. Treacherous ones also, since as they travel across boundaries they carry along with them, unheeded, the hidden values and biases that have been black-boxed in their design process.

Coming back to Edwards' argument, it follows from my own perspective that simulation models, in their 'naked' state, lend themselves well to being linked to metaphors through discourse. It can even be argued that simulations, once wrapped into layers of discourse – once 'dressed-up' – *become* metaphors. Even though Risan did not make the distinction between what I call naked simulations and dressed-up simulations, a distinction that I find quite useful, he defended a very similar view in his ethnography of Artificial Life at the University of Sussex.[279] Of course, as Risan has rightly pointed, the view that simulations are metaphors does not suit followers of the strong Artificial Life programme, for whom the relation between simulated life and Real Life is one of identity; but the idea that Artificial Life simulations are metaphors is in fact close to the position defended by supporters of weak Artificial Life.[280] I will refine this view using the 'naked / dressed-up' distinction: if dressed-up simulations are metaphors, then naked simulations may be conceived as metaphorical chameleons; because they can

[279] Risan (1997a), chapter 4, is a thorough discussion of metaphors and identities in Artificial Life research.
[280] Risan (1997a), chapter 4.

masquerade under multiple disguises, they offer a fundamental resistance to any form of neat pigeonholing and are thus intrinsically messy. Moreover, this messiness can only increase as we move from Fox Keller's 'first stage' towards 'third stage' simulations, since their ever looser anchoring into existing theory clearly augments their malleability and versatility. Understandably, innate messiness increases with agency.

4. ARTIFICIAL LIFE, AN EXTENDED TRADING ZONE

Section 2 has analysed the self-searching that has been agitating the Artificial Life community almost since the inception of the field, showing that it hinged on the community's perception of both the uncertain epistemic status of Artificial Life research and its uncertain institutional positioning. Section 3 has attempted to link these various uncertainties to simulation modelling, which is foundational to Artificial Life research practices. I have concluded that simulations were innately messy – malleable and versatile agents of hybridization, which messiness increases with their level of agency.

At this point, I would like to return to Galison's concept of the 'trading zone'. He came up with it while approaching a historical case from an angle very similar to the one I am taking on Artificial Life: he showed how in the years following World War II in the United States, it was the practice of 'Monte-Carlo' computer simulations which bound together what was at first glance "a chaotic assemblage of disciplines and activities".[281] The 'trading zone' as he defined it was constituted by the simulations themselves, "an arena in which radically different activities could be *locally*, but not globally, coordinated."[282] As such, his account was skewed towards nonhumans and their agency. He has rightly highlighted that the story of the particular 'trading zone' that he was investigating played on multiple levels, not just on that of interdisciplinary

[281] Galison (1996 : 119).
[282] Galison (1996 : 119).

practices: "It is a tale in the history of epistemology […]. It is a narrative of the history of metaphysics […]. It is a workplace history […]."[283] Yet as I have pointed earlier, with regard to interdisciplinarity itself, Galison's investigation was limited to the scientific domain.

Departing from Galison, I wish to propose an extended version of the concept of the 'trading zone'. I have highlighted that part of the uncertain epistemic status of simulation modelling in its scientific use can be attributed to the difficulty of positioning computerized simulations within existing categories in philosophy of science such as 'theory' or 'experiment'. I have also pointed that simulations could cut across the boundaries between the different genres of the sciences and the arts. So, simulations do not just hover between categories in philosophy of science. They must do so with other sets of philosophical categories as well, in a trafficking that extends across utterly distinct epistemologies. In this view, simulations may be seen as serial boundary-crossers. They are active agents of hybridization – 'bridgers' – which have the potential to act on different, although intersecting, planes (philosophical categories, institutional landscape, contexts of use, sets of skills), and thus to generate instances of the 'trading zone' of a much extended nature compared to that of Galison's case study.

I propose that the whole field of Artificial Life may be conceived as such an instance of extended trading zone; a cultural, epistemological, disciplinary trading zone, in which not just scientific but other contexts of use, with their afferent skills, are locally bridged, and from where may spring unlikely hybrids which cross over disciplines, philosophies, genres – relatives of Donna Haraway's bastardized, illegitimate cyborgs.[284] The trading zone investigated by Galison was born from the use of event generators, which belong to the first stage of simulation in Fox Keller's

[283] Galison (1996: 120).
[284] Haraway (1991).

taxonomy. By contrast, Artificial Life research uses third stage simulation models, which are being devolved a much higher level of agency by their human designers. It follows that the hybridization potential of Artificial Life computerized synthetic simulations is especially high, since messiness augments with agency.

Now, I would like to pick up on the discussion of modern and non-modern ontologies at the end of chapter 2, and examine the backdrop against which I have labelled agency-rich simulations as 'messy'. Let us consider Latour's definition of the modern stance in We have never been modern:

> "The hypothesis of this essay is that the word 'modern' designates two sets of entirely different practices […]. The first set of practices, by 'translation', creates mixtures between entirely new types of beings, hybrids of nature and culture. The second, by 'purification', creates two entirely distinct ontological zones: that of human beings on the one hand; that of nonhumans on the other. […] The first set corresponds to what I have called networks; the second to what I shall call the modern critical stance. […] So long as we consider these two practices of translation and purification separately, we are truly modern – that is, we willingly subscribe to the critical project, even though that critical project is developed only through the proliferation of hybrids down below. As soon as we direct our attention simultaneously to the work of purification and the work of hybridization, we immediately stop being wholly modern […]."[285]

Adopting Latour's perspective, agency-rich simulations are messy only with respect to the relentless work of categorization that characterizes the modern process of purification.

[285] Latour (1993: 10-11).

The agency-potent simulation models of Artificial Life are serial boundary-crossers, which are resisting the modern process of purification. They are the 'messiness engines' that power the extended trading zone of Artificial Life, where they keep propelling into light an entire ecology of non-modern hybrids, the kind of which the modern work of purification aims at hiding and segregating. Through their resistance to categorization, through the active crossbreeding that they facilitate and the contamination thus produced, they are a major obstacle to the stabilization of Artificial Life into the overwhelmingly modern epistemic and institutional matrix of academic disciplines (if we follow Latour, epistemology is indeed part of the modern critical stance, since it relies on the purified categories of modern science – a view shared by Pickering, for whom epistemology operates in the representational idiom associated to the modern ontological vision, while the performative idiom is characteristic of the non-modern ontological vision).[286] Thus the instability problems of Artificial Life are problems only when it comes to confronting, and co-existing with, the hegemony of the modern stance.

While chapter 2 has shown that agency-rich synthetic simulations act as cultural 'glue' for the global Artificial Life community, chapter 3 isolates them as a key obstacle to the institutional and epistemological stabilization of the field within the predominantly modern disciplinary matrix. Hence paradoxically, it appears that the cohesive force holding the field of Artificial Life together is also its major source of instability in the modern ontology. The independent and even orthogonal perspectives on Artificial Life adopted in chapters 2 and 3 thus reach congruent conclusions with regard to the key importance of agency-rich synthetic simulations in the constitution of

[286] Pickering (2002: 413-414).

the field. The dance of agency between human researchers and nonhuman computerized synthetic systems proves to be at the heart of the Artificial Life phenomenon.

The notion of an 'extended trading zone' is especially well adapted to keeping a tight focus on the nonhuman partner in that dance of agency, and to highlighting the ways in which Artificial Life may depart from a predominantly modern backdrop. Conceptualizing Artificial Life as an extended trading zone emphasizes the visibility of the multi-dimensional hybridization that the open-ended engagement between humans and nonhumans facilitates. It draws special attention to the nature and the amount of agency that the nonhuman part of the collaboration can display, thus giving more substance to the claim that in Artificial Life there is a balance to the human – nonhuman relation. This balanced human – nonhuman relation, that many ALifers appear to enjoy and explore, comes in striking contrast to the kind of asymmetric human-controlled dualism characteristic of the modern stance.[287] Indeed, the ontological vision which best agrees, resonates really, with the idea of the extended trading zone is the non-modern one.

[287] Pickering (2009: 199-200).

Chapter 4: Introducing the Sussex neighbourhood

1. INTRODUCTION

Taking inspiration from Galison, I have proposed that the whole field of Artificial Life was an instance of extended trading zone, which locally bridged contexts of use, comprised of skills, practices, cultural values, theoretical frameworks, ranging across the full disciplinary spectrum – an extended trading zone powered by agency-rich synthetic simulations. The next stage of my research is to investigate, through the example of Artificial Life, what may be going on in the extended trading zone.

I have explained in chapter 1 the rationale for adopting a hybrid approach that combined a macro-study at field level with the micro-level perspective of an in-depth local case study. Focusing on a specific locale of Artificial Life research was indeed more adapted to investigating what may be going on in the extended trading zone than a study at the level of the entire field. It was not just that an investigation at field-level would not provide the required depth of detail. It was also because forces at work in Artificial Life (like the threat of dislocation, the desire for recognition by the scientific establishment, or the necessity to be economically sustainable) could not fail to impact, possibly repress, the full emergence of the extended trading zone; and it was reasonable to expect that some forces would play differently in different local contexts. I have already highlighted, for example, that funding strategies in Artificial Life appeared to vary significantly between countries. Hence the way in which Artificial Life expressed the potential of the extended trading zone was unlikely to be uniform, but rather to vary according to localisation.

Once settled that the broad question of what may be going on in the extended trading zone was best addressed through an in-depth micro-study, I could refine it into more specific research questions: (1) Which local research community within Artificial Life was the best candidate for such a case study? (2) What can its study contribute to our understanding of other research communities native to the extended trading zone? (3) What can its study contribute to our understanding of their interdisciplinary practices?

Chapter 4 sets out to answer the first two of these questions. Section 2 will define what I have come to call the 'Sussex neighbourhood' and justify its choice for an in-depth case study. Section 3 will look at the mode of functioning of CCNR (Centre for Computational Neuroscience and Robotics) at Sussex University, the material centre and cultural attractor of the Sussex neighbourhood, in order to characterize its moral economy. Section 4 will further investigate its ethos of interdisciplinarity. Section 5 will broadly relate the findings of the two previous sections to the non-modern stance.

2. IDENTIFYING AND DELIMITATING THE SUSSEX NEIGHBOURHOOD

2.1 PLACE VS SPACE

The macro-study part of my work has shown that, despite the highly dispersed and heterogeneous character of Artificial Life, CCNR at the University of Sussex is by far the leading centre for Artificial Life research in the world. Its centrality in the Artificial Life landscape flags it unambiguously as the best candidate for an in-depth case study. Yet what the figures in my quantitative analysis have identified is the shell of an academic space, situated within the physical buildings and the organization chart of the University of Sussex. Figures do not tell us whether the cultural place defined by the Artificial Life research group at Sussex actually corresponds with the space thus selected. It would be a bit naïve to equate the 'place' and the 'space' of Sussex Artificial Life, and would show a gross disregard for the abundant scholarship produced over more than three decades by geographers on the distinction and relationship between place and space. A place does not reveal itself through figures. For example, in the present case, figures do not and cannot show that close ties unite CCNR with other strong British centres of Artificial Life research.[288] Grasping the actual contours of a place requires qualitative indicators.

Field observations might provide such indicators. When I was in the early stages of my project and trying to form some first impressions of Artificial Life and its community, I attended the international conference ALIFE X. Over the few days spent there, it became obvious to me that there was an informal, yet closely knit and quite large, group of participants which I perceived as sharing a common something which distinguished them from the rest of the participants. For example, they consistently congregated during breaks and hung around gang-like after hours; the day-long workshop organised by two of their members and involving a good many of them centred exclusively on embodied cognition and was unusually strong on anti-dualist continental philosophy; the number of women was proportionately much higher than in the conference overall. In short, they appeared to constitute some sort of distinct community within the community. It turned out that these individuals had in common that they were ex- or present members of the Artificial Life research group at University of Sussex.[289] This is where the idea of the 'Sussex neighbourhood' originates from: the impression I was left with, following ALIFE X, that those in the group who were not located institutionally at Sussex University anymore still appeared to belong there somehow.

[288] Tables 2 & 3.
[289] Fieldnotes, 03/06/2006-07/06/2006.

2.2 HOW TO CHARACTERIZE A NEIGHBOURHOOD?

What other signals could indicate the presence of a 'neighbourhood', of a research community held together by interpersonal ties that outgrow shared academic affiliation or joint research specialities? One such signal could be the contrast between individual researcher's experiences of the different research centres to which they have belonged. Let me illustrate this through an example. At ALIFE XI in August 2008, I had the opportunity to discuss at length with a young woman who graduated from the CCNR's EASy MSc in 2002. Prior to her master's degree, she had been an undergraduate at Sussex but in Mathematics, so in all she had belonged to CCNR for a year only. Following her MSc, she spent four years at UCL completing a PhD in Computer Science, within the group doing Artificial Life related research. By her own admission, she did not much enjoy her time at UCL, where she found her human environment to be rather cold and devoid of the sense of community she had relished at Sussex. And while two years on she did not have much contact with her former UCL group anymore, she had retained strong links with the extended Sussex group, as was very obvious throughout the conference. The stark contrast between her experiences at Sussex and at UCL marked the difference between a research group (Sussex) which had grown into a cultural place whose members' sense of belonging was not bound to their remaining located, physically or institutionally, within CCNR – and a research group (UCL) which was at this point hardly more than a shared space.

An interest in the Sussex research group's gossip by an ex-Sussex person would be a display of ongoing private (as opposed to professional) involvement with the group, thus another indication of the presence of a Sussex neighbourhood. For instance, a postgraduate fellow who had left Sussex for almost two years showed a great deal of excitement when I told him at some point that I was going down to Sussex about once a week to do some interviews. He hoped that as a result, I could top him up on the latest gossip. He thought that email and Skype were fine, but still he felt that he must have been missing some good titbits. Even though he was not unhappy with his current institution, it must be noted that not only had he retained his email address from Sussex but it still was his main one.

Finally, another clear signal of the presence of a neighbourhood would be the urge to keep track and re-unite. I have already explained that around 1990, a handful of individuals at the University of Sussex, postgraduate students and young lecturers, started ALERGIC (the Artificial LifE Reading Group in Cogs), in effect founding the Artificial Life research group of Sussex University. ALERGIC expanded and became formalised as the EASy (Evolutionary and Adaptive Systems) group, which strongly overlaps (something of a euphemism) with 10-year-old CCNR. EASy / ALERGIC actively cultivates a sense of community. It boasts that:

> "We are the largest Artificial Life research group in the world, with ~10 faculty and research fellows, ~30 doctoral research students, ~25 MSc students; and >> 100 ex-members in research institutes around the world."[290]

The "EASy Members" webpages are comprised not only of the traditional "Faculty", "Research Fellows" and "DPhil students" lists covering all current members of EASy, but also of "Recent DPhils" (25 names) and, more unusually, of "Past EASy members now at other institutions" (37 names, some overlapping with those of the "Recent DPhils") lists.[291] This last list is regularly updated to keep track of ex-Sussex people by posting their current affiliation. It somehow maintains them within the EASy

[290] http://alergic.pbwiki.com/What+is+ALERGIC, consulted 09/10/2008.
[291] http://www.informatics.sussex.ac.uk/research/groups/easy/members/Recent.html, consulted 10/10/2008; http://www.informatics.sussex.ac.uk/research/groups/easy/members/ExEasy.html, consulted 09/10/2008.

perimeter. Moreover, ALERGIC has revived as a wiki and email list, "for notifying Alergic people within Sussex and beyond about meetings, or any other items of interest -- plus organise meetings of its own […]."[292] ALERGIC emails are sent around on a daily basis approximately, to make all sorts of announcements, like calls for papers, conference deadlines, talks, jobs, new journals in which to publish, software releases, even announce social events, ask questions or launch debates, to a list of over 250 subscribers.[293] A page of the wiki, called "Alergic Reunited", encourages people who have moved away from Sussex to give their current details (email, location, link to webpages).

It thus appears that the urge to re-unite I witnessed at conferences, during and after hours, among members and ex-members of the Sussex group did not just flare on chance occasions, but was sustained and nurtured through other means during the rest of the time.

2.3 WHO IS IN?

The Sussex Artificial Life group disseminates widely at the international level thanks to its unique EASy (Evolutionary and Adaptive Systems) taught masters degree and to its doctoral programme, and regularly attracts students and visiting scholars from abroad. If following my previous observations, I take as a broad definition of the 'Sussex neighbourhood' that it is comprised of all present and past members of the Sussex Artificial Life group, I run into a major problem: the Sussex neighbourhood then covers such a major chunk of the Artificial Life community that it re-positions my study at the macro level, erasing the all-important local variations. I thus need to narrow down the scope of my definition. Fortunately, the term 'neighbourhood' carries connotations

[292] http://alergic.pbwiki.com/What+is+ALERGIC, consulted 09/10/2008.
[293] http://lists.sussex.ac.uk/mailman/roster/informatics_alergic_list, consulted 29/05/2009.

both of a fuzzy perimeter and of weaker / stronger ties[294], which suits my purpose well, since the relationship that ex-Sussex Alifers entertain with their alma mater may be of variable strength. I propose to tighten the Sussex neighbourhood around CCNR and its closest neighbours, closeness being understood in terms of interpersonal relationship rather than of geographical distance, and see if it enables me to retain a localised dimension while studying a cohesive group of individuals – indeed, the form of closeness I have chosen has no obvious reason for translating into geographical closeness.

Who would be the closest neighbours of CCNR? My working assumption is that the presence of an individual researcher in the "Alergic Reunited" or in the "Past EASy members now at other institutions" lists, supported by converging field observations, is a good enough indication of her/his belonging to CCNR closest neighbours. Let us consider first the case of the University of Southampton. Its recently founded (2005) and fast growing SENSe (Science and Engineering of Natural Systems) group in the school of Electronics and Computer Science is commonly considered within the Artificial Life community, and by its members themselves, as an offshoot (an appropriate term as it conveys the idea of a filial type of relationship, both strong and competitive) of Sussex. In 2005, Professor Dave Cliff was recruited by University of Southampton to lead the newly created SENSe group. Dave Cliff studied at COGS, Sussex's School of Cognitive and Computing Sciences; he holds a masters and PhD degrees in Cognitive Science from the University of Sussex, and although his DPhil was awarded as early as 1991, hence for a doctoral project started before the Artificial Life group came into existence through ALERGIC (he was among its early members), it is listed on the EASy website among the DPhil theses in the EASy area, that is, broadly

[294] For a sociological analysis of weak / strong ties that fits well with the neighbourhood metaphor, see Granovetter (1973).

speaking, in the domain of Artificial Life;[295] Dave Cliff then remained for a few more years at COGS as member of staff; he left Sussex over ten years ago, yet his details are to be found in the "Alergic Reunited" webpage. Dave Cliff did not stay at Southampton for long, nonetheless, of the seven SENSe staff members listed at the time of my writing,[296] the three who register interests in Artificial Life and whom I have repeatedly met at Artificial Life conferences (they actually organised ALIFE XI) are all ex-members of the Artificial Life group at Sussex and all three have their details on the "Alergic Reunited" webpage. In addition, all still publish joint papers with current or ex-Sussex members. According to my working assumption, Southampton SENSe fits squarely within a Sussex neighbourhood restricted to its closest neighbours.

What about the Artificial Life research group at the University of Leeds? Why was it pointed at me as another offshoot of Sussex, although there was no ex-Sussex staff member over there while I was pursuing my project? The key to this apparent puzzle is found by tracing the careers of two Southampton-located members of the Sussex neighbourhood: prior to joining SENSe in 2005, one spent six years in the School of Computing at Leeds first as a research fellow then as a lecturer, and the other was a research fellow there for several years. The Sussex neighbourhood in its restricted definition may not involve Leeds anymore, yet it has left enough of a cultural imprint on the Artificial Life research group it has helped build over there that the Leeds group may still be tagged as an emanation of Sussex.

Looking now at smaller British Artificial Life research centres, some are in practice revolving around an ex-Sussex researcher whose bond with CCNR remains strong and who qualifies as a member of the restricted Sussex neighbourhood. This was for example the case, at the time of my study, with the School of Environmental

[295] http://www.informatics.sussex.ac.uk/research/groups/easy/publications/DPhiltheses.html, consulted 13/10/2008.
[296] http://www.sense.ecs.soton.ac.uk/people/, consulted 13/10/2008.

Sciences at the University of East Anglia. The ongoing strength of their bond with CCNR is manifest, both at the private level (they are fully socialized within the Sussex 'gang', as I have repeatedly observed in the course of my fieldwork) and at the professional level (they go on conducting collaborative research, publishing collaborative papers and organizing workshops, summer schools, etc, with present or past members of the University of Sussex Artificial Life group).

Does my restricted definition of the Sussex neighbourhood retain a localised dimension? Surprisingly, it does. Here I benefit from a characteristic of the geographical distribution of Artificial Life research that I have pointed at earlier: the clear dominance of the field by the United Kingdom. It was first revealed through the quantitative analysis of chapter 2, and some elements of explanation (i.e. the privileged situation of British Artificial Life in terms of funding) were given in chapter 3. The result is that the ex-Sussex persons appearing on the "Alergic Reunited" or in the "Past EASy members now at other institutions" lists are in their large majority working in British research centres, so that the Sussex neighbourhood, restricted to CCNR and its closest neighbours, retains a distinctly British character – a trait which, besides its centrality to the Artificial Life global landscape, makes the Sussex neighbourhood especially representative of the Artificial Life phenomenon in its present geographical distribution.

2.4 A SUCCESSFUL ENDEAVOUR

The Sussex neighbourhood has demonstrated its capacity to grow into a cultural place bound by more ties than shared professional concerns or a continuing presence at Sussex, while being successful and unavoidable in the global Artificial Life landscape. In the quantitative analysis of chapter 2, the strong leading position of CCNR in Artificial Life becomes even stronger when the figures for CCNR are compounded with those of centres such as Southampton's SENSe so as to reflect the actual importance of the Sussex neighbourhood. It is independently confirmed by the composition of the board of directors of the International Society of Artificial Life elected in 2009: five out of nine directors belong to the Sussex neighbourhood (two are members of Sussex's CCNR, three are ex-Sussex members and members of SENSe).[297] This success is perceptible even at the material level of employability: a leading member of CCNR was congratulating himself at ECAL 2007 that contrary to what appears to be the case elsewhere, their own post-docs did find jobs in Artificial Life.[298]

The case of Sussex thus appears to offer a successful alternative to that of professionalization into a well-bounded respectable scientific discipline, to which aspire part of the Artificial Life community. Of course, we should not forget that the Sussex neighbourhood is a localized example, which might be difficult to propagate. And to be fair, the British funding context appears to be especially beneficial for Artificial Life research in general, even for centres that do not have close ties with Sussex, like for instance the University of Hertfordshire. Nevertheless, the striking success of the Sussex model has not gone unnoticed. The young and promising School of Informatics at the University of Indiana, which organised ALIFE X, seems to been modelled more or less explicitly after Sussex COGS.[299] In what follows, I will explore the mechanisms underlying the construction and maintenance of the Sussex neighbourhood. Section 3 examines to what extent CCNR, the material centre and cultural attractor of the Sussex neighbourhood, propagates a distinct form of moral economy as part of its mode of functioning. Building on the findings of section 3, section 4 further investigates the ethos of the Sussex neighbourhood. More precisely, because the Sussex neighbourhood is a research community who is native to, and has been thriving in, the extended trading

[297] http://alife.org/board.html, consulted 26/10/2009.
[298] Fieldnotes, 13/09/2007.
[299] Dictated fieldnotes, transcript, 04/06/2006.

zone, I explore CCNR's ethos of interdisciplinarity – I evaluate whether and how CCNR embraces and encourages hybridization, the active founding principle of the extended trading zone.

3. THE MORAL ECONOMY OF CCNR

Moral economy is a notion, initially introduced by historian Edward P. Thompson,[300] which STS practitioners have appropriated and adapted to their own domain. For Robert Kohler, author of a well-known case study of geneticist Thomas Hunt Morgan's 'fly group' at Caltech in the first half of the 20th century,[301] the moral economy of a research community refers to the moral principles guiding its knowledge-producing activities and is the most important aspect of its communal work.[302] The question he has addressed in the case of Morgan's 'fly group', which is valid in his view for any community of practitioners, is "how exactly instruments, practices, and moral economy operate together to make a line of work that is productive and attracts recruits and granting agencies, or (more commonly) to make one that breaks no ground and remains small and local."[303] Having already identified that within the field of Artificial Life, the Sussex neighbourhood falls rather in the former category, this too is the question that my proposed case study of the Sussex neighbourhood aims at addressing. The next chapter will be looking at what kind of interdisciplinary research the Sussex neighbourhood produces – at what, in its interdisciplinary practices and in the research they produce, appears meaningful for understanding work in the extended trading zone. For now, I will tackle the closely related issue of its moral economy: of the social rules and customs, the virtues and values regulating its functioning and its implicit

[300] Thompson (1971).
[301] Kohler (1994).
[302] Kohler (1994 : 249).
[303] Kohler (1995 : 243).

organisation (as distinct from the explicit organisation that is part of the public face of any social body).

In relation to moral economies of science, Lorraine Daston has made the point that "[a]pprenticeship into a science schools the neophyte into ways of feeling as well as into ways of seeing, manipulating and understanding."[304] The importance of inter-personal ties in the Sussex neighbourhood, over shared professional specialities or geographical proximity, points at the idea that enrolment and enculturation must be two powerful constitutive mechanisms of the Sussex Artificial Life community. These are complementary issues that I will explore alongside the distinctive features of the moral economy of the Artificial Life group at Sussex.

3.1 ELITIST ENROLMENT, VIRTUES AND TACIT VALUES

Part of the moral economy of a scientific community are the virtues and values selected for and promoted through enrolment. How does enrolment work in the case of Artificial Life at Sussex? Elitism is one of its explicit characteristic. This was made very clear to me by a major figure of the Sussex neighbourhood. He was among the handful who initiated the Artificial Life group at University of Sussex back in 1990 and has remained at CCNR ever since, a key actor of the EASy MSc and supervisor of many past and present DPhil students in the EASy lists. In his opinion, if there is only one person in the world going after an idea, chance is that it is a crackpot idea; if there are one hundred, it is already a bandwagon and it is not worth pursuing anymore; if there are about ten, then it might be interesting. This is why according to him the field of Evolutionary Computation and Genetic Programming, embodied in the GECCO series of conferences with its massive attendance, is a boring career-making enterprise, compared to Artificial Life whose numbers have remained low. In the light of the

[304] Daston (1995: 5).

institutional positioning and sustainability issues that I have discussed previously, it is noteworthy that he should consider the small size of the Artificial Life community to be an advantage, rather than a threat to its sustainability. He also advocates that Artificial Life should remain an informal forum for unconventional scientists, and staunchly opposes the professionalization and structuring of Artificial Life into a respectable discipline, as incompatible with a healthy research context for Artificial Life; according to him, Artificial Life is "a repository of flaky ideas […] outside the structured disciplines".[305] First time I interviewed him, he very openly told me, "I am pleased to say I am a bit of an elitist." He was not the only one who openly owned being elitist. Another leading figure at CCNR, whom I was questioning about the selection process of the research students, was happy to confirm that they were quite fussy about who they admitted in the group. He thought that the group had reached a critical mass which was fairly self-maintaining, provided they kept getting in "really good people, which we do".

Now a question worth asking is, what did "really good" correspond to? What was their enrolment process elitist about? Judging by the individual profiles I have come across in the Sussex neighbourhood, the desirable qualities, the virtues so to speak, making for "really good" according to CCNR leading researchers, were clearly quite different from those that might have been retained in other fields of research or at other institutions. For example, "really good" in their eyes did not appear to require being a straight-A student with a faultlessly linear academic trajectory, or being capable of fitting smoothly and efficiently in the established research agenda of a large research project team. For my interviewee, the evaluation of candidates hinged primarily not even on what project they wanted to do, but rather on why they wanted to do it:

[305] Fieldnotes, 21/06/2007.

> "We don't care what he'll do, we're happy he does anything; but you have to be clear about 'why am I doing it'. […] we make people think about what they do and why they are doing it. And […] try and ground it."[306]

Hence it appears that reflexivity and independent critical thinking were virtues strongly valued at CCNR, and they were among the traits selected for in prospective postgraduate students. In turn, my interviewee felt that their recruitment criteria had a positive impact on the profiles of the individuals attracted to CCNR:

> "[…] that kind of stuff again just attracts certain types of students. So then you have a feedback effect going because they will come here because we are known for that."

He felt it was good that COGS/CCNR had made for itself a strong enough brand name at the postgraduate level, because they would get lots of recommendations from other recognized universities who, when they had some bright students interested in certain kind of topics, would tell them "that's COGS stuff, go and look at COGS website". Having a strong contingent of candidates fitting the kind of profile they were looking for allowed them to be extra-selective. Elitism works best when the right students apply in number. Meanwhile, they do not want to be overwhelmed by unworthy candidates. As a Sussex member pointed it out to me:

> "[…] the EASy group and the CCNR are never widely advertised in mainstream publications. Some of that is just because of laziness, but there's also this idea that those who are worthy will find out about us anyway, and so this is an implicit selection criterion."[307]

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[306] Interview transcript, 12/07/2007; The use of 'he' was not unduly sexist: the interview was taking place just after meeting with a potential male PhD student, and 'he' in the quotation was referring to this particular individual.

[307] Froese, personal communication, 14/04/2010.

Elitism, as conceived by the leaders of the Artificial Life group at Sussex, is thus about cherry-picking students according to a specific set of virtues, two of which are reflexivity and independent critical thinking. In turn, reflexivity and independent critical thinking are clear assets when it comes to developing qualities of autonomy and individualism, values that appear to be actively promoted through the enculturation process into the group whose motto, as a senior member put it to me, is very much "Do your thing, go for it."[308] Autonomy and individualism are virtues that one of the group leaders clearly exhibited when he explained to me that, considering the work and stress involved into writing grant proposals, he did not want to do it for stuff he was not really interested in; he rather pursued his own ideas, even if that made things harder. And it was not just the content of the grant proposals he had in mind, but also the funding bodies they were aimed at: his view was that trying to tap into specific funding outlets did not merely influence rhetorically the formulation of a grant proposal, but that it may quite often affect the direction taken by the research

Elitist enrolment of the kind practiced by the Artificial Life group at Sussex evokes a community conforming to the invisible college model, a mode of functioning where mentors carefully select their protégés – hence that can be expected to work best when size remains small, which incidentally is another good reason for preferring to keep the headcount of the Artificial Life community rather low. It is a blatant instance of mechanism by which a research group may acquire a distinctive cultural character through the sharing of tacit values, in this case the election to the rank of virtues of specific character attributes and skills. Some values can be selected for and promoted through the recruitment process, which as a consequence never need be made explicit in

[308] Fieldnotes, 23/07/2007.

the daily existence of the group. It results in a community prone to follow tacit rules and to share implicit cultural values.

Kohler made the point that in Morgan's 'fly group', the values characteristics of its moral economy "were not preached but practiced", and presented the example of a researcher who was a member of the group for thirteen years "but could recall no explicit discussion of its virtues"; rather, this researcher thought that it was passed on through personal example.[309] It may be hard to discriminate between the parts played respectively by the enrolment process and by the role-model teaching, the enculturation, in the adoption of a set of virtues and values as part of a research community's moral economy, yet the resulting tacit dimension of the moral economy is evident in Kohler's study as well as in my own study.

In the Artificial Life group at Sussex, a case in point of shared unarticulated cultural value, of tacit agreement whose enforcement relies on self-regulation at the individual level, was the avoidance of military funding. After a couple of the group leaders had confirmed to me that avoiding the military as a source of funding was a deliberate choice, I thought for a while that it was an explicit rule. That it was in fact tacit, was brought to my attention when I broached the topic with another member of CCNR whom I was interviewing. My interviewee found interesting that two of the group leaders, interviewed separately, would have told me so, because as far as he was concerned this is something he had never heard articulated at CCNR; yet now that I mentioned it, he himself would never have done research there under military funding. But since it was not an explicit policy, he wondered what would happen if one of the researchers suddenly brought in research money from military sources.[310] The next time I met with one of the group leaders who had earlier made explicit to me the avoidance

[309] Kohler (1999: 251).
[310] Fieldnotes, 23/07/2007.

of military funding, I expressed my surprise that this rule of conduct was seemingly of a tacit nature and yet had never been breached. His answer was that he was fairly confident it would not happen, because they were good at cherry-picking who came to work with them.

3.2 ENTREPRENEURS, MENTORS AND PROTÉGÉS

Having examined which traits were valued by the mentors in their prospective protégés, it is worth having a look, in turn, at the traits which the younger members of the group most respected and admired in their elders – and indeed, they showed a great deal of esteem and respect towards their mentors. Entrepreneurship is one such virtue – and is also a rather natural outcome of the qualities of autonomy and self-reliance encouraged in the group recruits. One of the group founders has been repeatedly depicted to me like the 'financier' of CCNR, as he was so skilled at getting grants. One told me, "he is very entrepreneurial, but you have to be to set up and maintain a good research team."[311] And another, "he is a magician at getting grants and at solving political problems smoothly."[312] What was portrayed to me was more than a gift for fundraising; it was an entrepreneur's capacity to transform ideas into funded projects. For instance, he would not necessarily appear as main investigator in a project, but he would have been instrumental in convincing the person whose name was most likely to obtain the funding to take on the role of principal investigator in the grant proposal.[313]

Another of the group leaders was also repeatedly depicted as being a gifted entrepreneur, although less compliant and far more radical in his political positions; his entrepreneurial skills were known to extend outside academia, through various ventures he had been / was still involved in like a software company, an independent publishing

[311] Fieldnotes, 23/07/2007.
[312] Fieldnotes, 12/09/2007.
[313] Fieldnotes, 26/04/2007.

house or a fair-trade hand-knitted socks import business. By the end of my study, some younger group members had also either developed or further confirmed the valued entrepreneurial talent of bringing in large grants, like Anil Seth who has been awarded a five-year EPSRC Leadership fellowship in excess of one million pounds, started January 2009.[314]

The money-spinning ability of the CCNR leaders was such that, according to one of my informants, they seemed to conjure up funds out of thin air to make them readily available for various purposes. For example, when she failed to obtain a grant she had applied for in order to organize a workshop at ECAL 2007, the CCNR managed to provide her with the funds needed for paying the travelling and accommodation expenses of the invited speakers. And I was witness that the speakers whose expenses the CCNR took in charge throughout the conference, were accommodated in excellent hotels.

But what the younger members of the group most admired in their mentors was their capacity to ally excellent entrepreneurial skills with strong human values. I was told such things as, they are very principled guys in a nice and somewhat eccentric way;[315] or, they are great persons who help their students so much.[316] These could have been general statements turning out to lack in substance, but my interlocutors were keen to provide me with some practical evidence in support of their statements. The group leaders appear to be taking their responsibilities as mentors exceptionally far, so that the term ‘protégés’ is certainly not too strong a qualification for those they take under their wing. A young woman explained to me that she had conducted her PhD research part-time while benefiting from a teaching scholarship; at some point, the university

[314] For instance, http://gow.epsrc.ac.uk/ViewGrant.aspx?GrantRef=EP/G007543/1, downloaded 17/05/2010.
[315] Fieldnotes, 23/07/2007.
[316] Fieldnotes, 12/09/2007

administration had changed the contractual system but because of their inability to process the paperwork in time, they had failed to pay her at the end of the month, which meant she had found herself in a financial quandary; at which point, not only did the 'financier' of CCNR help sorting out the problem with the administration but he actually took money out of his own pocket, in the form of his debit card, to give her the immediate help she needed. Yet their help would not just translate in financial support. According to her, one thing which was great and quite unusual was that once you had completed your PhD, they allowed you to keep a desk with a computer, an email account, a library pass, etc, with the CCNR until you found a stable position. She said the group leaders were also very good at detecting and smoothing out individual problems, such as skillfully replacing an ill-suited supervisor by a more supportive one without causing any ill feelings. In her own case, they had been incredibly supportive when her child was born. Not only had they had left her time, but they had been very perceptive of the worries and doubts that she was having about returning to her research project, and they had managed to bring her back in very much 'en douceur'.[317]

In order to bring in a different perspective on the question of taking one's responsibilities as mentor exceptionally far, I was keen to gather a view from the mentors' side, especially the remaining founders. One of them was very clear about it: it was all about trying to give back as much as they themselves had been given when they had started the Artificial Life research group at Sussex in the early 1990s. Because of the number of open-minded yet hugely respected people who then belonged to University of Sussex, the nascent Artificial Life research group was lucky to have its work sponsored by several influential figures. My interviewees agreed that Maggie Boden, the founding dean of COGS (the School of Cognitive and Computing Sciences),

[317] Fieldnotes, 14/09/2007.

very well established and connected, was always incredibly supportive and generous of her influence. Although she might not have embraced some of their ideas, especially at a time when the Artificial Intelligence taught at COGS was still very much GOFAI, and although to this day they keep having utterly opposed views on a number of issues, still she found their philosophy interesting and from then on helped them a lot. Another very prominent sponsor of their ideas was biologist John Maynard Smith, thanks to whom they developed strong ties with biologists and neuroscientists in the School of Life Sciences. One confided that, although at the time, in their youthful naivety, they simply could not believe their luck that they were able to get money and studentships from the university in order to start building something, it was pretty obvious with the benefit of hindsight and experience that they had got political support from important places within the university, that figures like Boden and Maynard Smith had worked behind the scene to help them and smooth the way:

> "Looking back, you know, I am incredibly grateful for that, they were doing it in a quite implicit way really. Which is something I try and do now."[318]

These testimonials make it clear that the mentor-protégé system is apt at reproducing itself, as yesterday's protégés have become today's mentors, a role that they take strongly at heart. It was certainly the opinion of the young woman who spent time explaining to me in practical detail the kind of mentoring that the CCNR leaders were providing to their protégés. Her conclusion was that eventually, the attentive and supportive approach of the CCNR leaders was paying off in terms of growing a healthy Artificial Life research school, if one only considered the healthy burgeoning offshoots of CCNR, especially SENSe at Southampton. Her view has been further vindicated by subsequent events, as at the time of my writing, the Southampton offshoot has quite

[318] Fieldnotes, 21/06/2007; Interview transcript, 12/07/2007.

dramatically expanded its influence and its capacity to train a new generation of protégés. Early 2009, Seth Bullock, one of the three SENSe academic staff members whom I earlier squarely categorized into the Sussex neighbourhood, has become head of SENSe. This nomination accompanied the official launch, in March 2009, of the University of Southampton's Institute for Complex Systems Simulation, a £12 million institute "jointly funded by EPSRC (£6 million) and the University of Southampton and its partners (£6 million)." It will host "Southampton's *Centre for Doctoral Training (CDT) in Complex Systems Simulation*, running a doctoral training programme that is the first of its kind in the UK. […] There are 10 fully funded 4-year EPSRC PhD studentships available every year. We expect to admit a cohort of at least 20 students per year." Seth Bullock is the institute's Director, the initial contact point for all queries, and one of the three EPSRC award holders. Both his ex-Sussex colleagues at SENSe are also on the academic staff of the newly founded institute. [319]

The sense of duty, the felt necessity of reciprocating that the testimonials of the group founders expressed, reveals that loyalty is another characteristic virtue of CCNR's moral economy. It is personal loyalty to the mentors, which develops into loyalty to the community and to the virtues exemplified by the mentors, as the once protégés grow in turn into their role of mentors. The self-reproducing capacity inherent to the mentor-protégé model thus appears to be a fundamental mechanism through which the Sussex neighbourhood maintains itself, as loyalty to the mentors, through the contingent process of enculturation, becomes inseparable from loyalty to the virtues themselves that characterise the moral economy of the neighbourhood. The mentor-protégé model allows CCNR's moral economy to ally individuality plus continuity, evoking a sense of lineage on which I will expand later on.

[319] http://www.icss.soton.ac.uk/index.html, http://www.icss.soton.ac.uk/people.html, consulted 01/04/2009.

3.3 OUTER COHESION, INNER DIVERSITY

The Sussex neighbourhood is often perceived as quite overbearing from the outside. At ECAL 2007, organised by CCNR, some participants took exception with the massive presence of Sussex affiliates, especially staggering on the day dedicated to "Embodiment and Cognition". A young post-doctorate fellow who had not been involved in Artificial Life for long, his original field being linguistics, told me that at this particular conference he was experiencing the pressure to not just "do your science", but to belong to a community. He sensed a high level of camaraderie and felt in presence of a distinct culture, holding together a mismatched yet closely-knit community comprised of all sorts of individuals from very different backgrounds, into which either you were drawn or you would remain at the margin of Artificial Life. Another researcher angrily expressed that he found unwholesome such a near-hegemonic dominance of the field by a single research centre, which propagated a single worldview.[320] Does it mean that uniformity is part of the group's moral economy?

It is worth contrasting the perception of 'outsiders', that is of ALifers trained and working outside the University of Sussex, with the views expressed at the same conference by 'insiders', i.e. fully-fledged members of the Sussex neighbourhood. One of the group leaders was quite smug to learn about all the grumbling against the alleged Sussex imperialism, but denied all charges of unfair mafia-like behaviour in the paper selection process, which according to him had been fair, anonymous and played by the book. The papers selected were simply the best-marked papers. His account agreed with that of a younger member of CCNR, who told me that after the conference organizing committee came back with the results of the reviewing process, the chair of the

[320] Fieldnotes, 12/09/2007.

conference, also member of CCNR, had told his colleagues that "you guys have embarrassed me", because they had four papers ranked in the top 5 and nine in the top 25, and he did not want to incur charges of nepotism.[321]

She laughed when I mentioned that some conference attendees perceived the "Sussex crowd" as a kind of clan, a tight network of individuals all hammering the same message, in the same dialect, about embodiment and dynamical systems. She said she was used to this kind of reaction, not just from within the field of Artificial Life but also from other departments at the University of Sussex, who viewed the CCNR as this closely-knit group promoting a single, very specific, world view, which brought them remarks along the lines of "Here comes the CCNR". She agreed that inter-personal ties conferred a powerful cohesion to the Sussex neighbourhood, hence their clan-like image. But apart from that, she thought that the only characteristic of their research group that could possibly account for perceived uniformity was the high philosophical component of their work, more precisely their unusually strong continental philosophy streak, which tended to take people by surprise coming from a scientific group. For her, it was a completely erroneous perception, as in fact the CCNR harboured very different worldviews, which were the sources of many healthy discussions and arguments, and this was actually one of CCNR's strengths.

The contrast between the perception of outsiders to the Sussex neighbourhood and that of insiders highlights (1) that a degree of cultural uniformity is bound to result from the tacit values shared by the Sussex Artificial Life group – from the virtues characterising its moral economy – which are both selected for through its elitist enrolment process and transmitted through its mentor-protégé enculturation mechanism; (2) that this has no bearing on whether or not uniformity is a virtue of the moral

[321] Footnotes, 14/09/2007.

economy in question, since in the case of the Sussex neighbourhood, it is diversity which actually is a virtue – perceived uniformity, and uniformity as virtue, should not be conflated. Let us examine what promoting diversity as virtue may entail.

In the course of my fieldwork, many members of the Sussex neighbourhood have remarked upon the diversity of worldviews existing in their midst, and singled it out as a positive factor. For instance, artist Anna Dumitriu, who started a residency at CCNR in January 2007, wrote in her blog after interviewing one of CCNR's researchers:

> **"**As far as the commonalities between art and artificial life go Andy sees no big distinctions. In some ways that is why I'm enjoying this residency so much, at CCNR disciplines are blurred and creativity and philosophy are valued, it's almost that I kind of, sort of, fit in, even though my background is quite different. In fact I think everyone here has very different backgrounds, Andy said there are no common opinions or beliefs throughout the whole of CCNR."[322]

Someone who wanted to illustrate for me just how impossible it would be to put Sussex Alifers neatly into a single category told me how after a recent presentation at one of their weekly Life and Mind seminar, two senior members of the group had taken exception with the speaker, another seasoned member of the group, about the philosophy behind his work; according to my interlocutor, it came as no surprise really, since the speaker fitted rather into the neo-Platonist category, while the other two could rather be described as Wittgensteinians, all-is-construction-and-convention-so-what types. A founder and leader of the group relished the big discussions and arguments they had sometimes, especially frequent in the early days when there was around "this

[322] Dumitriu's blog entry, "GasNets, Bacteria and Hyper-reality", 25/01/2007: http://web.mac.com/annadumitriu/SOA/2007-2008/Entries/2007/1/25_GasNets%2C_Bacteria_and_Hyper-reality.html, consulted 11/12/2009.

whole kind of continuum of just almost every flavour of philosophers, who used to be in these early ALERGIC meetings", from radical continental to arch-classical anglo-american analytical. He thought it was great because they really added quite an important element, it helped to embed the philosophical aspect of things in the research that was being done, and it certainly had a lasting effect. The diversity of worldviews in the Sussex Artificial Life group was actually a theme of Risan's ethnography of the University of Sussex ALifers in the mid-1990s, which he analysed into the two conflicting categories of 'real science' and 'postmodern science'.[323]

I have argued earlier that the Artificial Life phenomenon, as an extended trading zone powered by the agency of synthetic simulations, had the capacity to attract very different sets of skills and types of individuals. The Sussex neighbourhood appears to have recognised this distinct capacity and to have attempted to harness it, since bringing in as much diversity of views as possible appears to be a major aim of the Sussex Artificial Life group leaders. A member of the group, who reviewed a late draft of the present chapter, commented on this particular point:

> "I would agree with this assessment. Your background is much less important than whether you have something interesting to contribute."[324]

They promote diversity using an array of different strategies: reaching outside the field, widening enrolment, welcoming amateurs. All three strategies are characteristic of a foraging behaviour. Foraging, which can be seen as a form of intellectual entrepreneurship, is encouraged by the moral economy of Artificial Life at Sussex. I will now examine these three strategies in detail.

First, reaching outside the field. I will not dwell on the keenness of Sussex ALifers to reach out for artists, as the multilayered relationship that exists in the Sussex

[323] Risan (1997a), chapter 3.
[324] Froese, personal communication, 20/04/2010.

neighbourhood between art and science will be examined in the next chapter; suffice to say for now that the most minimalist appreciation of the art-science relationship that I have encountered in the group still gladly acknowledged that although artists may not bring much to Artificial Life as a science, their presence forced the scientists to articulate the science for them, which, alongside the different perspective they were bringing in, was invaluable in helping the scientists to usefully question what they were doing. Sussex ALifers have been making their best to reach far and wide, a rather unusual move compared to what happens in established disciplines. For instance, a research fellow, whom I was questioning about CCNR relationships with other entities of Sussex university, explained that they were quite proactive in developing new ones, like at the time they were trying to involve Sussex's Media and Film Studies, but were finding it quite difficult to get them interested, there seemed to be a real problem of frames of thought.

The unusual eagerness of Sussex ALifers to forage outside their field was also manifest in an interview I had with one of the group leaders. His opinion was that while some ALifers "are just happy to stay between themselves and contemplate their navel", people in Artificial Life, in general, should try to reach out a bit more, should try to take the pain to publish in other disciplines' journals; after all, it was just a matter of giving your paper the appropriate form; he himself had once spent about a month reading psychology journals, trying to imbibe the style that permeated their pages; as a result, the paper on which he had been working had been accepted in New Ideas in Psychology; consulting the webpage for his publications, it appears that, aside journals in his own field, he has also published in both theoretical and experimental biology journals (Journal of Theoretical Biology, Theoretical Population Biology, Journal of

Experimental Biology), and in various philosophy journals (Phenomenology and the Cognitive Sciences, Philosophical Transactions of the Royal Society, Topoi).[325]

Reaching out was not just a way of bringing one's research to the awareness of other fields, in the hope of getting them interested and developing collaborative projects. It was also a means of bringing new blood into the Sussex Artificial Life group. For another group leader, they had to remain aware of the risk of homogenization, unavoidable because of the positive feedback effect of same-tends-to-attract-same. Beside reaching out, a second strategy to keep a high level of diversity within the group was the widening of recruitment into both their PhD program and their taught postgraduate degrees:

> "[…] we have to be careful to maintain diversity a bit, […] otherwise it kind of atrophies, it gets very boring. So we are trying. So one of the things I got to look into a few years ago, which has now kind of developed and taken a life of its own, was to bring in more interdisciplinary work […], for PhD students rather than just visiting artists. […] the [new Creative Systems] MSc came out of it. This kind of virtual group, Creative Systems Lab, came out of it. So that's the direction we are pushing into."

Beside the new master degree in Creative Systems and the Creative Systems Lab itself, diversity is also something they try to promote through the enrolment process into the EASy MSc programme – which is an important filter for the Artificial Life research group, since according to the group of PhD students who were around at the time of my fieldwork, about two thirds of them came from the EASy program. And indeed, one of the things they had most appreciated about the MSc was the heterogeneity of the population, which included international students, mature students, artists, biologists,

[325] http://www.informatics.sussex.ac.uk/users/ezequiel/papers.html, consulted 01/04/2009.

economists, computer scientists, and more. Another group leader, who has been strongly involved in the running of the MSc since it was launched, told me half-joking that they were trying to have one truly mad person around in the program each year, for the warped perspective they brought to the group could have unexpected productive repercussions.[326] In the same vein, one research fellow thought that some of the crazy artists that hung around the Sussex Artificial Life group played a beneficial role close to that of the 'trickster' – who transgresses established rules and does not conform to norms of behaviour.[327]

A third strategy to promote diversity among practitioners of Artificial Life at Sussex is welcoming amateurs. I should first clarify the sense in which I use the term 'amateur' in the present context: I use it to qualify individuals who do not derive their main income either from being academics doing primarily Artificial Life research, or from non-academic research activities in Artificial Life. This definition makes it possible to encompass a large array of Artificial Life amateurs, from those who engage into the same activities as their professional counterparts with a similar level of expertise, to those whose involvement is more superficial and inexperienced – all characterized by their enthusiasm for Artificial Life research.[328]

The ALERGIC mailing list is one of the mechanisms through which the Sussex community involves individuals who pursue Artificial Life and evolutionary robotics inspired projects on their spare time. Signing in on the list does not require an academic affiliation, and some ex-EASy or COGS students, who have gone on to pursue day jobs in the private sector, use it to advertise their extra-professional voluntary associations. Two such examples are Brighton Robotics and BuildBrighton, about which I will say more in my case study of the art and science nexus in Artificial Life at Sussex. I have

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[326] Fieldnotes, 29/11/2006.
[327] Fieldnotes, 23/07/2007.
[328] The sociological discussion of 'the amateur' in Stebbins (1977) has been helpful.

met with several individuals in the Sussex neighbourhood, who fit the profile of the amateur researcher. Some, for example, conduct their research activities on their free time or on a part-time basis. One such part-time research fellow at CCNR told me that for him "university [was] kind of a hobby" as it was certainly no money making pursuit; his main source of income by far came from being a free-lance programmer. When I asked him if his Artificial Life research activities eventually brought some payback under the form of transferrable skills into his main breadwinning activities, the answer was negative; he was not using any Artificial Life programming techniques in his job outside university.[329] Another one works full time as an information systems architect for a private transportation company. He has been pursuing "spare time computer projects" in Artificial Life for some years and presents papers and posters at Artificial Life conferences. He is not affiliated with any academic institution, yet he travels down to Sussex University on a regular basis to attend seminars at CCNR, and is invited to give talks there as well.[330]

Apart from these 'true' amateurs, one finds at CCNR career trajectories and lifestyles that negate the norms of a traditionally successful academic career, asserting to a certain extent the value and richness of amateurism. This is for example the case with one of the leaders and founders of the Sussex Artificial Life group. His joining University of Sussex back in 1989 to do postgraduate studies was a mature, career and life changing choice; yet despite choosing from then on to embrace academic life, his ambition is apparently not to rise in the academic hierarchy (his status remains that of a senior research fellow[331]), and he usually goes on sabbatical leave (a real sabbatical, not a research sabbatical) over the winter months to spend time in remote tropical islands.[332]

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[329] Fieldnotes, 23/07/2007.
[330] Fieldnotes, 05/08/2008.
[331] As of February 2009.
[332] Fieldnotes, 21/06/2007, 23/07/2007.

Another middle-aged research fellow was, by his own account, for a time a mathematician, then a musician playing African music, then an analyst-programmer in financial markets research. Shortly after he had a child, he decided to return to academia, and did the EASy MSc at Sussex the first year the programme was opened in 1996. He has never left Sussex since then, as he went on to do a DPhil and then research, diversifying into Artificial Life music along the way. His ambition is to go on doing just this for the rest of his life.[333]

There is a surprisingly strong parallel between these cases, and the account of 19th-century British amateur science by historian Morris Berman:

> "[…] what is involved in avocation […] is the pursuit of one's own interests irrespective of the pressure of a professional network and devoid of the hunger for professional recognition. […] For the amateur there was no advancement, no seeking of the approval of superiors. As a result, […] those pursuing science did so in an unrestricted sort of way. They followed their own interests and took chances in their creative work […]."[334]

In their hunger for a kaleidoscopic array of perspectives, which they hope will keep breaking the disciplinary mould into which their research would run the risk of settling down, in their wariness of specialization and professionalization, the Sussex ALifers are de facto reclaiming a form of amateurism. The value of amateurism against professionalism was actually celebrated by the first keynote speaker of ALIFE XI, a seasoned ALifer who has been around the field for over fifteen years. Both an artist and a scientist, he is close to the Sussex neighbourhood and very well respected by many there, among whom the chair of the conference who introduced him by saying that "he embodies all that is great about Artificial Life." In his speech, he directed the blame at

[333] Fieldnotes, 13/09/2007.
[334] Berman (1975: 40-41).

two major aspects of highly specialized and professionalized contemporary science, which most STS practitioners would happily endorse: the obsessive quest for universality that denies value to the singular and the anecdotal, and the amnesia that has erased from the collective memory of contemporary science that it has many roots in the amateurism of centuries past – indeed, that there was a time when science was entirely the affair of amateurs. He added that despite the continuing work of erasure, amateurism was still a valuable part of science, for instance the great development of non-linear sciences in the 1980s had come to a large extent from amateur scientists, thanks to the personal computer. So on the occasion of ALIFE XI, which was meant to be by its organizers "an extra-multidisciplinary conference", he wanted to promote the amateurism behind Artificial Life, which for him had played a great role so far and was not getting the acknowledgement it deserved.[335]

In the same vein, reflecting on the topic of amateurism in science, a member of the Sussex group observed to me that for some time now he had the feeling that amateurs had a lot to contribute to consciousness science:

> "[…] stuffy professors know surprisingly little about the scope of conscious experience. For that we have to turn to the amateurs who have explored consciousness in depth using a variety of apparently non-scientific methods such as meditation, yoga, body work, psychotropic breathwork, substances, etc…"[336]

3.4 THE STRENGTH OF LINEAGE

To close this section on moral economy, I wish to come back to the sense of lineage revealed by the self-reproducing capacity of the mentor-protégé model. I would

[335] Fieldnotes, 05/05/2008.
[336] Froese, personal communication, 22/04/2010.

like to show that in the case of the Sussex neighbourhood, lineage is not an empty metaphor but is apt at carrying the idea of an inheritance that can be traced, surprisingly intact, through a surprisingly long period of time. Drawing on a collection of essays edited by literary historian and critic David Daiches in 1964, entitled The Idea of a New University: An Experiment in Sussex, I intend to demonstrate that the virtues constitutive of the moral economy of Artificial Life at Sussex were to a large extent mapped into the very foundations of the University of Sussex.

Published as the university was only just completing its third year, Daiches' volume brought together contributions from the academics involved in these early years, who "have tried hard to map out a scheme both for the arts and the sciences, as well as for the relation between the two"[337], as well as from those who had planned and designed the university, and from a 3rd-year undergraduate who communicated his guinea pig experience of the new scheme. Its aim was to offer University of Sussex's "principles and practice as one contribution to the body of knowledge and understanding of the nature and function of a university in this period of history."[338] What does it tell us about the values that these principles and practice were promoting, which could be related, over forty years later, to the moral economy of the Artificial Life group?

First, mentoring and giving of oneself were part of the picture. Teaching was to be based to a large extent on small-size tutorials, and in the arts and social studies, "where the subject matter is less definite and more controversial", thus where "individual attention is indispensable", tutorials would be one-to-one, at most two-to-one.[339] This was providing the appropriate conditions for the development of strong tutor-tutored relationships that fit the mentor-protégé model. As for the mentors giving

[337] Daiches, ed. (1964: 7).
[338] Daiches, ed. (1964 : 8).
[339] Corbett (1964: 27).

of themselves, the 3rd-year undergraduate commented that "[t]he outstanding thing about Sussex is that when needs […] are realized people go out of their way to get things done."[340]

Then, autonomy, individualism, reflexivity, independent critical thinking, were seen as essential to the students' personal development, on which the university founders put a lot of emphasis:

> "As the three years went by, the student would become as 'independent' as he was prepared to be. […] Tutorials would guarantee that the undergraduate spent a great deal of his time thinking, arguing and writing. In other words there would be an active and personal element in the acquisition of knowledge. […T]here was the recognition that a university education involves not merely the acceptance of information or ideas but a personal quest […T]here was a strong argument for leaving scope not only for tutorial argument but for individual deviation and rebellion."[341]

Critical thinking was to be encouraged by the teaching of philosophy, which was intended to play "an unusually large part in undergraduate study. […I]f philosophy is conceived, in the Socratic manner, as the relentless probing of assumptions, come then what may, there is a strong case for the view that it is both possible and desirable to give it a central role in the education of undergraduates".[342]

Finally, diversity was welcomed, and its impact maximized through the constitution of hybrid research centres and schools of studies. A detailed account of how diversity and interdisciplinarity were inscribed in the founding charter of the University of Sussex is to be found in the next section.

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[340] Hawkins (1964: 195).
[341] Briggs (1964: 65-66).
[342] Corbett (1964: 32-33).

Ultimately, the key to understanding the strength of the lineage that runs from the blueprints for the new University of Sussex set down by its founders in the early 1960s, to the Artificial Life group in the years 2000s, may reside in a comment by Asa Briggs:

> "The main interest was in planning not for present change but for future change. There are likely to be immense rearrangements in the map of learning during the next fifty years […W]e were more interested in establishing conditions for growth than in plotting a map of learning for the 1960s."[343]

4. AN ETHOS OF INTERDISCIPLINARITY

I have highlighted that sustaining a high level of diversity within the Artificial Life research group was a characteristic of CCNR's moral economy, and I have identified different foraging strategies they use to achieve their goal: reaching outside the field, widening the recruitment, welcoming amateurs. This in itself is already strong evidence that the Sussex neighbourhood possesses an ethos of interdisciplinarity. What independent indicators would reinforce that conclusion?

The first would be the localisation of the group within the university's organisation. The complexity of its physical implantation on the campus,[344] which took me a while to master, echoes an even greater complexity at the organisational level. The website of the University of Sussex does not lie when it states that "Sussex is distinctive both academically and organisationally", structured as it is in Schools of Study and Graduate Research Centres "rather than more traditional faculties or departments".[345] It is certainly organisationally distinctive, and utterly bewildering to the eyes of the

[343] Briggs (1964: 66-67).
[344] It is implanted across two buildings, one of which labyrinthine.
[345] http://www.sussex.ac.uk/about/index.html, consulted 09/10/2008.

average observer. The individuals gravitating in the Artificial Life sphere at Sussex, depending on whom one speaks to and when, would say that they belong either to CCNR (Centre for Computational Neuroscience and Robotics), or to Informatics, or to COGS (Centre for Research in cOGnitive Sciences), or to the EASy (Evolutionary and Adaptive Sytems) group.

The webpages for these various entities show that there is indeed a strong overlap between them, but no identity.[346] Members of CCNR are usually affiliated to Informatics, which used to be in the School of Science and Technology until the said school stopped existing; yet CCNR is presented as sitting between the EASy group and the Sussex Centre for Neuroscience, the latter being an interdisciplinary venture between the School of Life Sciences (more especially the department of Psychology) and Informatics. Then there is COGS, which has been somewhat dismantled in the early 2000s, of which a good many in CCNR are still faculty members. According to its mission statement, COGS “fosters interaction and collaboration among all those working in Cognitive Science at Sussex, including researchers and students in Artificial Intelligence, Psychology, Linguistics, Neuroscience and Philosophy”.[347] Looking at where these various fields are housed in Sussex organisation, one finds that Artificial Intelligence (among whom many ALifers) belongs to Informatics; Psychology is in the School of Life Sciences; Neuroscience, as we have seen already, straddles the School of Life Sciences and Informatics; and Linguistics and Philosophy belong to the School of Humanities. The research students enrolled in the doctoral programmed of CCNR do not graduate as doctors in science as one might have expected but are delivered a DPhil.

[346] CCNR members: http://www.informatics.sussex.ac.uk/research/groups/ccnr/people.html, consulted 18/06/2009; COGS members: http://www.sussex.ac.uk/cogs/1-5-11.html, consulted 18/06/2009; EASy members: http://www.informatics.sussex.ac.uk/research/groups/easy/members/, consulted 18/06/2009.
[347] http://www.sussex.ac.uk/cogs/index.php, consulted 09/10/2008.

Finally, many at CCNR (and COGS, and the EASy group) are also members of the Creative Systems Lab;[348] home “to a group of researchers and students who are interested in using computers to model, enrich and extend creative processes and practices”, it takes its roots in the work of artists and musicians involved with CCNR.[349] In addition, a Sussex ALifer pointed to me that:

> “For several years now there has also been an informal discussion/seminar group called the ‘Life and Mind’ group. This originated out of a dissatisfaction with the prevalence of analytic philosophy within the department, and aimed to create a space where social sciences, continental phenomenology and systems biology could come together.”[350]

In the end, giving a clear picture of what exactly the Artificial Life research group at Sussex corresponds to and where it fits in the university organisation appears a lost cause, and maybe is it intended to be so. Incidentally, this post-justifies my choice to address it as a neighbourhood, which takes into account its complex fuzziness, its flexibility, and places the emphasis on the inter-personal ties shared by members of the group. I have retained CCNR (over COGS or the EASy group) as the flagship locus for Artificial Life at the University of Sussex, both because the Sussex ALifers I have encountered were all affiliated with CCNR (and EASy) but not all with COGS as well, and because the official affiliation appearing on their papers is invariably CCNR. But in effect, the Sussex Artificial Life research group hovers informally at the edges of a wide variety of fields and disciplines, which gives it an unparalleled flexibility when it comes to setting up interdisciplinary projects.

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[348] Creative Systems Lab members: http://www.informatics.sussex.ac.uk/courses/creative-systems/people.htm, consulted 18/06/2009.
[349] http://www.informatics.sussex.ac.uk/courses/creative-systems/home.htm, consulted 18/06/2009.
[350] Froese, personal communication, 30/04/2010.

It is indeed in the realm of interdisciplinary projects that another independent indicator of CCNR's ethos of interdisciplinarity is to be found, among the major research grants that it has been awarded in the past few years. Five major funded projects are showcased on CCNR website.[351] Four have benefited from traditional scientific sources of funding: three by the British EPSRC (Engineering and Physical Sciences Research Council) and one by the European Space Agency; their topics all fall squarely within the realm of science and engineering. The remaining one, funded by the British AHRC (Arts and Humanities Research Council), was a three-year £310,770 project entitled "Computational Intelligence, Creativity and Cognition: a multidisciplinary investigation", conducted from 2005 to 2008. [352] Otherwise known as the DrawBots project, it involved scientists, philosophers, artists and critical theorists collaborating into three inter-related teams, an Art and Science team, an Artificial Intelligence and Cognitive team, and an Art Theory team[353]. The aim of the project was "[…] to investigate the relationship between contemporary theories of creativity and the arts and of those of artificial life and artificial intelligence."[354]

I take the DrawBots Project to be a paradigmatic case of proactive interdisciplinarity. Why proactive? Projects bringing together scientists, philosophers and artists are certainly not unheard of, at least in the United Kingdom where research councils as well as other institutions are promoting such collaborations on a regular basis. The involvement of critical theorists is more unusual, and this unlikely

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[351] http://www.informatics.sussex.ac.uk/research/groups/ccnr/research.html, consulted 10/10/2008.
[352] http://www.informatics.sussex.ac.uk/research/groups/ccnr/research/creativity.html, consulted 22/10/2008; also AHRC website (http://www.ahrc.ac.uk/Pages/default.aspx) , consulted 11/05/2007; Award holder is Margaret Boden, philosopher, Research Professor of Cognitive Science at COGS, who was founding Dean of Sussex University's School of Cognitive and Computing Sciences (now Informatics); besides Professor Boden, two investigators and one researcher are members of CCNR.
[353] http://www.informatics.sussex.ac.uk/research/groups/ccnr/research/creativity.html, consulted 09/10/2008.
[354] Arts-humanities.net website, case study of Drawbots Project, http://www.arts-humanities.net/casestudy/drawbots_project_computational_intelligence_creativity_cognition_multidisciplinary_investi, downloaded 18/06/2009.

assemblage hints at a solid upstream collaboration predating the award. And certainly, the upstream collaboration, born from longstanding inter-personal ties, was strong, determined and enduring. The project was not set up in response to a call for interdisciplinary proposals; nor was the AHRC award easy to secure; on the contrary, the project was rejected several times and it took its initiators some years to get it right.[355] The DrawBots project was thus a project that was not opportunistically interdisciplinary, but rather proactively interdisciplinary.

Lastly, I would like to bring in some circumstantial evidence of CCNR's interdisciplinary ethos, through the long history of interdisciplinarity at the University of Sussex. Interdisciplinarity has been part of the ethos of University of Sussex since its inception and to this day. The university website informs us that over forty years after it came into existence in 1961, the main academic strengths characterizing the University of Sussex are "research excellence, internationalism and interdisciplinarity". It explains how its overall organisation is distinctive and geared towards interdisciplinarity:

> "The commitment to interdisciplinarity, whereby students are encouraged to broaden their academic horizons by studying topics other than those directly allied to their major subject, remains strong. Reinforcing this approach, the University is organised into Schools of Study and Graduate Research Centres, rather than more traditional faculties or departments, promoting the cross fertilisation of knowledge between subjects."[356]

This could be mere window-dressing but there are other sources of evidence corroborating that Sussex has a long-standing ethos of interdisciplinarity.

I will not expand on the distinctively complex and deliberately fuzzy aspect of its organisation, I have already illustrated it through the example of the Artificial Life

[355] Fieldnotes, 26/04/2007; Interview transcript, 24/05/2007.
[356] http://www.sussex.ac.uk/about/index.html, consulted 09/10/2008.

research group. Let me just point that it enables researchers to somewhat tailor their environment to their taste and facilitates highly interdisciplinary intersections. I will turn instead to individual experiences of interdisciplinarity at Sussex. I will first consider the case of one of the leaders and founders of the Artificial Life group. Having initially trained in physics and spent time working in the private sector, he eventually joined COGS in 1989, the year in which he was awarded the first PhD in the UK on the topic of GAs (genetic algorithms), which are among the main tools used in synthetic simulation. According to him, the reason he was recruited by Aaron Sloman, who then held the Chair in Artificial Intelligence and Cognitive Science at Sussex, was specifically for his competence and interest in non-mainstream AI, i.e. for his embracing a philosophy of cognitive behaviour that was a fringe phenomenon.[357] In return, an important reason why he accepted the position was the wide-ranging interdisciplinarity encouraged by University of Sussex, which offered an appropriate environment for the fusing of his artistic and scientific interests:

> "I've never really had personal boundaries between art and science, myself. I come from a music background […]. Science and art, that's always the worlds I have always in part inhabited. And so, I've always been interested, you know, in trying to merge the two. It wasn't always possible. It certainly wasn't very easy. At the start of my scientific career it was very difficult. You know, it was not the done thing and it was very hard to try and get a little bit. It is one of the things that attracted me at Sussex, it was again that interdisciplinarity, it was absolutely fine here."[358]

This personal testimony highlights that an ethos of interdisciplinarity, in a space such as the Sussex neighbourhood of Artificial Life, and such as University of Sussex more

[357] Interview transcript, 31/05/2007.
[358] Interview transcript, 12/07/2007.

generally, does not just promote hybridization by paving the ground for interdisciplinary projects. It is also likely to attract individuals who display an ‘inner’ interdisciplinarity – who are themselves, so to speak, ‘voluntary hybrids’, i.e. who have hybrid interests and skills and refuse to dichotomize them. I will return to this aspect of interdisciplinarity in the next chapter.

Moving outside the sphere of the Artificial life research group, a case in point of interdisciplinary experience at Sussex appears to have been that of the late Roger Silverstone, pioneer of media studies, between 1991 and 1998. It is well documented in an essay by an ex-colleague of his, entitled “Home, Work and Everyday Life: Roger Silverstone at Sussex”.[359] These are extracts of her essay:

> “Perhaps academically Roger felt most ‘at home’ in Sociology and Media Studies, but he gladly and adventurously went travelling across many other fields in his quest to find an approach that was adequate to the task of understanding the media […]. It was fitting, then, that Roger should take up a Chair at the University of Sussex, an institution which, since its inception in the 1960s, has prided itself on its commitment to interdisciplinarity. […M]y own first sense of Roger’s approach to Media Studies at Sussex was one that did not necessarily recognize conventional disciplinary boundaries. […] Roger became the Chair of the Media Studies ‘Subject Group’ which worked across two interdisciplinary Schools […]. This framework fostered engagement with colleagues across many different subject areas […]. Just as importantly, it brought students together in the seminar room from a wide variety of intellectual traditions to discuss concepts in common across disciplinary boundaries. Roger clearly thrived in this environment […]. The

[359] Lacey (2007).

> interdisciplinary ethos certainly also lay at the heart of his plans for the Graduate Research Centre in Culture and Communication […], which came into existence in 1994, with Roger as his first Director. It brought together researchers and students in the fields of Media and Cultural Studies, Music, English, Women's Studies, Social Anthropology, Sociology, History of Art and Museology. […] He was particularly committed to defining a space for work across the social sciences and humanities, the separation of which he described as a 'kind of atavistic binarism which is totally unacceptable'[…]. The book he edited within [the Sussex Studies in Culture and Communication series], *Visions of Suburbia*, is, in his own words, 'very Sussex'. He called it, 'the product of an interdisciplinary environment that really does work' and claimed it would have been 'inconceivable', at least for him, anywhere else […]."[360]

This very long quotation hardly does justice to the account of Silverstone's experience of interdisciplinarity at Sussex that Lacey has given us, yet it provides a useful sketch of its main characteristics. Especially, it reveals strong parallels with the characterization I have given of CCNR's ethos of interdisciplinarity: the emphasis put on diversity, the refusal of conventional boundaries, the distinctively complex and deliberately fuzzy organisation of teaching and research, the unconventional interdisciplinary projects. And as in the previous individual case, it also gives a hint that Sussex ethos of interdisciplinary may be attractive to a certain type of voluntarily 'hybrid' individuals.

Finally, a major primary source documenting the distinct interdisciplinary character of the University of Sussex is, again, Daiches' <u>The Idea of a New University: An Experiment in Sussex</u>. It is striking that although the term 'interdisciplinary', or any

[360] Lacey (2007: 64-65).

of its variations and relatives, such as transdisciplinary, crossdisciplinary, multidisciplinary, etc, does not appear anywhere in the essays (we have to surmise it had not yet come into fashion), some of the characteristic traits of CCNR's (and more broadly Sussex's) ethos of interdisciplinarity were, again, deliberately inscribed into the founding charter of University of Sussex. Considering that the individuals involved in the beginnings of University of Sussex – beginnings which were at best the promise of a future – were to a large extent experimenting in uncharted territory, it is an extraordinary achievement that their blueprint should have had such a lasting outcome.

How was the germ of a fully fledged ethos of interdisciplinarity thus inscribed into the Sussex experiment? First, diversity in the student population was not considered a problem to be managed but an asset to be encouraged:

> "[The undergraduates] should be so selected that they will form a rich diverse body, stimulating the whole university through differences of social origin, of educational background, and of vocational motive."[361]

Then, flexibility of mind was thought to be a mandatory skill in the ever faster changing world of the sixties, and as a consequence:

> "It was accepted that such flexibility would be encouraged and sustained if a main discipline studied in depth were accompanied by cognate, 'minor', 'contextual' subjects which would naturally illuminate and be illuminated by the 'major' subject and by one another. […] All that need be said in general is to record the striking degree of willingness to exchange the narrower dominion of the single-subject course for the freedom to

[361] Fulton (1964: 20).

> contribute from the angle of one's own subject […] to the understanding of a more complex whole."[362]

This both outlined and justified the holistic approach to subjects of study that was the founding principle of the original system of interdisciplinary schools of study and graduate research centres (rather than conventional faculties and departments) which would organize the University of Sussex. The conception of the schools of study, geared towards interdisciplinarity, was quite innovative, and pre-figured the present fuzzy complexity of Sussex organisation:

> "The Schools were envisaged not as super-departments, to which 'subjects' were attached, but as centres of linked studies, some of which would be shared with other Schools."[363]

The multi-perspective approach went down to the most practical aspects of teaching, with the hope that it would be good not only for the students but also for the teachers:

> "[…] we propose to make much use of seminars held by two or more teachers whose different interests and skills converge on a particular topic. We believe that seminars of this kind will not only be very stimulating to students but will provoke fresh thoughts among those who conduct them. We are all to some extent prisoners of the academic classifications in which we are placed; it does us good to have to move outside them."[364]

The multi-perspective approach to teaching was certainly very well adapted to train future 'voluntary hybrids', and to encourage latent dispositions to inner interdisciplinarity in the teachers themselves. Overall, active anti-dualist interdisciplinarity was the answer of Sussex founders to the dangers of narrow-

[362] Fulton (1964: 18).
[363] Briggs (1964: 62).
[364] Corbett (1964: 26).

mindedness born from un-reflexive overspecialization.[365] It was, more generally, their response to C.P. Snow's 'Two Cultures', which they recast rather as a threesome than a twosome issue:

> "[…] the answer to the question of 'the two cultures' – a question which is often formulated in such a way that the role of the social studies is completely ignored – seemed to be to seek for 'natural links' between arts and sciences and to strengthen them."[366]

To close this section, I wish to make a final point that concerns my inquiry into both the moral economy of the Artificial Life group at Sussex and its ethos of interdisciplinarity. Kohler has warned us that "[c]lose inspection of group behavior takes us a good way toward understanding why they do what they do, but it risks a vulgar functionalism, which explains behaviour in terms of its benefits to group members but leaves unexamined how conceptions of 'benefit' and its proper pursuit derive from the larger social context."[367] Although I have not attempted to relate to a larger social context the benefits that the Artificial Life group at Sussex appear to derive from its moral economy, or from its ethos of interdisciplinarity, I believe that I have nonetheless avoided vulgar functionalism. Falling in line with Daston's view that a moral economy is "a psychology at the level of whole cultures, or at least subcultures, one that takes root within and is shaped by quite particular historical circumstances" ,[368] I have shown instead that the distinct features of CCNR's moral economy and ethos of interdisciplinarity were highly localised and embedded into the historical fabric of the

[365] For instance, Briggs (1964: 63).
[366] Briggs (1964: 76); following the passage quoted, Briggs gives a list of examples of possible links that were examined, which taken together outline a very STS sort of research programme; Briggs deems them to be "a proper part of a scientific education", as well as "natural extensions of interest for many arts students also, or perhaps more particularly of students in the social studies." (76-77).
[367] Kohler (1995 : 252).
[368] Daston (1995 : 5).

University of Sussex. Indeed, it looks as if, in keeping with Roger Silverstone's testimony, it could not have happened anywhere else but at Sussex.

5. MORE MANIFEST NON-MODERNITY

In the present chapter, I have defined what I have come to call the 'Sussex neighbourhood', justifying its choice for an in-depth case study of research communities native to the extended trading zone. I have investigated the salient features characterizing the moral economy of CCNR, the material centre and cultural attractor of the Sussex neighbourhood, along with its enrolment and enculturation processes. I have also investigated its ethos of interdisciplinarity. To conclude, I would like to anticipate once more on the argument that I will develop in the final chapter, by relating some findings of the present chapter to the idea of non-modernity.

I have highlighted that the mentor-protégé model was the mechanism through which the moral economy of the Sussex neighbourhood was reproducing itself. Another salient characteristic of the mentor-protégé model is that it is well adapted to the transmission of skilled crafts, best learnt through role-model teaching. And indeed, building robots is foremost a craft, a skilled artisanal practice. Writing software is much the same. One of my informants said it was a 'black art',[369] a term often used in computer science to qualify practices that are uncertain, opaque and especially difficult to abstract into reproducible methods – hence difficult to blackbox and propagate. The research practices of Sussex ALifers have thus more in common with artisanal crafts, paradigmatically associated with the pre-modern era, than with the ideal of modern science.

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[369] Fieldnotes, 11/09/2007.

Sussex ALifers proudly own the artisanal nature of their work when, for instance, they characterise themselves as doing “mechanical philosophy” or “philosophy with a screwdriver”. Risan’s ethnography reveals that, already in the mid-1990s, part of the Sussex Artificial Life group chose to call themselves engineers, in the sense that they made machines rather than discovered nature. Risan analysed this claim as “a rejection of the value scale in which *engineering* was seen as a less respectable endeavour than *science*. The role of the *engineer* – and the creative process, the process of creation – was given increased value.”[370] One of his informants went as far as stating provocatively:

> “We would get in trouble with the funding agencies if we admitted openly that it was a kind of art or self-expression we were doing, and nothing more. So we will have to claim that it is engineering we are doing. We are, and we will have to be, closet artists clothed as engineers.”[371]

By proudly reclaiming the creative, both artisanal and artistic, dimension of their work, by highlighting its individual, non-standardized, non-replicable character, by contesting the superiority of science over engineering (a normative categorisation especially strong in Great Britain, where contrary to many other European countries the title of ‘engineer’ is not subordinated to having an appropriate academic qualification and where as a consequence scientists are especially prone to look down their nose at engineers), ALifers in the Sussex neighbourhood deny the work of purification which, according to Latour, was started by the likes of Boyle and Hobbes, and has been a staple of the modern critical stance ever since.[372] The foraging strategies destined to encourage diversity can be read in exactly the same light.

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[370] Risan (1997a), chapter 3.
[371] Risan (1997a), chapter 3.
[372] Latour (1993:15-32).

Erasure and categorization are intrinsic to the process of purification that Latour has described, and translate into much boundary work to demarcate both science from non-science and research traditions from one another. Handmaiden to the purification process, boundary work helps maintaining watertight categories and erasing the existence of hybrids. Boundaries were precisely a theme on which one of the founders and leaders of Artificial Life at Sussex chose to dwell during one of our interviews. It came up when I questioned him on the topic of art and science in Artificial Life. In keeping with CCNR's ethos of interdisciplinarity, he thought that the interaction with art was beneficial to the science. Even when it was just the kind of interaction where scientists and artists work alongside but separately, it allowed them both to start seeing things in a slightly different way. But he was not content with this limited form of interaction:

> "[…] what's more interesting is actually when you start dismantling the boundaries, just start doing this work which can be looked at as both science and art. I just think that that kind of work, […] stuff on the boundaries really interest me.[…] So I can claim that's where really lots of exciting creative stuff comes from. It's just personally why I have always been around boundaries of science and history and art and partly… whatever, any boundary would do. But also, you know, that's always been a kind of personal drive for me, always, and I guess for quite a few people here, that's why they came to Sussex in the first place. So we try and keep that alive. But, apart from it being a personal kind of interest and pleasure I have out of it, things just happen when you start doing stuff like that. […] I just find it is a fine way of keeping things moving."

This personal statement ties up very neatly with some of the views expressed by another founder and leader of the Sussex neighbourhood, that a healthy research context for Artificial Life is one in which it can remain “a repository of flaky ideas […] outside the structured disciplines”, and that he is quite satisfied to belong to a group of “cockroach scientists doing science in the cracks”.[373] I have quoted the passage at length, for it is a glaring illustration that the kind of interdisciplinarity met with in the Sussex neighbourhood of Artificial Life may be of a different nature, may obey a different dynamic, than that which results from bringing together well-bounded blocks from established disciplines. Rather, it is a form of interdisciplinarity that comes into existence through the utterly non-modern move of explicitly blurring and dismantling boundaries, and thriving in the resulting gaps. The following chapter explores the actual practice of interdisciplinarity in the Sussex neighbourhood through its most visibly distinct manifestations: the strong continental philosophy streak, the reclaiming of hybrid historical roots, the art and science relationship.

[373] Noble, Bullock & Di Paolo (2000: 146-147); Fieldnotes, 29/11/2006.

Chapter 5: Interdisciplinary practices in the Sussex neighbourhood

1. INTRODUCTION

Second part in the case study of the Sussex neighbourhood, the present chapter sets out to answer the last of the research questions put forward at the start of the previous chapter: what can it contribute to our understanding of interdisciplinary practices in research communities native to the extended trading zone? The chapter's focus is an empirical investigation into the Sussex neighbourhood's interdisciplinary practices that straddle the 'two cultures' divide. I have deliberately targeted forms of research that cross over the sciences, arts and humanities, including traditionally separate schools of thought, because such practices are more especially illustrative of the hybridizing power that I claim for the extended trading zone. My investigation has retained three areas of interest, as the most visible manifestations, in the Sussex neighbourhood, of the kind of interdisciplinarity I was looking for: (1) the strong continental philosophy streak, (2) the reclaiming of hybrid historical roots, (3) the art-science connection.

Interdisciplinarity is multiple, may come in many flavours and obey different dynamics. I propose to filter, interpret and organize the empirical material that I have collected in the three areas of interest, through the analytical grid proposed in the conclusions of the project "Interdisciplinarity and Society: A Critical Comparative Study", led by Andrew Barry, Georgina Born and Marilyn Strathern between 2004 and 2006 as part of the British ESRC 'Science in Society' programme. There are good reasons for adopting the analytical framework elaborated by Barry, Born and Strathern's research team. The timeframe of my project has been roughly contemporary to theirs;

their study, like mine, has targeted interdisciplinary practices bridging the ‘two cultures’ divide; both have been empirical investigations; one of their in-depth case studies has been art-science, which has also been a focus of my investigation. Because of these strong parallels, our respective findings lend themselves to comparison, and evaluating whether my own results support or contradict theirs is of interest for the validation and refining of their conclusions.

Section 2 will broadly present the “Interdisciplinarity and Society” project along with the thought-provoking typology of interdisciplinarity that its investigators have proposed as a result. Sections 3, 4 and 5 will explore interdisciplinary practices in the three areas of interest that I have retained, i.e. the strong continental philosophy streak, the reclaiming of hybrid historical roots and the art-science connection, situating these against the different modes and logics of interdisciplinarity isolated by Barry et al. Section 6 will deepen the analysis of interdisciplinarity in the Sussex neighbourhood, in the light both of Barry et al.’s conclusions and of my findings in prior chapters.

2. AN EMPIRICAL INVESTIGATION INTO INTERDISCIPLINARITY

The project “Interdisciplinarity and Society: A Critical Comparative Study” was led between 2004 and 2006 by Andrew Barry, Georgina Born and Marilyn Strathern as part of the British ESRC ‘Science in Society’ programme. It sprung from the observation that although interdisciplinarity was at the foreground in contemporary discourses on the future of scientific and technological research, interdisciplinary research practices had been devoted little empirical investigation. The project aimed to account for the different types of interdisciplinarity found in research fields that bring together researchers from across the arts, the natural sciences and the social sciences divides.

The decision to focus on interdisciplinary forms of research straddling the ‘two cultures’ chasm followed from a different rationale than the one guiding my own inquiry. In my case it was because such practices would better illustrate the hybridizing power that I claimed for the extended trading zone. In the case of Barry et al. it was because “these kinds of interdisciplinary research […] are thought to have greatest significance in the transition to a new mode of knowledge production, auguring closer relations between science and society.”[374] The mapping survey conducted at the beginning of the project identified three fields of interdisciplinarity whose apparent richness deserved an in-depth analysis: art-science, environmental and climate change research, ethnography in the IT industry. [375]

A major and thought-provoking result of Barry et al.’s eighteen-months comparative empirical study into these three fields was to question “influential contemporary accounts of interdisciplinarity, in which it is portrayed as offering new ways of rendering science accountable to society and/or of forging closer relations between scientific research and innovation.”[376] First, contrary to a commonly held assumption about interdisciplinarity, the project investigators were led to conclude that the relations between disciplinary and interdisciplinary forms could not be reduced to the ‘integrative-synthesis’ mode of interdisciplinarity, in which an interdisciplinary field simply results from the integration of two or more ‘antecedent disciplines’.[377] They identified two other modes of interdisciplinarity (ideal types that may coexist in some cases): the ‘subordination-service’ mode, in which “one or more disciplines are organized in a relation of subordination or service to other component disciplines”,[378] and the ‘agonistic-antagonistic’ mode, in which “interdisciplinary research is conceived

[374] Barry, Born & Weszkalnys (2008: 22).
[375] Weszkalnys (2006: 2-3).
[376] Barry, Born & Weszkalnys (2008: 20).
[377] Barry, Born & Weszkalnys (2008: 28).
[378] Barry, Born & Weszkalnys (2008: 28).

neither as a synthesis nor in terms of a disciplinary division of labour, but as driven by an agonistic or antagonistic relation to existing forms of disciplinary knowledge and practice."[379] To the investigators, this last mode revealed that some interdisciplinary fields and practices result "from a commitment or desire to contest or transcend the given epistemological and ontological assumptions of historical disciplines."[380]

Considering my analysis in chapter 3 of the issues (uncertain institutional and disciplinary positioning, uncertain epistemological grounds) that keep plaguing Artificial Life since its inception, we can surmise that the dominant mode of interdisciplinarity in Artificial Life should be the 'agonistic-antagonistic' mode. It is not clear that the field of Artificial Life has antecedent disciplines in the sense that Barry, Born and Weszkalnys appear to conceptualize inter-disciplines; its very existence was predicated from the start on its own set of hypotheses and methods, and it has tried to carve out a space for itself at the margins of established disciplines. Yet its crossed relationship with biology, its challenge to the traditions of Artificial Intelligence and cognitive science, the disregard that other complexity sciences appear to have for its suspicious wooliness, all indicate that it is agonistic-antagonistic to many established fields of research. As a Sussex ALifer put it to me, "ALife […] is a bit of a trickster to mainstream science".[381]

As a matter of fact, the trading zone of Artificial Life, anchored in the premise that computerized synthetic systems are relevant to understanding biological, cognitive and socio-cultural processes (should I describe it as a Kuhnian paradigm?), seems to act as a refuge for individuals dissatisfied with their original disciplines. For example, at ECAL 2007, I met with a research fellow whose original field was linguistics. He was currently working within an Artificial Life research group, and was attending there his

[379] Barry, Born & Weszkalnys (2008: 29).
[380] Barry, Born & Weszkalnys (2008: 29).
[381] Froese, personal communication, 22/04/2010.

first conference in Artificial Life. I asked him how he had ended up there and how he felt about the conference. His answer was, for a long time he thought he was doing linguistics, but increasingly his papers were rejected by linguistics journals and instead were accepted by Artificial Life-sympathetic periodicals, so he had taken the cue that maybe what he was doing, although in the areas of syntax and of the cultural evolution of language, was more at home in Artificial Life than in linguistics. This is how he had eventually ended up with a fellowship in an Artificial Life research group. The conference was achieving to convince him that what he was doing was really Artificial Life.[382] Another misfit who has eventually settled in Artificial Life had first gained a PhD in physics, before becoming disgruntled with physicists and the physics establishment. As a consequence, he had done a master degree in science and technology studies and had by his own account turned into an infamous social constructivist. He had eventually returned to science, but he was by then more attracted by biological complex systems than physics, so he ended up doing another PhD, this time in Artificial Life, in a department of Logic and Philosophy of Science.[383] The appeal of Artificial Life as a haven for misfits may be such that at ALIFE XI, an artist-scientist who is a long-time and well-respected member of the Artificial Life community complained to me that he was weary of all the time receiving emails and having people come to him, who were all sorts of 'weirdos' – it made him wonder, what kind of things people thought he was doing?[384] As for the Sussex neighbourhood in particular, my study of their moral economy and their ethos of interdisciplinarity indicates that overall they seem to relish being in agonistic-antagonistic mode – for example when promoting Artificial Life as "a repository for flaky ideas", when claiming that they are "cockroach scientists doing science in the cracks", when

[382] Fieldnotes, 12/09/2007.
[383] Fieldnotes, 07/08/2008.
[384] Fieldnotes, 07/08/2008.

defending the role of Artificial Life as umbrella for unorthodox pursuits, when confessing their taste for the dismantling of disciplinary boundaries, etc. This first evaluation of Artificial Life in the Sussex neighbourhood as being predominantly in agonistic-antagonistic mode towards its neighbouring research fields will gain in substance in sections 3, 4 and 5.

Alongside the three modes characterizing the relations between interdisciplinary and disciplinary forms of life, the investigators of the "Interdisciplinarity and Society" project have identified three different logics governing how interdisciplinarity is justified by practitioners, sponsors and policy makers: the logics of accountability, of innovation and of ontology. When framed by the logic of accountability, interdisciplinarity "is guided by the idea that it helps to foster a culture of accountability, breaking down the barriers between science and society, leading to greater interaction, for instance, between scientists and various publics and stakeholders."[385] The authors have found that accountability covered a full range of possibilities, "from legitimation and regulation to radically critical and militant forms."[386] The logic of innovation, which they have found most pronounced in the area of ethnography in the IT industry, can gear interdisciplinarity towards both short-term goals like better adapting product design to user needs, and longer-term goals such as altering the corporate imagination.[387] In the logic of ontology, interdisciplinarity finds its justification in the shortcomings of existing ontologies, by proposing alternate perspectives on the objects of knowledge – which makes it irreducible to 'antecedent disciplines'.[388] According to Barry et al., existing accounts on interdisciplinarity tend to conflate and emphasise accountability and innovation but ignore the logic of ontology;

[385] Barry, Born & Weszkalnys (2008: 31).
[386] Barry (2007: 26).
[387] Barry (2007: 26).
[388] Barry (2007: 27); Barry, Born & Weszkalnys (2008: 29).

instead, in their findings, the three logics "are non-exclusive and are often entangled, but are nonetheless analytically distinct."[389] As for the relationship between modes and logics of interdisciplinarity, on the basis of their case studies, they have found that "the salient point is that only the agonistic-antagonistic mode is associated with the logic of ontology and the attempt to transcend the given ontology of existing disciplines and interdisciplines. But this mode can equally be associated with those practices in which the logic of ontology is combined with that of accountability […] or of innovation […]."[390]

In sections 3, 4 and 5, I will examine how interdisciplinary practices in the three areas of interest that I have retained fit the typology of interdisciplinarity provided by Barry et al., and whether they converge towards a predominant type of interdisciplinarity. In particular, if the agonistic-antagonistic mode proves, as it appears in a first approximation, to be the dominant mode of interdisciplinarity in the Sussex neighbourhood, I will consider whether the logic of ontology predominates as well, or whether my case study of Artificial Life in the Sussex neighbourhood contradicts the conclusions of the "Interdisciplinarity and Society" project.

3. NATURALIZING PHENOMENOLOGY

The present section picks up on the discussion of embodied-embedded cognition, subjects and objects initiated in chapter 3. The main difference, apart from the increased depth of analysis, is one of focus. In chapter 3, the embodied-embedded cognition current in Artificial Life was accessory to my focus on the epistemology of simulation. I introduced just enough of it to frame the rejection of the subject-object divide by part of the Artificial Life community, and from there to establish a causal link

[389] Barry (2007: 26).
[390] Barry (2007: 2).

between allegiance to embodied-embedded theories of cognition and concern with the epistemological status of simulations. In the present section, the embodied-embedded cognition current in Artificial Life takes centre stage, as it fosters practices of which I investigate the interdisciplinary character. I will demonstrate that it gives rise, in the Sussex neighbourhood, to interdisciplinary research programmes that cross over the sciences and humanities divide, are in agonistic-antagonistic mode, and follow a logic of ontology.

3.1 A VERY 'SUSSEX' PURSUIT

For the sake of intelligibility, let me give a brief introduction to embodied-embedded cognitive science. I have previously explained that a main tenet of the embodied-embedded cognition current in Artificial Life is, to use an oversimplifying yet catchy formula heard in the field, that 'life = cognition', where cognition is understood in a broad, non-anthropocentric sense of the term, encompassing the simplest kind of animals, plants even. Tractability is not the main driver behind this interest in so-called low-level cognition (although the artificial synthesis of low-level cognitive functions may look like an easier target than that of high-level ones). A fundamental reason for the focus on low-level cognition is revealed in the following attempt at delineating embodied-embedded cognitive science:

> "[…] the embodied-embedded approach is the offspring of four parallel claims: (1) that online intelligence […] is the primary kind of intelligence; (2) that online intelligence is typically generated through complex causal interactions in an extended brain-body-environment system; (3) that cognitive science should increase its level of biological sensitivity; and (4) that cognitive science should adopt a dynamical systems perspective. […]

> the primary expression of biological intelligence, even in humans, consists not in doing math or logic, but in the capacity to exhibit […] *online intelligence*. […] A creature displays online intelligence just when it produces a suite of fluid and flexible real-time adaptive responses to incoming sensory stimuli."[391]

According to Harvey, low-level cognition is eventually key to understanding all kinds of intelligence:

> "[…] from my perspective, […] start at the bottom is my motto, and if we could understand C-elegans, […] if we can really understand what makes that tick, what is the difference between that and a dead alarm clock, then […] we are 90% of the way towards understanding human beings."[392]

The top names appearing repeatedly as philosophical inspiration for the embodied-embedded theories of cognition used to frame the development of Artificial Life simulations are phenomenologists Husserl, Heidegger and Merleau-Ponty, as well as biologist-philosopher-neuroscientist Varela, who developed the concept of autopoiesis with Maturana and later the enactive approach to perception with Thompson and Rosch.

Now, is the embodied-embedded approach distinctive of Artificial Life in the Sussex neighbourhood? Although the two individuals I have just quoted are both members of this research community, Sussex ALifers are certainly not alone in the Artificial Life landscape to develop research projects framed by embodied-embedded theories of cognition. But outside the Sussex neighbourhood, most of the research in that area that is presented at Artificial Life conferences is conducted by individuals / groups whom Sussex has strong ties with; and my field experience of Artificial Life conferences has shown that Sussex dominates the scene. Dominance in the area of

[391] Wheeler (2005: 11-12).
[392] Extract from Inman Harvey's keynote lecture at ALIFE X, "Morphologies, Motion and Cognition" workshop, 03/06/2006.

embodied-embedded Artificial Life was actually one of the pointers, which first led me to suspect the existence of a community-within-the-community that I came to identify, in time, as the Sussex neighbourhood: they were the organizers, and predominant audience, of the "Morphologies, Motion and Cognition" day-long workshop at ALIFE X, with its unusual emphasis on anti-dualism, embodied-embedded cognition and action-perception. Then, at ECAL 2007, particularly on the day dedicated to "Embodiment and Cognition", some took exception with the hegemony of the Sussex group whose members were allegedly all hammering the same message, in the same dialect, about embodiment and dynamical systems; and commenting on this critique, one of my informants in the Sussex group acknowledged that although they were a very diverse group, what could account for this perception of uniformity was the especially high philosophical component of their work, and more precisely their unusually strong continental philosophy streak.[393]

But to me, nowhere was the distinctively deep involvement of the Sussex neighbourhood with embodied-embedded theories of cognition more glaring than during the day-long track on "Philosophical Issues" at ALIFE XI. In the first two sessions, four out of the six papers presented bore the Sussex stamp. These two sessions enjoyed a massive attendance (a testimony to the high philosophical component of Artificial Life in general) with a strong representation of the Sussex neighbourhood.[394] What was especially striking about these four papers was that they sounded as if they were part of an on-going conversation, started prior to ALIFE XI and meant to continue – while in contrast, the non-Sussex papers felt like isolated statements, interspersed

[393] Fieldnotes, 11/09/2007-14/09/2007.
[394] At some point I estimated that there were about eighty people in the overcrowded room, when the overall attendance to the conference was around 300, split in six parallel tracks (fieldnotes, 07/08/2008); there was a third session in the "Philosophical Issues" track, but only two papers were presented (one of the speakers defaulted), and the attendance was much lower; none of these two papers were by Sussex affiliates; this last session was in competition with a one-off session on "Embodiment", where Sussex was strongly represented (2 out of 3 papers).

among voices that responded to each other. This was all the more obvious during question time, when additional voices piped in, who were clearly part of that conversation. Plus all four papers addressed issues related to embodied-embedded theories of cognition, whereas this was not the case for the non-Sussex papers.

The first voice in this truncated Sussex conversation was philosopher Michael Wheeler, who despite having long left Sussex falls squarely within its neighbourhood according to the restricted definition I have given of it. His talk "Autopoiesis, enactivism, and the extended mind" aimed at showing that "[t]wo strands of recent embodied theorizing about cognition that are commonly held to be in harmony are actually in tension", due in part to their subtly different conceptions of the relationship between life and mind. These two strands are the extended mind hypothesis (EMH), which he defends, and enactivism, in which a group of researchers at CCNR is actively involved.[395] Wheeler's argument presupposed that the audience had a real degree of familiarity with all these notions. I did not, and I will not further enlighten my reader either: I would like to convey not only an insight into the level of specialist sophistication that the embodied-embedded cognition current has reached, but also into the feeling of being excluded from a private discussion that part of the audience experienced.

Next speaker was Ezequiel Di Paolo, a leading member of the Sussex Artificial Life group, whose enactivist arguments Wheeler had specifically targeted. He discussed the missing temporal dimension in Maturana and Varela's theory of autopoiesis (a building block of enactivism) and the kind of temporality introduced as "a consequence of expanding the theory of bare autopoiesis with the notion of adaptivity."[396] Following ALIFE XI, Di Paolo has published a paper in the philosophy journal Topoi, which

[395] Wheeler's abstract of "Autopoiesis, enactivism, and the extended mind", in ALIFE XI program.
[396] Di Paolo's abstract of "Life in time: the missing temporal dimension in autopoiesis", in ALIFE XI program .

replies to Wheeler's questioning of the consistency between enactivism and the extended mind hypothesis.[397]

The third Sussex voice was that of Inman Harvey, another leader of the Sussex Artificial Life group and one of its founders. His talk "Misrepresentations" engaged in ground-level cleanup work, by addressing the controversial issue of internal representations, a fundamental concept of traditional (representational and computational) cognitive science and symbolic Artificial Intelligence. His pitch was that "much time-wasting confusion could be avoided if participants in such controversies came to recognize the variety of different senses, often incompatible, in which such terms are used. […] Once such fruitless controversies are swept aside through linguistic hygiene, there remain interesting real problems, which are eminently appropriate for being tackled by an Artificial Life methodology."[398] Finally, Xavier Barandiaran, ex-EASy graduate student for whom enactive cognitive science is a major research interest,[399] presented a joint paper with Di Paolo on "Artificial mental life", an operational notion which "involves a shift from building artificial systems that satisfy externally imposed norms (engineering or evolutionary) to systems capable of generating their own norms"[400]. Barandiaran has developed this notion into a postdoctoral project entitled "Artificial Mental Life. A study of Brain-Body-World integration through neurocognitive robotics", conducted at CCNR.[401]

3.2 PHILOSOPHY AS EXPERIMENTAL SCIENCE

Do the papers presented in ALIFE XI "Philosophical Issues" by Sussex-related ALifers-philosophers belong to philosophy as academic discipline? Do they rather fall

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[397] Di Paolo (2009).
[398] Harvey's abstract of "Misrepresentations", in ALIFE XI program.
[399] http://xabierbarandiaran.wordpress.com/research/, consulted 13/10/2009.
[400] Barandiaran & Di Paolo's abstract of "Artificial mental life", in ALIFE XI program.
[401] http://xabierbarandiaran.wordpress.com/, consulted 13/10/2009.

under the heading of scientific frame building for conceptual and empirical investigations? I believe that attempting the distinction is misguided. Let us consider the journal Phenomenology and the Cognitive Sciences, which, for instance, Di Paolo regularly contributes to and has guest-edited a special issue of,[402] or which Barandiaran aims to publish some results of his post-doc project in – and whose founding editor was Francisco Varela. Its publisher Springer presents it as:

> "[…] a forum for illuminating the intersections between phenomenology, empirical science, and analytic philosophy of mind. The journal builds bridges between continental phenomenological approaches in the Husserlian tradition and disciplines that have not always been open to or aware of phenomenological contributions to understanding cognition and related topics. The journal presents work by phenomenologists, scientists, and philosophers who study cognition."[403]

According to this wording, phenomenology ("the study of structures of consciousness as experienced from the first-person point of view", according to the Stanford Encyclopedia of Philosophy[404]) is the realm of phenomenologists, and analytic philosophy of mind, of philosophers. Intentionally or not, presenting phenomenology and analytic philosophy of mind as the pursuit of two distinct types of practitioners acknowledges them as two separate fields, emphasizing the estrangement between continental philosophy and anglo-american analytic philosophy. Yet if I refer again to the Stanford Encyclopedia of Philosophy, "the fundamental character of our mental

[402] http://www.cogs.susx.ac.uk/users/ezequiel/, consulted 19/10/2009; Di Paolo has guest-editing a special issue of Phenomenology and the Cognitive Sciences on "Enactive Approaches to Social Cognition", issue 8:4, 2009.
[403] http://www.springer.com/philosophy/phenomenology/journal/11097?detailsPage=description, consulted 12/10/2009.
[404] http://plato.stanford.edu/entries/phenomenology/, consulted 15/10/2009.

activity is pursued in overlapping ways within these two traditions."[405] The mission statement of Phenomenology and Cognitive Science concurs and goes one step further, defending the idea that there can be fruitful crossovers between the three distinct fields of phenomenology, analytic philosophy of mind, and empirical science.

The resulting interdisciplinary project does more than bridge the gap between sciences and humanities. It blurs boundaries that have been well-maintained historically, hybridizing hands-on experimental science with two philosophical traditions that usually behave like oil and water (they do not mix). And again, ALifers in the Sussex neighbourhood appear to be keen to work in the interdisciplinary borderlands thus created. The abstract of Barandarian's post-doc project is exemplary in this respect:

> "The present project aims at investigating the theoretical foundations of cognitive science and philosophy of mind through the use of robotic simulations inspired on current theories of large-scale brain activity […]. The connection with phenomenological approaches to mind and world will be explored […]. Finally the epistemological status of simulation models of complex generative organizations and the way they transform our understanding of mechanistic explanations in philosophy of science [will be addressed]."[406]

Barandiaran situates his project at the intersection of evolutionary robotics,[407] cognitive science, phenomenology, and analytic philosophies of mind and of science, in the unlikely interdisciplinary borderlands I have just outlined. The large diversity of conferences and journals in which he envisions to present his results adds weight to his

[405] http://plato.stanford.edu/entries/phenomenology/, consulted 15/10/2009.
[406] Barandiaran (2008: 1).
[407] Barandiaran (2008: 6).

interdisciplinary claim.[408] Yet despite the interdisciplinary nature of his project, Barandiaran is conducting it solo: here is another member of the Sussex neighbourhood who fits the 'voluntary hybrid' profile, upon which I have already touched and to which I will return.

In the face of such a project, which inextricably weaves empirical science, technology, continental and analytic philosophies, the questions that opened the present sub-section, of whether the papers presented in ALIFE XI "Philosophical Issues" by members of the Sussex neighbourhood should fall under the heading of philosophy or of scientific frame building, appear irrelevant. The description given by quite a few Sussex ALifers, of Artificial Life as "experimental philosophy" or "philosophy with a screwdriver", takes on a deeper and more ambitious meaning: their agenda is to naturalize philosophy, and more precisely, considering the predominant philosophical penchant, to naturalize phenomenology. This conception of Artificial Life closely parallels the more general view about philosophy and cognitive science defended by computational linguistics scholar Serge Sharoff, who claims that philosophy can become experimental science.[409] Heideggerian philosopher Hubert Dreyfus makes a similar claim about early Artificial Intelligence.[410]

Naturalizing phenomenology, the foremost goal pursued by Wheeler in his book Reconstructing the Cognitive World (reviewed by none other than Di Paolo in 2007 for the journal Artificial Life[411]), is a project that departs significantly from phenomenological approaches in philosophy of technology which we in STS are most

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[408] Barandiaran (2008: 8).
[409] Sharoff (1995): "As classic philosophy fades away, said Heidegger, cybernetics becomes philosophy for the twentieth century. However, this thesis can be reversed; that is, philosophical systems can be interpreted from the viewpoint of computer science. Different schools of cognitive science, then, represent the interpretations or realizations of corresponding schools of philosophy."
[410] Dreyfus (2008: 331): "In short, without realizing it, AI researchers were hard at work turning rationalist philosophy into a research program.".
[411] Di Paolo (2007).

familiar with – although Heidegger is a common source of inspiration. As Wheeler defines it, his restrained brand of naturalism requires no more than the weakest possible continuity of philosophy with natural science "that is, […] *mere consistency* with natural science, a reading that makes room, in principle, for multiple modes of explanation." Nonetheless, "if philosophy and natural science clash (in the sense that philosophy demands the presence of some entity, state, or process that is judged to be inconsistent with natural science), then it is philosophy and not science that must give way."[412] Following a thorough articulation of Cartesian psychology and critical discussion of orthodox cognitive science, Wheeler demonstrates the Heideggerian character, albeit largely implicit, of the dynamical systems and embodied-embedded turns in the study of cognition, and goes on to articulate a Heideggerian framework for embodied-embedded cognitive science. Later chapters of the book "explore the underlying conceptual shape of embodied-embedded cognitive science", grounding the discussion in empirical robotics research (for a large part conducted at CCNR) that lie "at the intersection of AI and A-Life";[413] to which he adds, "[…] I have argued elsewhere that A-Life may constitute the intellectual core of a genuinely biological cognitive science."[414] Commenting on his overall method, he points that he has tried to work "at an interface where analytic philosophy, continental philosophy, and cognitive science may meet in a mutually profitable way."[415] This position comes in stark contrast to that of roboticist Rodney Brooks, whose careful distancing from a Heideggerian

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[412] Wheeler (2005: 5-6).
[413] Wheeler (2005: 19, 289).
[414] Wheeler (2005: 289).
[415] Wheeler (2005: 19).

connection Wheeler takes as starting point of his book.[416] Wheeler's conclusion amounts to a manifesto for naturalized phenomenology:

> "The very fact that one can have a Heideggerian cognitive science is, I hope, something of a surprise to many readers of this book. For where philosophers and scientists have engaged with Heideggerian philosophy, the message has typically been that any theory of mind that bears its stamp must be hostile to cognitive science. Indeed, Heideggerian thinking is standardly paraded, by its supporters and by its critics, as being opposed to the naturalism about mind in which the very idea of a cognitive science is rooted. But, as far as I can see, this is just wrong. […] although Heideggerian ideas have often been used as sticks with which to beat cognitive science, the next step is for those same ideas to play a positive role in the growth and development of the field."[417]

To come back to my overall concern of characterizing interdisciplinary practices in the Sussex neighbourhood according to Barry et al.'s typology, this passage emphasizes that the interdisciplinary project of naturalizing phenomenology through a Heideggerian cognitive science is in full agonistic-antagonistic mode toward both traditional cognitive science and continental philosophy. Wheeler ends by insisting that although it is far from clear where this new cognitive science is going, the idea of a Heideggerian cognitive science is not hot air and wishful thinking. Borderlands are being conquered:

> "Some ground has been cleared, some foundations have been laid, and some scaffolding has been erected. There are even some high-quality bricks and

[416] Wheeler (2005: 1-2): following the publication of Brooks' famously controversial 1991 paper "Intelligence without Representation" that was attacking the very foundations of mainstream Artificial Intelligence, Brooks was apparently keen to comment "It isn't German philosophy".
[417] Wheeler (2005: 285).

mortar on site. It's not yet a place for cognitive science to call home; but it's a start."[418]

Heideggerian cognitive science is work-in-progress "in the laboratories and offices around the world where embodied-embedded thinking is under active investigation", among which CCNR appears foremost on the basis of the robotics case studies that ground Wheeler's discussion in the later chapters of the book.[419] Sussex ALifers are indeed busy "cockroach scientists doing science in the cracks."

3.3 THE ENACTIVE STRAND

An important conclusion of the "Interdisciplinarity and Society" project is that the logic of ontology offers a real possibility of autonomy, which can lead to interdisciplinary practices irreducible both to participant disciplines and to the logics of accountability and innovation.[420] This is the perspective in which I will investigate the enactive strand of embodied-embedded interdisciplinary practices in the Sussex neighbourhood.

What is the enactive approach to cognition? [421] It was first advanced by Varela, Thompson and Rosch in their 1991 book The Embodied Mind: Cognitive Science and Human Experience, as a new framework for understanding cognition "that emphasizes the role of embodied experience, the autonomy of the cognizer and its relation of co-determination with its world".[422] It stresses the importance of embodiment and action to cognition, and goes against Cartesian dualism and representational theories of the mind. Over the years, it has grown into an accepted alternative to traditional approaches in

[418] Wheeler (2005: 285).
[419] Wheeler (2005: 285 and chapters 8, 9, 10).
[420] Barry, Born & Weszkalnys (2008: 21,42).
[421] A clear and thoughtful exposé of the enactive approach to cognition is given in Di Paolo, Rohde & De Jaegher (2007).
[422] Di Paolo, Rohde & De Jaegher (2007: 4).

cognitive science. According to Sussex enactivists Di Paolo, Rohde and De Jaegher, the downside is that the word enactive has come to be used with significant variations of meanings. This presents the risk of diluting the radical originality of the enactive framework: calling enactive all views in embodied-embedded cognitive science that have some conceptual overlap with enactivism would only contribute to a meaningless proliferation of the term. It also presents the risk of limiting its potential scope of application, notably by confining it to low-level cognition and recovering newly clothed versions of representationalism and computationalism to address higher levels of human cognition.[423]

Coming back to the impression of ongoing conversation that the Sussex voices conveyed during ALIFE XI "Philosophical Issues" sessions, it turns out that beforehand, Di Paolo, who discards all forms of representationalism, had criticized Wheeler when reviewing Reconstructing the Cognitive World in the journal Artificial Life, for clinging nostalgically to representations through the notion of 'offline intelligence'.[424] Di Paolo, Rohde and De Jaegher refuse what they call the 'reform-not-revolution' interpretation of the enactive framework, and do not believe that "what enactivism cannot yet account for must necessarily be explained using an updated version of old ideas." Yet they recognize that "it will be tempting to do so *as long as the principal tenets and implications of enactivism remain insufficiently clear*. […] *Enactivism is a framework that must be coherently developed and extended*." To start with, the "five highly intertwined ideas that constitute the basic enactive approach […]: *autonomy, sense-making, emergence, embodiment,* and *experience*" are often imprecisely used, and their exact meaning for enactivism demands to be clarified and articulated if the enactive framework is to be seriously developed into a scientific

[423] Di Paolo, Rohde & De Jaegher (2007).
[424] Di Paolo (2007).

research programme. Then, many important areas of cognitive science need to be developed in the enactive framework, typically those involving high-level cognitive functions such as reflexion, imagination, complex social interactions. Finally, what constitute valuable experimental and methodological resources for enactive cognitive science requires further consideration. Much work is thus necessary before enactivism can constitute a solid framework for understanding cognition in all its manifestations.[425]

This is the work that a loosely defined group of researchers at Sussex CCNR and in its neighbourhood have set out to contribute to. Their privileged forum at Sussex is the active Life & Mind seminars series (which, as I have already pointed, "originated out of a dissatisfaction with the prevalence of analytic philosophy within the department, and aimed to create a space where social sciences, continental phenomenology and systems biology could come together"[426] – it has run over fifty seminars since its inception in October 2006) and its lively associated blog: "a philosophy discussion group organized by members of the CCNR but opened to everyone…".[427] Latest seminars (as of 21 October 2009) were typically entitled "Shallow and deep embodiment: Reasons for embracing enactivism" and "Sociality and the life-mind continuity thesis". The issues addressed by Sussex enactivists reflect to a large extent the agenda set forth by Di Paolo, Rohde and De Jaegher. Some foundational papers investigate the core concepts of enactivism. For instance, "Autonomy: a review and a reappraisal"[428] starts from the observation that in Artificial Life, there is no consensus on a definition of 'autonomy', and categorizes diverse approaches according to a conceptual distinction between 'behavioral' and 'constitutive' autonomy. Tracing constitutive autonomy to Maturana and Varela's

[425] Di Paolo, Rohde & De Jaegher (2007: 4-7, 40-41); italics are the authors' .
[426] Froese, personal communication, 30/04/2010.
[427] http://lifeandmind.wordpress.com/, consulted 21/10/2009.
[428] Froese, Virgo & Izquierdo (2007).

autopoietic tradition, the paper argues that this type of autonomy is problematic for most Artificial Life methodologies, and that "[o]nly when we are able to investigate both constitutive and behavioural autonomy via synthetic means can the field of artificial life claim to provide one coherent framework of autonomous systems research."[429]

The paper "Defining Agency" (already discussed in chapter 2) targets the largely intuitive and deceptively uncontroversial uses of the term 'agency', a concept of crucial importance in cognitive science, Artificial Intelligence, robotics. These uses rest on definitions of agency "either too loose or unspecific to allow for a progressive scientific program." The paper identifies the conditions required for a system to be considered as a genuine agent, defines "the kind of organization that is capable to meet the required conditions for agency (which is not restricted to living organisms)", and from there proposes a precise (naturalised) definition of agency.[430] The authors point in conclusion the practical usefulness of such foundational work:

> "Being specific about the requirements for agency has told us a lot about how much is still needed for the development of artificial forms of agency but at the same time it gives an indication of the different goals that must be achieved along the way."[431]

Beside this necessary groundwork, many research projects are painstakingly assembling building blocks in the under-developed areas of enactive cognitive science. It is for instance the case of Froese's "Sociality and the life-mind continuity thesis" DPhil project, or Barandiaran's "Artificial Mental Life" postdoctoral project.

With regard to the autonomy (understood not in the enactive sense but as disciplinary autonomy) that the logic of ontology can lead to in interdisciplinary

[429] Froese, Virgo & Izquierdo (2007: 9).
[430] Barandiaran, Di Paolo & Rohde (2009 : 1).
[431] Barandiaran, Di Paolo & Rohde (2009 : 12).

practices, a most promising line of inquiry is what constitutes valuable experimental and methodological resources for enactive cognitive science.

3.4 MINIMAL MODELS AND PHENOMENOLOGICAL PRAGMATICS

The first category of resources, which scientific value for the enactive approach to cognition Sussex enactivists are working to establish, 'minimal modelling', belongs to Artificial Life – hence they are indirectly working towards the validation of Artificial Life as science, but approaching it from a very different angle than the legitimization attempts presented in chapter 3. A seminal paper in that area (the qualification as seminal is based on how systematically it is quoted whenever minimal models are discussed) thus explains and justifies minimal modelling, drawing on examples:

> "Unlike modeling efforts in cognitive science, where the objective is to build a system that can be directly compared with empirical data, ER [Evolutionary Robotics] has a different sort of use as a scientific tool. The homeostatic agent is not meant to be a good model of how humans adapt to visual inversion (crucial factors such as kinaesthetic and tactile modalities are ignored), the origin-of-learning study did not pretend to establish how learning happens in actual small nervous systems, and the minimal developmental systems example has factored out essential aspects of real development such as morphological changes induced by growth. These systems, then, will not tell us how real cognitive systems work, but […] provide us the proofs of concept and exploratory studies that can challenge existing views and unwritten assumptions in a healthy manner. They can help us reorganize our conception of a problem […], bring added importance to factors previously considered of little relevance […], and

> explore situations too complex even to start asking the right questions about using traditional tools […]. ER as a scientific tool is therefore quite different from the typical idealized and disembodied modeling that is found in connectionism or computational neuroscience (let alone GOFAI)."[432]

I have quoted this passage at length, not only for the illustration it gives of what minimal modelling consists in, but also for the insight it provides as to why the epistemological status of simulation models is such a pressing issue for Artificial Life researchers engaged in the embodied-embedded cognition current. Minimalist simulation models, as described by Harvey et al., do not correspond to any of the three stages of epistemic novelty proposed by Fox Keller that I reviewed in chapter 3. I ventured then that there was no reason to believe that the gradual emergence of epistemic novelty had stopped with the appearance of 'third stage' simulations, and indeed, minimalist simulation models might represent a new stage of epistemic novelty. As pointed in the extract, minimal modelling departs radically from the kind of modelling found in mainstream Artificial Intelligence and cognitive science. Minimal modelling is exploratory, which makes it especially congruent with my understanding of simulations as enacting 'what if?' scenarios. It circumvents the major problem that plagues simulation modelling in general, i.e. the difficulty (the impossibility in a majority of cases) to establish a model faithful to its object, and turns this liability into an asset, thus transforming the epistemic function of the simulation model. Here is an obvious sign of real disciplinary autonomy, a sign that in the Sussex neighbourhood, embodied-embedded interdisciplinary practices are irreducible to participant disciplines – let alone to the logics of accountability and innovation.

[432] Harvey et al. (2005: 95).

Sussex enactivists take the view that “[m]ethodological minimalism is […] a key element contributing to the acceptability of enactive ideas”,[433] and accumulating evidence that corroborates the usefulness of minimal modelling for enactive cognitive science, especially in under-developed areas, is a goal hotly pursued. It is for example at the heart of Barandiaran’s “Artificial Mental Life” project; or of Rohde’s DPhil project, “Evolutionary Robotics Simulation Models in the Study of Human Behaviour and Cognition”, completed in 2008. But minimal modelling as scientific tool still belongs to “the realm of third person methods”.[434] Enactive modelling must also relate to experience, and to be consistent with the idea of Heideggerian cognitive science, of naturalized phenomenology, this should be first-person experience (meaning, “[…] the lived *experience* associated with cognitive and mental events.”[435])

How do Sussex enactivists justify and propose to integrate first-person experience as a valid source of empirical scientific evidence, alongside third-person approaches like minimal modelling? I will answer the question through the example of a specific project, conducted by Tom Froese and Adam Spiers. The two researchers argue that adopting a full third-person approach to the study of conscious experience, such as Dennett’s heterophenomenology which is third-person interpretation of verbal reports on first person experience, is inherently flawed and cannot work. No such studies are entirely free of phenomenological elements, as they are in fundamental ways “implicitly based on the first-person experience of the investigator herself”.[436] This agrees with Varela and Shear’s reminder, in their introduction to “First-person Methodologies: What, Why, How?”, that “the subjective is already implicit in the objective.”[437] It is worth pointing that to denounce the fallacy of objectivity and defend first-person

[433] Di Paolo, Rohde & De Jaegher (2007: 41).
[434] Di Paolo, Rohde & De Jaegher (2007: 41).
[435] Varela & Shear (1999: 1).
[436] Froese & Spiers (2007: 5).
[437] Varela & Shear (1999: 1).

methodologies, Varela and Shear mobilised "recent history and philosophy of science", more precisely Shapin and Schaffer's Leviathan and the Air Pump,[438] hence recruited allies outside their field who were unlikely to be accepted as valid scholarly sources by cognitive scientists or even philosophers of mind. Froese and Spiers go on:

> "It is because of *our own* first-person experience of being conscious subjects that it is possible for us to even conceive of investigating how other subjects undergo a certain experience and pick out the relevant third-person data."[439]

They follow the view, articulated by Varela and Shear, that "first-person experience in the researcher is a legitimate source of additional evidence which not only needs to be explicitly acknowledged but also practically cultivated" and call for the establishment of "a full blown *phenomenological pragmatics*".[440]

In their view, a first step toward turning first-person subjective experiencing into an epistemologically valid mode of scientific investigation would be for the research community to engage into concerted disciplined training for describing experience accurately – which would also make the researchers more skilled at eliciting phenomenological descriptions from untrained subjects, hence improving the collection of third-person data. [441] This is where Froese and Spiers' "Enactive Torch" project fits in. Its starting point is that an important source of evidence for the enactive approach to perception "is the data generated by experiments with subjects who have mastered the skilful use of a 'sensory substitution' device", or "*perceptual supplementation* (PS) device" as they prefer to call it. Such a device functions "by making use of neural

[438] Varela & Shear (1999: 1,11).
[439] Froese & Spiers (2007: 4-5).
[440] Froese & Spiers (2007: 6).
[441] Froese & Spiers (2007: 6).

plasticity […], namely the ability of the central nervous system to incorporate the device's feedback into the subject sensorimotor exploration of the environment".[442]

With such devices, a main issue and source of controversy so far has been the collection and interpretation of empirical evidence, and for Froese and Spiers the root of the problem lies with purely third-person methodologies like Dennett's. The study of the qualitative experience of using the PS device relies on "the interpretation of descriptions of behavioural or physiological data and verbal reports": a serious limitation, and the reason why "a scientific investigation has slowly been turned into an open-ended debate about mere interpretations of interpretations."[443] So far, personal experience of the device by the researchers has not informed the debate.

In contrast, Froese and Spiers propose that a step toward the establishment of a phenomenological pragmatics of enactive perception is for researchers to become skilful in the use of PS devices. These devices should be standardized and made readily available to the research community in order to allow for intersubjective validation, to help train the researchers in describing their own experiences. The experimental platform that they have devised, not only cheap and easy to replicate but also quick to master, is a tactile-vision substitution system called the Enactive Torch, "provid[ing] the subject with one continuous channel of vibro-tactile feedback to the hand, where the strength of simulation depends on the distance to the object which is currently pointed at."[444]

The enactive approach to cognition, according to some in the Sussex Artificial Life group, thus requires a range of experimental and methodological resources in which a third-person method like minimal modelling coexists with a first-person approach like phenomenological pragmatics. In that, it departs radically from the

[442] Froese & Spiers (2007: 3).
[443] Froese & Spiers (2007: 3-5).
[444] Froese & Spiers (2007: 7-8).

tradition of modern science, in which purely third-person methodology, anchored in the strict separation of subjects and objects, reigns unchallenged. This is evidence that the enactive research programme pursued in the Sussex neighbourhood possesses the kind of disciplinary autonomy that, according to Barry et al., interdisciplinary practices following the logic of ontology can foster.

4. RECLAIMING HYBRID ROOTS: A CHALLENGE TO HISTORY

Contrary to philosophy and art, history is a marginal pursuit in the Sussex neighbourhood, and I have met with no academically trained historian. At face value, one may thus expect those of them who take a particular interest in history and involve themselves in historical projects to fit the commonplace profile of the scientist who writes some history of science – usually of the popular kind, most often of the linear and internalist variety – and this has not much to do with actual interdisciplinarity. Why have I chosen, then, to include an entire section on history in the present chapter, as a distinct aspect of interdisciplinary practices in the Sussex neighbourhood?

Sussex ALifers write history as amateurs. But as I have already highlighted, amateurism is valued in the Sussex neighbourhood. Amateurism is not an attitude that they would, inconsistently, find justified when it comes to their doing history, while dismissing it when it comes to non-professionals doing Artificial Life. Moreover, despite a lack of formal training, it appears when reading some of their pieces and perusing their references that there is some thorough and competent bibliographical research involved. For instance, in a piece on Babbage in The Mechanical Mind in History, the author displays an awareness of the dangers of Whiggish reinterpretation and linear progressive explanations in history, and explicitly draws on recent works by

Schaffer and Carroll-Burke.[445] Even in papers mostly targeted at an Artificial Life audience, one can find the occasional knowledgeable nod to history of science.[446] Here, I think, may be a first departure from the dominant attitude of scientists towards doing history: valuing the contribution of un- or self-trained amateurs while recognising a distinct expertise to the work of academically trained historians.

I will argue that the practice of history by Sussex ALifers is distinctive in more than one respect, and that it deserves to be included into the present study of interdisciplinarity. In what follows, I will analyse, through the writings of ALifers in the Sussex neighbourhood and my own field material, their professed justifications for engaging into historical projects along three axes: fighting erasure, reclaiming hybridism and challenging history, before discussing them in the light of pertinent historical scholarship.

4.1 FIGHTING ERASURE

Among the justifications for writing history put forward by individual members of the Sussex neighbourhood, a recurring theme is that of fighting erasure. For one of my respondents, his criticism of what he called "a general amnesia" was not levelled at Artificial Life in particular, but at computer science in general. Computer science, in his view, was hardly a science; writing software was a craft – a point I have highlighted at the end of the previous chapter. In his experience, undergraduates and graduates coming through computer science departments were not taught any history of their field, most especially of the failures and catastrophes that have paved it, which would give them the degree of reflexivity required to practice their craft properly. It was as if there was a

[445] Bullock (2008: 36-37).

[446] Di Paolo (2004: 231): "As historians of science know very well, concepts and methods evolve, disfavored theories get buried under successful ones (and not necessarily because they are any less valuable), metaphors and languages change, and social perception and pressures influence the directions of research.".

moving wall of short-term memory, no more than five years, and any prior memory was wiped out. He thought it was deleterious to computer science because the graduates it produced, whether they went on to get a job or pursued postgraduate studies (for instance in Artificial Life), were in general very arrogant and naive with regard to what they thought they could achieve, which did not lead to much good work.[447] Thus for him, history was a way to embed disciplinary values into the field of computer science and improve its standards of practice; reflexivity was one of those values, key to becoming an accomplished computer science professional rather than just a narrow-minded technician requiring directions and close monitoring.

Among scientists, such an attitude towards history, although far from predominant, is neither unique nor restricted to computer science. French physicist and philosopher of science Etienne Klein, reacting to the announcement by the French government that history and geography were to become a facultative option of the scientific baccalaureate, has recently declared: “One must know that contemporary physics – quantum mechanics, etc. – cannot be taught without its history. Alas it is not done!”[448] Using history to bear on the theoretical corpus, the methods and research agenda of a scientific discipline was apparently typical of Stephen Jay Gould throughout his career. As early as 1965, his essay “Is Uniformitarianism Necessary?” already made an extensive use of the history of 19th-century geology to critique uniformitarianism, both as geological theory and scientific method.[449] As for the benefits of teaching history for enforcing certain disciplinary values, the emphasis placed by my interlocutor on the value of reflexivity as key to successful university

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[447] Fieldnotes, 11/09/2007.

[448] Etienne Klein was quoted in an article by Sophie Lherm, “L’histoire-géographie ne serait plus obligatoire en terminale S: ‘S’ bien raisonnable?”, in Télérama 3125 (02/12/2009), p. 8: “Il faut savoir que la physique contemporaine – mécanique quantique, etc. – ne peut pas être enseignée sans son histoire. Malheureusement on ne le fait pas ! ”.

[449] Lowood (1998); Gould (1965).

training into the profession of computer scientist agrees more generally with the views of professor of Higher Education Stephen Rowland, of UCL Centre for the Advancement of Teaching and Learning, on the mission of the university in teaching and research – in learning at large – for both its academics and its students.[450]

Another of my interviewees, who had taught at Sussex for over twenty years, had a similar complaint regarding historical amnesia, this time in the teaching of Artificial Intelligence. He told me that when he was lecturing on adaptive systems, Artificial Intelligence, etc, he always used to start off by teaching the students "about where did the stuff come from" – its history. He said, "I always found it very strange that the standard AI textbooks at the time had no history on the subject, there was no history on the subject. It was as if it had all just appeared somewhere around 1960. It seemed very odd." He was interested in tackling this issue, but his problem was that it was very difficult to do some history of science in a computer science department: "Very difficult to justify, very difficult to get any money." Eventually, when he became professor and had a bit more freedom, he managed to get historical projects going, on topics which he found had been especially ignored.[451]

This has led to the publication in 2008 of The Mechanical Mind in History. Two of the three editors of the book squarely belong to the Sussex neighbourhood, and seven out of the sixteen authors.[452] The contributions, coming "from a mix of artists, historians, philosophers, and scientists", address "the quest to formalize and understand mechanisms underlying the generation of intelligent behavior in natural and artificial

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[450] For example, Rowland (2001), Rowland (2002), Rowland (2006).
[451] Interview transcript, 31/05/2007.
[452] I do not count as authors the five individuals whose interviews constitute the last five chapters of the book.

systems", a quest which, according to the editors, "has a longer and richer history than many assume."[453]

In The Mechanical Mind in History, the concern with erasure manifested by members of the Sussex neighbourhood extends beyond the fields to which they are connected through their research and teaching. The pervasiveness of erasure in modern science and its ill-effects are brought up from the very opening, in the preface that begins in the following manner:

> "In the overlit arena of modern science, where progress must be relentless, leading to pressure to dismiss last year's ideas as flawed, it is all too easy to lose track of the currents of history. Unless we nurture them, the stories and memories underpinning our subjects slip through our fingers and are lost forever. The roots of our theories and methods are buried, resulting in unhelpful distortions, wrong turns, and dead ends."[454]

Although Latour was referenced neither by the editors of the volume nor by the authors involved, there is a striking parallel between this passage and his description of the workings of modernity in We Have Never Been Modern. The interdisciplinary historical enterprise of The Mechanical Mind in History denounces from the onset the fallacy of an internalist, linear model of progress in the sciences and its afferent erasures. From a Latourian perspective, erasure, as part of the process of purification, is a staple of the modern stance. Going against it is in itself a non-modern move on the part of the ALifers who have initiated and taken part in the project – a move which strongly echoes that of the keynote speaker at ALIFE XI, who associated the reclaiming of amateurism to the condemnation of general amnesia in contemporary science.[455] Their fight against erasure brings to the fore the two other axes of my analysis,

[453] Husbands, Holland & Wheeler (2008: vii).
[454] Husbands, Holland & Wheeler (2008: vii).
[455] Fieldnotes, 05/08/2008.

reclaiming hybridism and challenging history: by shedding light "on what we regard as hitherto underrepresented areas",[456] they reclaim and expose the impure, hybrid roots of their own research, and in so doing challenge received histories.

4.2 RECLAIMING HYBRIDISM

The introductory chapter of The Mechanical Mind in History states that as soon as one delves into the history of the idea of intelligent machines,

> "[…] one finds oneself enmeshed in the often obscured roots of ideas currently central to artificial intelligence, artificial life, cognitive science, and neuroscience. Here one confronts a rich network of forgotten historical contributions and shifting cross-disciplinary interactions in which various new questions emerge, questions such as: What intellectual importance should we give to little-known corners of the history of the mechanical mind, such as cybernetic art, the frequently overlooked British cybernetic and pre-cybernetic thinkers, and cybernetic influences in politics? And, more generally, how is our understanding of the science of machine intelligence enriched once we come to appreciate the important reciprocal relationships such work has enjoyed, and continues to enjoy, with a broad range of disciplines? […] Unsurprisingly, given the nature and scope of these issues, the volume is essentially and massively cross-disciplinary in character […]"[457]

Reclaiming and bringing to light the impure, hybrid roots of one's own research, another non-modern move in a Latourian perspective, was thus a main goal of the project. But is the claim of being "massively cross-disciplinary" sustained when looking

[456] Husbands, Holland & Wheeler (2008: vii).
[457] Husbands, Holland & Wheeler (2008: 1-2).

at who are the sixteen authors who contributed to the volume? Although scientists and mathematicians predominate, the arts and humanities are well represented with seven names. Among them, Margaret Boden (both philosopher and cognitive scientist), and Michael Wheeler (philosopher) are 'natives' of the Sussex neighbourhood, with which they have been involved since its inception. It is also the case of artist and writer Paul Brown, although his involvement is more recent. But we find names besides, who illustrate the ongoing capacity of the Sussex neighbourhood to attract 'others' in interdisciplinary collaborations, bringing in an extra degree of diversity to the project: Peter Asaro, PhD in history, philosophy and sociology of science, researcher in the Center for Cultural Analysis at Rutgers University (USA); Andy Beckett, writer and journalist for The Guardian newspaper; Heideggerian philosopher of science Hubert Dreyfus, well-known for his strong charges against traditional symbolic Artificial Intelligence; and Jana Horáková, assistant professor in Theater and Interactive Media Studies at Masaryk University (Czech Republic). Hence the writing of The Mechanical Mind in History was approached from a multiplicity of perspectives, which justifies the inclusion of history to my study of interdisciplinary practices in the Sussex neighbourhood.

In its reclaiming of a hybrid network of historical roots, the book reveals a concern for both breadth and depth. With regard to depth, it traces the idea of mind as machine back to the seventeenth century, and claims to make in the process a genuine intellectual contribution by illustrating, through the various papers and memoirs included, "the rich kaleidoscope of diverse and interacting notions of mechanism that historically have figured in the shifting landscape of the mechanical mind",[458] a claim which smacks strongly of relativistic cultural history. With regard to breadth, the result

[458] Husbands, Holland & Wheeler (2008: 2).

is mixed. The collection of papers does not attempt to present a more or less continuous overall historical narrative, but aims at reviving movements and figures whom the authors believe to have been neglected so far in the long history of mind as machine (such as British cybernetics and more particularly the British cyberneticians of the Ratio Club), as well as lesser-known contributions by famous figures (such as Descartes of whom philosopher of mind Michael Wheeler argues that he was not "as hostile to the idea of mechanistic explanations of intelligent behaviour as he is often portrayed today"[459]). But apart from Descartes and the Czechoslovak writer Karel Čapek, the figures who are reclaimed in the pages of the volume, although very diverse, are overwhelmingly Britons and Great Britain-based: Charles Babbage, Ada Lovelace, D'Arcy Thompson, Kenneth Craik, the Ratio Club, Alan Turing, Ross Ashby, Gordon Pask, Stafford Beer, the Experimental and Computing Department at the Slade School of Fine Art (University College London) in the 1970s. In the oral history part at the end of the book, one finds two more British, Horace Barlow and John Maynard-Smith, besides two North-Americans and an Anglo-American. The result may thus be broad in terms of the thematic diversity of the reclaimed roots, it is quite narrow in terms of their localisation, essentially British. I will return to this particular point when addressing the theme of counter-memory.

Yet in terms of thematic diversity, the breadth is there. Taking a closer look at the reclaimed roots reveals that they spread across many fields and crisscross boundaries. Here are some examples. The paper on Babbage situates his work against the economic, social and moral debates of his time on the possibility of automated reason, and the book's introductory chapter further highlights that Ada Lovelace, who collaborated closely with Babbage, "[…] was perhaps the first person to see the

[459] Husbands, Holland & Wheeler (2008: 4).

possibility of using computational engines in the arts, writing of the Analytic Engine's potential to compose music and generate graphics."[460] The joint paper by Jana Horáková (Theater and Interactive Media Studies academic) and Jozef Kelemen (professor of Computer Science) delivers a (multi-) cultural study of "why, how, and where the word *robot* was born, how it changed its meaning, how it grew up, and how it spread, becoming a part of language all over the world."[461] The book's introductory chapter presents Horáková's and Kelemen's paper as tracing the roots of the word 'robot' "to the dreams and folk tales of old Europe" and showing "how it was a product of its troubled times and how the idea of robot was interpreted in different ways in Europe and America as it seeped into the collective unconscious".[462] The paper "The Ratio Club: A Hub of British Cybernetics", which attempts to give its rightful place in history to the first wave of British cybernetics (among whom Ross Ashby, Horace Barlow, Alan Turing, etc), shows that in contrast to the US, the centre of gravity of cybernetics in Great-Britain was frankly toward the brain sciences, and insists on the diverse and interdisciplinary character of the Ratio Club, whose members came "from a rich mix of social and educational backgrounds, ranging from privileged upbringings to the humblest of origins" and had, for many of them, very broad backgrounds "[e]ven when war work was factored out".[463] Boden, who reclaims D'Arcy Thompson as "A Grandfather of A-Life" through his 1917 book <u>On Growth and Form</u>, brushes the portrait of a true polymath, conforming to the 'voluntary hybrid' profile; she describes a man who had "an extraordinary span in intellectual skills. He was a highly honored

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[460] Husbands, Holland & Wheeler (2008: 5).
[461] Horáková & Kelemen (2008: 283).
[462] Husbands, Holland & Wheeler (2008: 7).
[463] Husbands & Holland (2008: 127, 137).

classical scholar […]. In addition, he was a biologist and mathematician. Indeed, he was offered chairs in classics and mathematics as well as in zoology."[464]

Many of the figures reclaimed in The Mechanical Mind in History seem to fit the 'voluntary hybrid' profile and to have enjoyed straddling boundaries – this ends up punctuating the volume as a leitmotiv: Ross Ashby, clinical psychiatrist, philosopher of mind, pioneer of cybernetics and systems science theorist;[465] Kenneth Craik, psychologist and radical philosopher;[466] Gordon Pask, cyberneticist, 'mechanic philosopher', entrepreneur, artist of sorts, entertainer, who had studied geology then medicine before he discovered cybernetics and "found a field of study that was broad enough to accommodate his wide range of interests and also combine theory and practice";[467] Stafford Beer, cyberneticist whose collaboration with Pask throughout the 1950s resulted in the growing of an electrochemical 'ear', who went on to apply cybernetics ideas to industrial management and became a very successful consultant working with both corporations and governments, among which the Chile administration of Salvador Allende in the early 1970s for whom he designed and developed "a revolutionary electronic communication system [called Cybersyn] in which voters, workplaces, and the government were to be linked together by a kind of 'socialist internet'";[468] members of the Ratio Club, "open-minded, with wide-ranging interests outside science […] carried this spirit with them throughout their careers and many were involved in an extraordinary range of research, even if this was within a single field. This lack of narrowness meant that most had other strings to their bows (several were very good musicians and a number were involved with other areas of the

[464] Boden (2008: 42-43).
[465] Asaro (2008).
[466] Husbands & Holland (2008: 108).
[467] Bird & Di Paolo (2008 : 188).
[468] Bird & Di Paolo (2008: 199-203); Husbands, Holland & Wheeler (2008: 11-12); Beckett (2008).

arts), sometimes starting whole new careers in retirement”;[469] artists who attended EXP (the Experimental and Computing department) at the Slade in the 1970s;[470] etc.

The Mechanical Mind in History is not the only historical project to date into which members of the Sussex neighbourhood got involved and have reclaimed the historical hybridism of both (British) cybernetics and Artificial Life. Second-generation pioneer of computer art Paul Brown, who has been artist-in-residence since 2000 and visiting professor since 2005 at Sussex’s CCNR (also contributing author to The Mechanical Mind in History), has been one of the two principal investigators of the AHRC-sponsored CACHe (Computer Arts, Context, Histories, etc) project, hosted by the School of History of Art and Visual Media at Birbeck, University of London, between 2002 and 2005. The other principal investigator, and project leader, was Charlie Gere, new media studies scholar and chair of CHArt (Computers and the History of Art association), who subsequently became in 2007 head of the department of Media, Film and Cultural Studies at Lancaster University. Embodying another fight against erasure, this time literal, the CACHe project was born from the fear that after the first generation of British computer art pioneers disappeared, there might be no inventoried repository of their work, nor a record of their activities, and much valuable archival material may get lost. Thus the project’s aim has been to digitise and catalogue the image holdings of the Computer Arts Society and other archives “that charted the development of computer-based art in the UK. These archives offer a unique record of the evolution of digital imagery in the 1960s and 1970s.”[471] Another outcome of CACHe has been a volume edited by the project team (Brown, Gere, and historians of

[469] Husbands & Holland (2008: 137-138): the authors sustain their claims with a number of examples.
[470] Brown (2008a: 273-277).
[471] CACHe Archives, http://www.e-x-p.org/cache/index.HTM, consulted 10/09/2009.

art Nicholas Lambert and Catherine Mason), entitled White Heat Cold Logic: British Computer Art 1960-1980.[472]

In the paper he has contributed to the volume, entitled "From Systems Art to Artificial Life: Early Generative Art at the Slade School of Fine Art", Brown takes as starting point of his narrative the 1968 'Cybernetic Serendipity' show at the London's Institute of Contemporary Arts, which in the 1960s spirit "challenged many long-held attitudes about the visual arts and their place in culture and society. In particular works by scientists were shown alongside those of professional artists and Reichardt[473] did not differentiate, at least on the level of the exhibited artefact, between these 'two cultures'."[474] Among the works that were presented at the show (including Gordon Pask's 'Colloquy of Mobiles'), Brown singles out one piece, Edward Ihnatowicz's 'SAM' (Sound Activated Mobile). Why 'SAM', or rather, why Ihnatowicz?

> "During the time he worked on these robotic pieces ['SAM' and the later 'Senster'] Ihnatowicz was a researcher in the mechanical engineering department at University College London, where the Slade School of Fine Art is also based. […] Ihnatowicz was a frequent visitor during the 1970s and often engaged in informal discussions with staff and students on topics of interest."[475]

So Brown, in taking Ihnatowicz as exemplar to set up the stage for his story, characterizes him upfront as another of the 'voluntary hybrids' whom we have already seen populating the pages of The Mechanical Mind in History. He goes on to claim that "Ihnatowicz was an early proponent of embodiment in both the arts and AI and it's clear

[472] Brown et al., eds. (2008).
[473] Jasia Reichardt curated the exhibition.
[474] Brown (2008b: 275).
[475] Brown (2008b: 275-276).

that he was also a pioneer of the discipline now known as artificial life",[476] thus explicitly reclaiming a British artistic root for Artificial Life.

The overall aim of Brown's essay is to establish the influence and contribution of the EXP community at the Slade. The EXP experiment, which for Brown transferred the ethos of the systems art movement into the computer domain, lasted for about a decade from 1973 to 1982, and during that time it became "a magnet for artists and theorists throughout the United Kingdom and Europe".[477] He himself studied there between 1977 and 1979, and his primary interests were "cellular automata and both deterministic and probabilistic systems. At the Slade I developed a system for interpreting CA [cellular automata] output using tiling systems, and this has dominated my practice over the past three decades."[478] Through his experience and recollections of EXP, Brown shows how it fostered a community of artists in the domain of computing, who were engaged in strong reciprocal relationships with scientists and engineers. By the end of the paper, Brown's reclaiming of historical artistic roots for Artificial Life is strengthened and broadened:

> "We did not use the term 'artificial life' nor would we have associated with the term as Langton defined it over a decade later as a form of 'experimental biology'. […] However, references to life and physical and biological processes were implicit in many of the works. […] It has been interesting (and reassuring considering the continuing lack of recognition by the arts mainstream) to find that we are now being rediscovered by a new generation of Alife researchers who are seeking the origins of their discipline. […] It's one of the only examples I can think of where an art community, while

[476] Brown (2008b: 276).
[477] Brown (2008b: 281); Brown (2008a: 274-275).
[478] Brown (2008b: 285).

> pursuing the dominant aesthetic concepts of the period, were also able to contribute so dynamically to the development of a new scientific field."[479]

Further, he refers the reader to Australian artist and theorist Mitchell Whitelaw who "suggests that Alife is a natural development of artistic practice in the twentieth century" through the examples of Paul Klee and Kasimir Malevich.[480]

The drive to reclaim hybrid, and preferably British, roots for Artificial Life could even extend to a major source of inspiration for the Sussex neighbourhood: Maturana and Varela's theory of autopoiesis. In an interview with Brown during which he was tracing for me some of the pre-Langtonian historical roots of Artificial Life, I asked him about the autopoietic Maturana-Varela genealogy, and his answer was that apparently Varela had been strongly inspired by the Laws of Form, published in 1969 by George Spencer-Brown. He pointed me for confirmation towards a website dedicated to the book, copyrighted and maintained by Richard Shoup[481] ("one of the pioneers of computer graphics, he made the first paint system at Xerox Park in the 70s"[482]). Unsurprisingly, Spencer-Brown (trained in medicine, philosophy and psychology, with a doctorate in probability, who practised both as an electronic design engineer and as a professional psychotherapist[483]) is yet another instance of British 'voluntary hybrid'.

4.3 CHALLENGING HISTORY

A strong characteristic that the reclaimed historical roots I have just explored have in common, apart from their overall Britishness, their hybrid heterogeneity and their disregard for boundaries, is that they challenge history, in ways that I will now examine.

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479 Brown (2008b: 286-287).
480 Brown (2008b: 286).
481 http://www.lawsofform.org/lof.html, consulted 12/11/2009.
482 Interview transcript, 24/05/2007.
483 http://www.lawsofform.org/gsb/vita.html, consulted 12/11/2009.

Shedding light on ignored, underexplored or misrepresented areas of the history of mind as machine was the structuring goal of The Mechanical Mind in History. By showing that this history goes much further in time and is much more complicated than one is usually told, collaborators to the project reveal their dissatisfaction with received histories of mind-as-machine. I have highlighted that although the historical hybridism that they reclaim offers a rich thematic diversity, it was essentially British in terms of provenance. In the field of cybernetics in particular, the heterogeneous British roots they bring into the open, which crisscross the sciences (with a centre of gravity in brain science), the arts and humanities, come in sharp contrast to prevailing accounts in the history of cybernetics – overly biased towards North America, electronic engineering and information science – and the book makes a point not only of battling against a presupposed North American hegemony and of reclaiming these alternative genealogies, but also of distancing them from the North American context. Even the cultural history of the word 'robot', which shows that North America's and Europe's collective unconscious led to differing interpretations of the idea of robot, may be read as part of an overall distancing operation, especially as the editors comment in the introductory chapter that "[t]he new dreams and images thus created undoubtedly inspired future generations of machine intelligence researchers", thus hinting at ongoing distinctions between the cultural frames of research in America and Europe.[484]

The chapter retracing the existence of the Ratio Club (as one of its authors explained its birth to me, "we hatched the plot one day that nobody had seriously looked at the Ratio Club, this kind of mythical thing, that is mentioned in a few histories of Artificial Intelligence but very briefly, […] a tiny mention of it here and there but

[484] Husbands, Holland & Wheeler (2008: 7).

nothing really"[485]) attacks on several fronts. Not only does it explicitly distance the scope of cybernetic interests among first wave cyberneticists in the UK from that in the US,[486] it also asserts British simultaneity and even antecedence to North American cybernetic thinking. It reproduces in full, and takes delight in commenting on, a letter dated July 1949 from John Bates to British-assimilated Grey Walter (who constructed his famous autonomous robotic tortoises Elsie and Elmer between 1948 and 1949) proposing the creation of a cybernetic dining club – a letter in which Bates provocatively states:

> "I know personally about 15 people who had Wiener's ideas before Wiener's book appeared and who are more or less concerned with them in their present work and who I think would come."[487]

The paper goes further and strengthens its antecedence claim, by highlighting how Scottish psychologist and philosopher Kenneth Craik, through a slim volume entitled <u>The Nature of Explanation</u> published in 1943 before his untimely death in May 1945 at the age of thirty-one, influenced the birth of cybernetic thinking on the other side of the Atlantic:

> "In a move that anticipated Wiener's *Cybernetics* by five years, […] he viewed the proper study of mind as an investigation of classes of mechanisms capable of generating intelligent behavior both in biological and nonbiological machines. Along with Turing, who is acknowledged in the introduction to Wiener's *Cybernetics*, and Ashby, who had begun publishing on formal theories of adaptive behavior in 1940 […], Craik was a significant, and largely forgotten, influence on American cybernetics."[488]

[485] Interview transcript, 31/05/2007.
[486] Husbands & Holland (2008: 99).
[487] Husbands & Holland (2008: 100).
[488] Husbands & Holland (2008: 108).

The Mechanical Mind in History thus revisits the history of cybernetics by reclaiming a distinctly rich British strand. And by appropriating the position of heirs to British cybernetics (the counter-memory work they have engaged into is certainly akin to an act of heirloom conservation), the ALifers who have edited and contributed to the volume simultaneously revisit the history of Artificial Life. White Heat Cold Logic similarly reclaims the British cybernetic heritage of Artificial Life. For instance, a paper on Gordon Pask argues that 'Colloquy of Mobiles', the piece he contributed to the 'Cybernetic Serendipity' show, "was a material implementation of a complex theory of artificial organisms and self-organizing systems, which predated the advent of artificial life."[489] And Brown's reclaiming of the artistic roots of Artificial Life, in the passage quoted earlier, denies both that the naming of the field by Langton was the actual starting point of the field (as popular, mostly North-American, accounts of the birth of Artificial Life would have it) or even that Langton's definition of it was correct. Another public reclaiming of the British cybernetic heritage of Artificial Life, again by a member of the Sussex neighbourhood, was the fifth annual Turing memorial lecture held in the Mansion Ballroom at Bletchley Park in July 2009, given by Margaret Boden under the title "Turing and Artificial Life". The abstract included in the event advertisement boldly asserted that:

> "[a]lthough this field of study was named as recently as 30 years ago [in fact, a little over twenty years], A-Life was pioneered much earlier by eccentric British genius, Alan Turing, who was the first to use a digital computer to simulate self-organisation. […] The founding father of

[489] Fernández (2008: 62).

computer science, he was also the first to pioneer the fields of Artificial Intelligence and Artificial Life."[490]

4.4 BRINGING IN THE HISTORIANS

I would like at this point to bring in historians to bear on my analysis of the root reclaiming endeavors into which Sussex ALifers have engaged. More precisely, I wish to revisit my findings in a memory-versus-history perspective, since it appears that an important way in which historical memory can relate to history is by challenging "the biases, omissions, exclusions, generalizations, and abstractions of history" – and this is exactly what the historical interdisciplinary collaborations that I have examined are doing.[491] I will not engage in a comprehensive review of the scholarship pertaining to the relationship between history and memory, it is plentiful and has grown steadily over the past two decades. Since 1999 the topic even has its dedicated journal.[492] The idea was rather to give a sense of some important issues that can be related to my study, and I have thus used a small selection of scholarly landmarks in the domain, most especially the 1989 special issue of Representations entitled "Memory and Counter-memory", because of its relevance to my findings. This collection of essays, edited by historians Natalie Zemon Davis and Randolph Starn, was born out of their desire to understand why, "[h]ardly for the first time, but, so it seemed, with particular urgency, talk about 'our' cultural amnesia was tied to a fascination, even obsession, with historical memory."[493] Even though the two interdisciplinary historical projects I have been looking at (The Mechanical Mind in History, and CACHe with White Heat Cold Logic), took place almost twenty years later, they both showcase the same dual concern with

[490] http://www.bletchleypark.org.uk/news/docview.rhtm/578266, consulted 17/09/2009.
[491] Zemon Davis & Starn (1989: 5).
[492] History and Memory.
[493] Zemon Davis & Starn (1989: 1).

amnesia and memory. The Mechanical Mind in History is exemplary in that respect. Fighting historical erasure is stated as the overall goal of the volume; while its last part, comprised of interview transcripts, belongs to oral history whose proliferation is tagged by French historian Pierre Nora as characteristic of the obsession with historical memory.[494]

An important point that Zemon Davis and Starn elevate to the status of working principle when studying historical forms of memory is that "whenever memory is invoked we should be asking ourselves: by whom, where, in which context, against what?"[495] This I have pretty much covered in the case of the Sussex neigbourhood – I have shown that memory was invoked to reclaim a British historical strand for cybernetics (and consequently for Artificial Life) hybridizing the life sciences, arts and humanities; it was invoked by the self-proclaimed heirs themselves, against a dominant historical view heavily biased towards North America, electronic engineering and information science; in so doing it placed the blame, implicitly, in the garden of historians of science. Still, we may ask ourselves whether redressing a defective history was the only justification behind the collective counter-memory work that some Sussex ALifers have involved themselves into. After all, they may have been content to continue drawing explicitly on British cyberneticists' work in their Artificial Life research, which is a performative way to both fight erasure and contradict wrongful historical accounts, without feeling that the 'rectified truth' had to be set in historical stone.

When the invocation of counter-memory is associated with commemorative practices, like on the occasion of the 2009 Turing memorial lecture by Margaret Boden, there is a strong suspicion that disciplinary politics are impinging on the historical

[494] Nora (1989: 14).
[495] Zemon Davis & Starn (1989: 2).

claim. Commemorations characteristically attempt to fix who/what is important and who/what is not, in the public image that a research field attempts to give of its construction.[496] With Boden's claim that Turing was a pioneer of Artificial Life, the resulting feeling is that a 'memory war' is publicly declared. It is undoubtedly waged against the account of the birth of Artificial Life that prevails not only in popular science books and articles, but also, more surprisingly, in several scholarly sources – broadly, that Artificial Life was invented *ex nihilo* at Los Alamos around 1987 by Christopher Langton; and the more popular versions of the story have given wide circulation to number of anecdotes, told and retold, which together amount to a highly mystical myth of origin, giving the impression that Artificial Life sprung out of the brains of its presumed founding father.[497] This prevailing account of the birth of Artificial Life is also the one that we have seen Paul Brown resist through his personal counter-memories in the paper "From Systems Art to Artificial Life". For Sussex ALifers, making public the challenge to a history of Artificial Life with which they do not identify, on the occasion of a politically significant commemoration, confirms that their historical endeavours are not aimed simply at redressing historical wrongs, they are also aimed at changing the perceived image of their field.

This brings me to the identity-defining functions of memory. In the interdisciplinary collaborations that I have examined, the historical continuity between British cybernetics and British Artificial Life is established on two levels. On one level, the memories invoked reveal the historical lineage existing between the two. On another level, they trace a striking parallel between the fates that both research fields have known at the hands of history, in particular the overwhelming bias towards the United States and the erasure of impure hybrid roots. This second level of continuity functions

[496] For a thorough introduction to historical studies of commemorations, see Abir-Am (1999).
[497] An in-depth analysis of the somewhat mystical myth of origin of Artificial Life is given in Helmreich (1998: 187-190).

by analogy, and should not be collapsed with the first level, as analogy is not a form of historical explanation.[498] Yet despite the lack of actual historical relevance, this second level of narrative achieves the goal of reinforcing the overall perception of historical continuity. Why would the authors want to do that, considering that their first level of narrative presents solid historical evidence to sustain their claims and can thus stand on its own? If anything, the demonstration by analogy, invalid as a logical form of demonstration, interferes and weakens the explanatory power of the evidence-based demonstration. So, what is to be gained by thus reinforcing the perception of historical continuity? In his essay "Collective Memory and the Actual Past", Steven Knapp makes the following observation:

> "[…] socially shared dispositions are likely to be connected with narratives preserved by collective memory, for example by oral tradition or a canonical literature. Beyond the *causal* role they play in influencing people's dispositions, the narratives preserved by collective memory sometimes play a *normative* role – that is, they may in various ways provide criteria, implicit or explicit, by which contemporary models of action can be shaped or corrected, or even by which particular ethical or political proposals can be authorized or criticized. For convenience, I will speak of a narrative that possesses such normative status as bearing collective *authority*."[499]

I will venture that the narratives of historical continuity between British cybernetics and Artificial Life in the Sussex neighbourhood bear a form of collective authority, and in this perspective the demonstration by analogy, although invalid as historical explanation, serves its purpose in that it reinforces the perception of continuity. In my

[498] Zemon Davis & Starn (1989: 4).
[499] Knapp (1989: 123).

view, such narratives are part of the normative mechanisms by which the moral economy of the Sussex neighbourhood sustains itself. They have a role to play in its enforcement. To be convinced that this is the case, one just has to look at the 'ancestor' figures that their home-grown historical project, The Mechanical Mind in History, is dragging out of oblivion and how they are portrayed. 'Voluntary hybrids' with a strong disregard for boundaries, eccentric oddballs with a knack for business, independent thinkers engaging in successful interdisciplinary ventures, all in a distinctive British positioning: they very much embody the virtues characterizing the moral economy and the ethos of interdisciplinarity of Artificial Life at Sussex.

Finally, I would like to return to the overall aim of my studying interdisciplinary practices in the Sussex neighbourhood, which is to characterize them according to the typology proposed by Barry et al. So far, my examination of the interdisciplinary collaborations in the domain of history into which members of the Sussex neighbourhood have engaged has revealed that a shared fundamental characteristic was a challenge to the authority of established histories. Thus we may conclude that once more, we are facing interdisciplinary practices that fit the agonistic-antagonistic mode. Although they seem unlikely to fit the logics of accountability or of innovation, it remains to ascertain whether they actually situate themselves into a logic of ontology.

How should history, as a discipline, receive the counter-memory challenges put forward by the interdisciplinary historical projects I have been looking at? From a historian's perspective, the challenges offered by White Heat Cold Logic are bound to possess an added academic legitimacy. Where the hybridism and counter-memory claims of The Mechanical Mind in History may be more easily dismissed as partisan and amateurish since the project was set up and led by ALifers and roboticists (two of whom members of the Sussex neighbourhood), CACHe cannot incur the same charge despite the presence of Brown in the project team, since the three other team members were themselves historians of art (and Brown is the only Sussex affiliate in the long list of contributors[500]).

The counter-memory claims of White Heat Cold Logic narrow down those of The Mechanical Mind in History, in that they challenge received histories specifically for their disregard of a British computer arts contribution rather than for their general disregard of a wider British contribution. What is the position of the historians of art who have collaborated to the project with respect to these counter-memory claims? They sustain them and make their involvement in the battle explicit. The opening paragraph of Gere's introductory chapter actually puts it at the forefront of the book's agenda. Here is an extract:

> "[…] the aim of this book is to recount the history of the digital and computer-based arts in the United Kingdom from their origins to 1980. It also has a rather more polemical intention: to forcefully argue for the importance of such a history, which has otherwise been disregarded. It is our belief that the digital and computer-based arts, both in the United Kingdom and elsewhere, have been woefully neglected by contemporary art galleries and institutions involved in the history of art. […] We hope and intend that this collection of essays will be part of a process of redressing the marginalization of the pioneering work of these artists and their vital contributions to our contemporary technoculture."[501]

Hence in this interdisciplinary enterprise, historical scholarship allies itself to (counter-) memory work rather than opposing it, and instead opposes the institutional history of art. Similarly, in The Mechanical Mind in History, contributing humanities scholars

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[500] Brown et al., eds. (2008: 421-429).
[501] Gere (2008: 1).

(although not academic historians) were allying themselves to counter-memory work in order to oppose prevailing accounts in the history of science. Those two cases fit with what Zemon Davis and Starn have described as one of the ways to negotiate the gap between history and memory, remarking that "[m]uch of the 'new' social history written in recent years about marginal and otherwise forgotten people depends on the return to (and of) such counter-memories. […] Rather than insisting of the opposition between memory and history, then, we want to emphasize their interdependence."[502]

But I believe that The Mechanical Mind in History and White Heat Cold Logic do more than challenge what may be "repressive or merely complacent systems of prescriptive memory or history".[503] In my view, they question the compartmentalized disciplinary organisation of history, as they reveal an implicit challenge to the specialist histories of art, science and technology, and I would say to specialist histories in general. It is a challenge that coalesces out of the recurrence of inconspicuous remarks, which are so many indirect attacks on the restricted perspectives adopted by specialist studies – like when Brown argues that some British artists such as himself were doing Artificial Life before Artificial Life was supposedly invented by American scientists;[504] or when Boden reveals that D'Arcy Thompson was drawing upon the heterogeneous traditions of biology, mathematics and the classics.[505] The historians of White Heat Cold Logic are present on this front as well. For instance, Gere writes:

> "[…] Harold Wilson, speaking at the 1963 Labour Party conference, promised that a new Britain would be forged in the white heat of the scientific and technological revolution. The cold logic of computing was a

[502] Zemon Davis & Starn (1989: 5).
[503] Zemon Davis & Starn (1989: 5).
[504] Brown (2008b: 286-287).
[505] Boden (2008).

> vital component of this white heat, and artists played a central role in enabling cultural understanding and acceptance of new technologies".[506]

The immediate implication of this passage is that any worthy social or cultural history of computing in the United Kingdom through the 1960s and 1970s cannot ignore computer art. Another example is professor of art history María Fernández, who writes about Gordon Pask that "Pask's work exemplified interdisciplinarity. His machines and theories were neither art nor science; they utilized and exceeded both"; and later in the chapter, about Pask's piece 'Colloquy of Mobiles': "Colloquy may be discussed as a contribution to art, cybernetics, engineering, simulation, sociology, and artificial life."[507] Fernández's claim of paradigmatic interdisciplinarity has the unavoidable consequence that it questions the adequacy of specialist histories to properly address and assess the work of individuals like Pask, which in turn questions the segregation between specialist histories.

What we witness here, is not merely members of the Sussex neighbourhood, unhappy with the way the history of their field has been misapprehended by historians, trying to bring it to awareness so that it gets redressed – like in <u>The Mechanical Mind in History</u>, when the author of the paper on Babbage concludes that "[i]t will be left to historians of science to provide an accurate account of the significance of the activities presented here. This chapter merely seeks to draw some attention to them."[508] This, incidentally, may be partly answering a question that has been hovering, unarticulated, over the present discussion – as a STS scholar, what use am I to the Sussex neighbourhood? Why have they easily accepted my presence and my questioning? Part of the answer is, as stated in a former chapter, that they hoped I could help them understand what it is they are doing and where Artificial Life is heading. They may also

[506] Gere (2008: 1).
[507] Fernández (2008: 54-55, 58).
[508] Bullock (2008: 37).

be hoping for champions ready to engage on their behalf in a crusade to rectify the slanted histories of cybernetics and Artificial Life. In an actor-network perspective, this could be described as recruiting allies in research communities independent of their own, in order to widen and strengthen their network.

What we witness also, is professional historians who, being dissatisfied with their own discipline, engage in interdisciplinary collaborations in order to palliate the disciplinary shortcomings of history. At this point, I will argue, it becomes clear that these interdisciplinary collaborations in the domain of history, performed on the agonistic-antagonistic mode, inscribe themselves into the logic of ontology.

5. A NEXUS OF ART AND SCIENCE

The present section explores the relationships between science and art that have developed in the Sussex neighbourhood. Using fieldwork material as well as bibliographic and web resources, it showcases a number of initiatives and realizations. It also examines how individual Sussex ALifers may understand, conceptualize, and justify, their experience and practice at the art-science junction in Artificial Life. Artificial Life art ('art in an Artificial Life research group' would be more appropriate, as not all artworks and performances make actual use of Artificial Life methods, but I will go on using the phrase 'Artificial Life art' for the sake of convenience) has been the most obvious and ubiquitous case of interdisciplinary crossover that I have encountered in the field of Artificial Life in general, and in the Sussex neighbourhood in particular. Yet I have kept the discussion of Artificial Life art for last, because it refers at times to my prior discussions of interdisciplinary practices in the domains of philosophy and history, and also because the case of history usefully established that the entwining of art and science in Artificial Life was not a recent trend but had instead contributed to shaping the field.

Additionally, art-science is among the three case studies developed in the "Interdisciplinary and Society" project that has provided the framework for the present study of interdisciplinarity; and it is the case of art-science that has led the project investigators to identify the logic of ontology in what might be, in their own words, its "purest expression".[509] I will thus use the results of their art-science case study as both evidence and benchmark.

5.1 MULTIPLE HETEROGENEITIES

The phrase 'Artificial Life art' (in this particular instance I use it in its proper sense, restricted to art that actually involves Artificial Life methods) is deceiving. It sounds as though it labels such a specialist niche that one would expect to find a high level of homogeneity behind it. There is homogeneity, but to a very limited extent only, in the sense that Artificial Life art, as part of Artificial Life, relies on a broad range of biology-inspired synthetic processes. Artificial Life artworks otherwise come in a widely heterogeneous multiplicity of forms. They may come as musical, visual or multi-media productions, as artefacts, installations or interactive man-machine performances, and belong non-exclusively to the soft (virtual), hard (robotic), or wet (chemically-produced) categories. The diversity is such that art historian Ingeborg Reichle and critical art theorist Mitchell Whitelaw have both felt the necessity to categorize Artificial Life art (and neither included Artificial Life music in the scope of their inquiry) prior to discussing it. Reichle identifies "three tendencies in media art which utilizes technologies of artificial life sciences in very different ways", while Whitelaw presents the practice of Artificial Life art "through a simple typology based on four of

[509] Barry, Born & Weszkalnys (2008: 38).

its prominent techniques and tendencies". With such similar sorting criteria, we could have expected them to come up with parallel typologies. Yet although they overlap, they do not converge.[510]

I will follow neither. I do not come to Artificial Life art from an art studies perspective, but from a science and technology studies perspective. And my aim in this section, following the overall aim of the chapter, is to evaluate to which degree, in the Sussex neighbourhood, some interdisciplinary practices crossing over science, technology and art are, once again, in agonistic-antagonistic mode towards parent disciplines, and follow the logic of ontology. I have thus chosen to organize my inquiry into the art-science nexus of the Sussex neighbourhood around another, more productive for my purpose, set of categories, transversal to those of both Reichle and Whitelaw. Since Artificial Life art is foremost Artificial Life, it is worth asking what distinguishes it from non-artistic Artificial Life realizations. It is, in many cases, the lack of constraint from scientifically accepted empirical data. But my fieldwork perception has been that, more fundamentally, the distinction tends to be located in the authors' motives – a view supported by Artificial Life artist Ken Rinaldo:

> "Artificial life artworks could be considered as a subgroup of artificial life research in that most artists are more concerned with the creation of an aesthetic as opposed to testing theoretical biology. Which is not to say that the techniques utilised by artists do not result in real artificial life, or that artificial life researchers cannot find a visual or behavioral aesthetic in their research. Still, motivations often differ between the two groups."[511]

And the range of authors' motives reveals a deeper heterogeneity, hidden behind the more perceptible heterogeneity of forms. My plan is certainly not to investigate the

[510] Reichle (2009: 168); Whitelaw (2004: 20-21).
[511] Rinaldo (1998: 374).

full spectrum of possible motives for doing Artificial Life art that can exist in the Sussex neighbourhood. Motives hardly ever come in isolation but rather intertwined, and can be implicit as much as explicit. Moreover, their affinity with interdisciplinary practices in the agonistic-antagonistic mode and in the logic of ontology is variable. I will concentrate on motives that I find most relevant to the goal of my inquiry, and they fall into two broad categories. One is critical questioning; art motivated by critical thinking in the conceptual art vein is more likely to follow the agonistic-antagonistic mode of interdisciplinarity than, for instance, art primarily motivated by such first-degree fascination as some Artificial Life scientists experience toward their creations. Another is knowledge production, with art as research method; artistically engaged interdisciplinary projects, where investigating novel forms of knowledge production practices is a driving motive, should be predominantly in the logic of ontology. But before I start exploring empirically these two broad categories of motives, I will survey yet another order of heterogeneity in the art and science nexus of the Sussex neighbourhood, that of the sites where Artificial Life art is produced and performed. It will add yet another dimension to the multiple diversity of Artificial Life art and highlight some of its crossbreeding potential.

5.2 A THICKLY NETWORKED CONFIGURATION

The Sussex Artificial Life group organised the fourth ECAL conference in 1997, and although it was customary to have arts exhibits of sorts at Artificial Life conferences, mostly with participants displaying their realisations on the side of the sessions, it seems that ECAL 1997 took a step further and was the first Artificial Life conference to involve the actual curation of an exhibition of art-science collaborations, Like Life, sponsored by Arts Council England. Australian performance artist Stelarc, known for his provocative explorations of human body-machine interfaces, was invited as keynote speaker. This led to his doing a residency with COGS/CCNR early 1998, initiating a series of artist-in-residence internships. There is no special provision for providing artists-in-residence at CCNR with financial support, in the form of a stipend or otherwise. But as members of CCNR, they have some office space, access to computers, to the Robotic Lab, to the Creative Systems Lab, and more generally to all the facilities of the university. They are welcome to sit in on courses, participate in reading groups, organise seminars, etc.

For resident artists, a major benefit seems to be the stimulating confrontation with perspectives different from their own. Paul Brown, artist-in-residence since 2000 and visiting professor since 2005, says that he used to be very much into the abstract computationalist paradigm but CCNR has converted him to embodiment.[512] Australian computer artist Jon McCormack, who was there for a couple of months around 2001, remembers that the variety of the population was both amazing and exciting;[513] he himself shared an office with a biologist doing research on bees' trails and enjoyed the interaction.[514] Norwegian visual artist Sol Sneltvedt, whose fascination with brain dynamics and the flux of mind states led her to meet professor of neuroscience and co-director of CCNR Michael O'Shea, writes:

> "O'Shea bravely invited me to become an intern at the Centre for Computational Neuroscience and Robotics (CCNR) at the University of Sussex. During this time O'Shea would answer my zillion questions and

[512] Fieldnotes, 26/04/2007.
[513] It was especially so since at the time COGS had not yet been dismantled by University of Sussex management, and housed many biologists and psychologists; the population diversity shrunk significantly after COGS was split and its computer science component became Informatics; the dismantling of COGS has been unanimously lamented by all my informants who had been acquainted with the former COGS.
[514] Fieldnotes, 08/07/2007.

> arrange for Tom Smith[515] and me to carry out computational experiments that resulted in a pilot and a plan for visualization of brain activity."[516]

Overall, what is on offer is an enabling interdisciplinary environment, for the artists to appropriate and eventually to develop into collaborative projects. British conceptual artist Anna Dumitriu, artist-in-residence since January 2007, has given an exemplary illustration of such an appropriation, leading to project development, when taking stock in her blog of the two years she had already spent at CCNR:

> "It's a long time since that first Life and Mind seminar I attended and a steep learning curve. I've audited many courses including: Artificial Life, Non Symbolic Artificial Intelligence, Object Oriented Programming and Generative Creativity. I've organised many events on and off campus including 'Forms of Life' at Lighthouse in Brighton. As well as attending a huge number of seminar groups and lectures including The History of Cognitive Science, Alergic, e-Intentionality, COGS and of course Life and Mind, who I created an art event for […]. I've also made some great friends and am working on some fascinating projects […]."[517]

The result is undeniable in terms of collaborative projects that have secured substantial grant awards from public funding bodies. Sneltvedt and O'Shea's collaboration led to their successful application in 2003 under the first round of Art and Science Research Fellowships programme run jointly by the Arts Council England and the Arts and Humanities Research Council. This programme, according to Barry et al., was an experimental model of project-based commissioning, premised on the agonistic

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[515] Tom Smith was then a DPhil student at CCNR, working on the evolvability of artificial neural networks for robot control.
[516] O'Shea & Sneltvedt (2006: 455-456).
[517] Anna Dumitriu' blog entry, 14/01/2009, http://web.mac.com/annadumitriu/SOA/Blog/Entries/2009/1/14_Review_of_Past_two_years.html, downloaded 19/11/2009.

mode, which made clear "the grounding of some art-science in the entanglement of the logics of innovation and ontology."[518] Anthropologist James Leach, who had the role of 'attached observer' to the program, has insisted on its experimental nature, and observed that all of the nine projects selected for reporting in the art-science journal Leonardo at the end of the first round of fellowships,[519] among them Sneltvedt and O'Shea's Mindscape project, "were long-term intense collaborations in which directions and possibilities emerged as a vital part of the process. They were genuine 'research' projects."[520] The Mindscape project pre-existed the introduction of the fellowships programme, but the award allowed Sneltvedt and O'Shea to develop and refine their plan, and to assemble an interdisciplinary team of neuroscientists, computer scientists and artists. For Sneltvedt in particular, the award meant that she "could devote [her]self to full-time work in the up-to-date space [they] had established in the CCNR laboratory."[521]

Another major funded collaboration was the international, highly interdisciplinary DrawBots project on computational creativity, run between 2005 and 2008 on an AHRC grant in excess of £300,000. DrawBots was brought about by Brown's close and long-lasting upstream collaboration with scientists and philosophers at CCNR and COGS.[522] On a smaller scale so far, Dumitriu's collaboration with philosopher Blay Whitby and neuroscientist Luc Berthouze has led in 2009 to the "Emergence of Consciousness" project, funded by Arts Council England.

Artist-in-residence internships are one component only of the institutional backbone nurturing Artificial Life art at Sussex. The traditional route of research

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[518] Barry, Born & Weszkalnys (2008: 30).
[519] They were part of a special section dedicated to the Art and Science Research Fellowships program in Leonardo 39:5, 2006.
[520] Leach (2006: 447).
[521] O'Shea & Sneltvedt (2006: 455-456).
[522] Another collaborative project which Brown has collaborated to at CCNR is of course the historical volume The Mechanical Mind in History.

degrees is open to art-science projects. This was for instance the case with generative musician Alice Eldridge, EASy graduate in 2002. Adaptive music systems were the topic of her masters dissertation (comprised of both text and sound tracks)[523] and she went on to do a DPhil at CCNR, entitled “Collaborating with the Behaving Machine: Simple Adaptive Dynamical Systems for Generative and Interactive Music”. Another example is Sam Woolf, whose EASy dissertation in 1999 was “An interactive installation artwork: The Sound Gallery”, a work of Artificial Life art that made use of reconfigurable hardware technology to achieve interactive and adaptive behaviour. Woolf went on to do a DPhil in Interactive Art, which involved Artificial Life ideas and techniques, in the Sussex school of Informatics; one of his supervisors was a member of the Artificial Life group. Woolf and Eldridge both followed the EASy masters’ programme before pursuing their doctoral studies. Their individual cases are corroborating Barry et al.’s finding, in the case study of art-science at University of California Irvine (UCI) and their masters in Arts, Computation and Engineering (ACE): that interdisciplinary degrees at masters’ level, which accommodate students with artistic and creative profiles alongside scientific and engineering profiles, are a key component for an inventive and productive university-based art-science.[524] This is the case of EASy to some extent, although scientific and engineering profiles are largely predominant on the programme. In Woolf’s year only, two other dissertations, out of a total of twenty or so, were on artistic topics. A quick survey of EASy dissertations

[523] Music tracks and the full text of Alice Eldridge’s MSc dissertation are downloadable from the EASy publications pages, http://www.informatics.sussex.ac.uk/research/groups/easy/publications/msctheses2002.html, consulted 24/11/2009.
[524] Barry, Born & Weszkalnys (2008: 38-42).

between 1999 and 2005 shows that the proportion of topics falling within the arts and entertainment (gaming, edutainment, etc) categories is about 10%.[525]

Another important component of the institutional backbone sustaining Artificial Life art at Sussex is the Creative Systems Lab, a structure set up in 2003 within the school of Informatics to encourage projects at the intersection of art, science and technology. It serves as a forum for researchers and students, many of whom members of CCNR and COGS, interested in using computers for creative processes and practices. In 2007 it started offering a MSc in Creative Systems, which curriculum and targeted audience are comparable to that of Irvine's ACE graduate programme. The Creative Systems Lab was an initiative of musician and computer scientist Andrew Gartland-Jones[526], another 'voluntary hybrid' who "rapidly decided Sussex was his home" when he embarked in 2001 on a DPhil "on the application of adaptive computing techniques to algorithmic composition and generative music." [527] When he looked for a supervisor, Gartland-Jones did not land in the office of a founder and leader of the Sussex Artificial Life group out of chance: the latter (whom I have quoted earlier for saying that he had always in part inhabited the worlds of science and art and been interested in merging the two, and for thinking that the most interesting things happened when one started dismantling boundaries) has a background in music and strong connections with the world of generative music.

Music is indeed an important dimension of Artificial Life art in the Sussex neighbourhood. Gartland-Jones was instrumental in convincing the University management that they needed a new interdisciplinary degree crossing over art and science, and in setting up a pioneering undergraduate degree in Music Informatics as a

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[525] http://www.informatics.sussex.ac.uk/research/groups/easy/publications/msctheses.html, consulted 27/11/2009.
[526] Andrew Gartland-Jones died shortly after, in 2004, at the age of 40.
[527] Phil Husbands's tribute, Memorial website of Andrew Gartland-Jones, http://www.atgj.org/drew/tributes.htm, downloaded 19/11/2009.

collaboration between the Music department and the school of Informatics. The degree was successfully launched in 2003 and has been running since. Its current convener is a member of the Creative Systems Lab, and teaches on the MSc in Creative Systems. Such interactions should be fertile grounds for the development of interdisciplinary projects at the intersection of Artificial Life and music, as well as for the development of collaborations between artistic forms and currents that do not easily mix. An indicator that new research possibilities may emerge through these interactions is the recently set up interdisciplinary music/sound research seminar series, InterMus, aimed at “all those with an interest in research on music and sound”, be they from Informatics, Psychology, Music, Media and Film, Neuroscience, Creative Systems, Engineering, Mathematics, Physics, Acoustics, or other.[528] Launched in May 2009 by two members of the Music Informatics group, it is advertised through the InterMus mailing list, but invitations are also circulated through ALERGIC, as well as Life and Mind, COGS and Creative Systems mailing lists, showing the interest of the Artificial Life research group for InterMus (considering the overlap between these various lists, some must receive each message many times). Indeed, the second season of Intermus seminars, which has only just started as I am writing, opened with a talk by a member of the Artificial Life group; while the second of the two seminars in the first season, held in June 2009, featured two presentations, one by a member of the Creative Systems Lab, the other one involving CCNR current artist-in-residence Anna Dumitriu.

Gartland-Jones did not just actively participate in the development of an institutional framework for art-science projects. Outside academia, he collaborated with three other postgraduate students at Sussex University (all three were members of the Creative Systems Lab; one was researching the application and possibilities of Artificial

[528] https://lists.sussex.ac.uk/mailman/private/intermus/2009-May/000002.html, https://lists.sussex.ac.uk/mailman/private/intermus/2009q4/000009.html, consulted 20/11/2009.

Life in sound synthesis and real time performance, one was doing research on the scientific side of Artificial Life, and last was Sam Woolf earlier mentioned; two of them are still at Sussex as of November 2009) to set up Blip:

> "[…] a forum that would bring together artists and scientists whose practice involved artificial creativity, interactivity, generative and procedural processes, and artificial life. Basically, our idea was to invite people whose work we were interested in to come and speak in Brighton. We also decided to hold the events in city centre bars and show work by local artists and so they became a unique hybrid of a talk, a show and a night out."[529]

Blip was a successful idea. Between 2002 and 2006, it organised more than thirty-five presentations, exhibitions and gigs, as well as four annual Big Blip festivals. First one was one day long, second was two days long, and the 2005 and 2006 festivals lasted for a week. The last one had over two thousand visitors.

Although Blip proved quite resilient, the downside of voluntary sites is often their volatility. In 2007 and 2008 Blip's activities were limited to participating in the first two editions of Loop, Brighton newly launched digital arts festival. By then, the initial group of volunteers had dwindled to two, who were increasingly absorbed into other projects. Blip has now gone dormant, "unplugged but not junked, and we'd be happy to talk to anybody who has the time and energy to power it up once more."[530] But multiplicity can make up for volatility. Other non-academic voluntary sites propitious to Artificial Life art-science practices have appeared in, or come to intersect with, the Sussex neighbourhood. A software developer who is an ex-COGS student has set up Brighton Robotics, advertised through the ALERGIC mailing list as "Brighton's only non-academic robotics and A-life enthusiasts group". Some Sussex ALifers have now

[529] Jon Bird (2004), In Memory of Andrew Gartland-Jones, Guest Book, http://www.atgj.org/drew/guestbook.php?start=30, consulted 25/11/2009.
[530] Blip website, http://www.blip.me.uk/, consulted 25/11/2009.

joined her group, and have actively collaborated to a recent music/arts performance evening, entitled “Robot Takeover”.[531]

“Robot Takeover” was a fundraising event to the benefit of another organisation, BuildBrighton, which presents itself as “Brighton’s hackerspace – a collective of like minded people who love to build stuff with electronics.”[532] BuildBrighton is a not-for-profit community providing a space “for hacking, equipment, machinery and tools” to its members, as well as tutorials and workshops for the public.[533] The young woman who founded Brighton Robotics is among the seven core members, as well as a recent EASy graduate, freelance web-developer, who “is very interested in the potential of artificial life and bio-inspired computing”.[534] The latter gave a talk at the first ever social event organised by hackUS, University of Sussex Informatics society. The evening program also featured a repeat of a talk given at “Robot Takeover”, “Do you want a robot lover?” by COGS philosopher and ethicist Blay Whitby, and a live interactive music generation performance – as well as a showing of Ridley Scott’s Blade Runner: The Final Cut, a reminder that ‘sci-fi nutters’ were expected in the audience.[535]

Another non-institutional site intervening both in academic and non-academic settings is Dumitriu’s Institute of Unnecessary Research, which she founded in 2005. The Institute of Unnecessary Research starts from the premise that artists are innovators, and as soon as a new piece of technology or a new medium becomes

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[531] Held on 30th October 2009, “Robot Takeover” was “featuring live performance coding music by TOPLAP, the 55th Flotilla (rum and bass and nautical dubstep with an (un)theremin!), interactive art, real robots, electronics demos, robot dancing and talks by Blay Whitby ‘Do you want a robot lover?’ and Seb Lee-Delisle” (extract from its advertisement on Facebook).
[532] http://www.buildbrighton.com/wiki/Main_Page, consulted 25/11/2009.
[533] http://www.buildbrighton.com/wiki/Subscription_Information, consulted 25/11/2009.
[534] http://www.buildbrighton.com/wiki/The_Community, consulted 25/11/2009.
[535] Informatics_alergic_list Digest, Vol 57, Issue 17; the event took place on 27th November 2009.

available, they want to experiment with it and push boundaries. This is how they define themselves:

> "The IUR is a hub for researchers and artists working experimentally and deeply engaged with their specific research areas. We present our research through performative and experiential methods, engaging the public and new audiences."

Their research translates into performance events that can take place in a variety of settings: art galleries in the fine arts tradition, but also universities, festivals, businesses, participatory workshops, etc.[536] Connections between the Institute of Unnecessary Research and the Sussex neighbourhood are multiple, through its Director Dumitriu, through its Head of Ethics Blay Whitby, long-time member of COGS staff, through its Head of Robotics Paul Granjon, low-tech ironic robotic artist whom many in the Sussex Artificial Life group became acquainted with through "Art, Body, Embodiment", a COGS interdisciplinary symposium held over two days at University of Sussex in March 2005.[537]

A material example of the role that non-academic, voluntary sites of art-science practice can play for university-based art-science is the recruitment of Anna Dumitriu by the Sussex Artificial Life research group: she first came across members of CCNR through Blip (in her own words: "[…]a great forum for artists, scientists and members of the public interested in new forms of art that explore[d] generative and procedural processes, interaction, emergence and artificial life, and I've spent many a wonderful evening at events they've put on […] as far as I'm concerned Blip [were] doing some of

[536] http://web.mac.com/annadumitriu/IUR/Welcome.html, consulted 25/11/2009.
[537] http://www.sussex.ac.uk/cogs/1-4-3.html, consulted 25/11/2009.

the most interesting art stuff that happens in Brighton") and her residency at CCNR was set up in the first place by one of Blip organisers.[538]

A PhD student of the school of Informatics, who is an interactive new media artist member of the Creative Systems Lab, pointed me towards a less obvious way into which such sites may play a valuable role for university-based art-science. She felt that the institutional environment of academia had an impact on her as an artist. For example, when she was out of her PhD context, hanging around with Brighton artistic crowd, she said she would have no problem slapping someone whom she barely knew on the shoulder and say, let's do something wild, and put together some kind of crazy installation overnight; by contrast, she would never dream of doing such a thing within the academic context of CCNR.[539] Different sites are socially governed by different rules of conduct, tacit ones no less binding than explicit ones. And as certain sites encourage types of social behaviours that would feel inappropriate in other settings, my interlocutor's experience was that this had an impact on the art she produced; she was not the same artist in and out of the institutional context. Non-academic voluntary sites may thus offer a useful complementarity to academic institutional sites as they may motivate different styles of artistic expression.

As well as different styles of artistic expressions, these sites may also lend themselves better than academic sites to open-ended inquiry into the interdisciplinary collaborative process itself, thanks to an environment that, being overall much less constrained by accountability than academia, is under lesser pressure for well-defined prior research goals and accompanying assessment criteria. Open-ended inquiry into the interdisciplinary collaborative process itself was for instance an important outcome of a

[538] Fieldnotes, 08/03/2007; Dumitriu's blog entry, 22/02/2007, "DrawBots", http://web.mac.com/annadumitriu/SOA/2007-2008/Entries/2007/2/22_DrawBots.html, consulted 11/12/2009.
[539] Fieldnotes, 31/05/2007.

project organised by Blip, which initial idea was "to encourage local artists and scientists to collaboratively develop an installation" for Big Blip 04.[540] I would like to present this case in some detail, because it anticipates on my examination of critical questioning and knowledge production as motives for engaging into Artificial Life artistic projects.

The Blip organizers solicited local communities for "enthusiastic, open-minded artists, scientists and technologists who could make a commitment to working collaboratively for up to twelve weeks. […] Participants had to have some free time during the day to attend workshops at the University of Sussex and the University of Brighton. We offered training, equipment and support."[541] The project was supported by Blip, by CCNR and by the Centre for Research and Development in the Faculty of Arts and Architecture at University of Brighton (about which more below), as well as by the Arts Council England. It involved two CCNR Artificial Life researchers and three artists who together acted as co-ordinators and mentors, two Brighton-based artists, and three graduate students (scientists and engineers), from the EASy MSc programme. It resulted in two installations. The first, corresponding to the initial brief, was an interactive installation involving eight low-tech custom-made robots in a display cabinet, entitled <u>There Does Not, in Fact, Appear to Be a Plan</u>. <u>Clutch</u>, the second, was an unforeseen last minute product of the collaborative process. <u>There Does Not, in Fact, Appear to Be a Plan</u> did not fulfil the artistic goals that the team had set out to achieve since most of the project allocated time was spent getting the robots up and running, and <u>Clutch</u> was formed as a desperate one-sided effort by the unhappy artists to make the whole enterprise work as art, to the dismay of the scientists and engineers in the group: "<u>Clutch</u> was a visually arresting piece: the display cabinet was taken apart, the robots

[540] Bird et al. (2005: 58).
[541] Bird et al. (2005: 59).

switched off and the velcro covered foam cubes scattered on the floor. This installation was filmed for display on a monitor at the Big Blip 04 and then the participants reconstructed There Does Not, in Fact, Appear to Be a Plan."[542]

A joint paper recounting the whole enterprise was presented at the AISB (Artificial Intelligence and the Simulation of Behaviour) 2005 convention. The paper aimed "to explore the relationship between scientific enquiry and artistic practice and stimulate new critical debate about this emerging cultural hybrid."[543] The structure adopted in its writing was itself part of the authors' inquiry into the interdisciplinary creative process they had experienced, as it weaved third-person factual accounts of the project and design of the robot technology with first-person subjective comments by the participants on the collaborative process and its end result, a narrative structure which for the authors "echoes the tension between practical constraints and creative ideas that was very evident in the collaborative project and that is at the heart of much artistic and scientific practice."[544] Clutch, the emergent (in the complex systems sense of unpredictable) outcome of the project, which initially affronted the scientists as they took it as a rejection of their hard work and personal involvement in the project, was meant by the artists "not to belittle what was achieved in that project; rather, Clutch was meant as a commentary about the working process between two different practices."[545] It is interesting that although the project failed in its initial goal, it achieved other things. Despite technical difficulties, problems of communication across cultures, frictions between individuals, the initial anger and incomprehension provoked by Clutch in some of the scientists, disagreements on the set-up of the installations, the participants all

[542] Bird et al. (2005: 61).
[543] Bird et al. (2005: 58).
[544] Bird et al. (2005: 59).
[545] Bird et al. (2005: 63).

ended up with a positive outlook on the project. For instance, one of the scientists commented:

> "I initially found the artists' satisfaction with Clutch utterly beyond my comprehension. Upon reflection though I think the video has significance in that it captures aspects of the scientific process that don't make it to scientific journals. Firstly, the murky issue of results that don't conform with a desired hypothesis. Secondly, the lonely romance of the road to implementation."[546]

The positive outlook could have been for the show only, but it seems that the participants remained convinced by the value of their original concept, and they have kept the collaboration going, to try and bring their idea of interactive installation to fruition. An important conclusion reached by one of the mentoring artists was that the project was "a good case study for further discussion surrounding the pros and cons of collaboration. The question today is no longer 'why collaborate?' but rather 'how might one collaborate?'"; for him, despite a common goal that could have ordered and directed the development of the collaboration, the project had instead explored collaborative practice "as a dynamic learning system with multiple feedback loops."[547]

To conclude on the case of the Blip project, I have just shown that the main two motives for engaging in collaborative art-science projects, which the reflexive inquiry into the project draws special attention to, are (1) critical questioning and (2) investigating the interdisciplinary creative process as such. These are two major stepping stones towards attempting to establish novel modes of knowledge production. The case of the Blip project illustrates that voluntary sites at the margins of academia (this particular project brought together academic and non-academic resources) may be

[546] Bird et al. (2005: 63).
[547] Bird et al. (2005: 62).

nurturing grounds for interdisciplinary practices on the agonistic-antagonistic mode and in the logic of ontology.

My survey of the sites available for the production and performance of Artificial Life art in the Sussex neighbourhood reveals their heterogeneous profusion – some short-lived, some more permanent, some institutionally driven, some voluntary and grass-root, some purely academic, some in the professional artistic circuit, some part-amateur – and the more or less transient configurations that they associate into. Such a profusion may appear bewildering, especially in its extra-institutional richness, unless we remember that the University of Sussex is located in the city of Brighton. Artificial Life at University of Sussex is embedded in a very dynamic and experimental city in the artistic domain.[548] It benefits from the proximity of University of Brighton Faculty of Arts and Architecture, which became in 2005 the Centre for Excellence in Teaching and Learning through Design (CETLD), and its world-class Centre for Research and Development (CRD).[549] For instance, Sneltvedt, ex-CCNR artist-in-residence, has since become member of staff at CRD; Dumitriu is a research student and visiting tutor at CRD, where she has been pursuing a part-time Fine Art PhD since before she joined CCNR; and another CRD staff member, Sue Gollifer, course leader for the MA in Digital Media Arts among other things, who like Paul Brown is a veteran of digital art, was a Blip adviser. Gollifer has since become adviser to Dumitriu's Institute of Unnecessary Research.[550] Once again, localisation clearly matters.

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[548] For instance, the Brighton Festival, running since 1966, is the 2nd largest arts festival in the UK after Edinburgh, while the Brighton Festival Fringe, running alongside the main Festival since 1967, is the 2nd largest fringe festival in the world, also behind Edinburgh; Brighton has by all means a long history of attracting artists.
[549] The CETLD is a five-year partnership project between the Faculty of Arts and Architecture of the University of Brighton, the Royal College of Art, the Royal Institute of British Architects and the Victoria and Albert Museum, funded by the HEFCE (Higher Education Funding Council for England).
[550] Research staff and research students webpages of CRD, http://artsresearch.brighton.ac.uk/, consulted 10/12/2009; Dumitriu's blog entry, 19/04/2007, "Replacing Humans with Robots", http://web.mac.com/annadumitriu/SOA/2007-

We cannot expect all the sites of Artificial Life art production in the Sussex neighbourhood to give rise uniformly to interdisciplinary practices on the agonistic-antagonistic mode and in the logic of ontology. But their profusion reveals a thickness of networking between art, science and technology that marks a dense, durable and continuous engagement, as well as the will to sustain it and keep it as diverse as possible. The verdict of Barry et al.'s analysis of the art-science case, reached by comparing university-based art-science (especially University of California Irvine) and project-based commissioning (British programmes), is that the former most clearly embodies the agonistic-antagonistic mode and the logic of ontology, and that "it is the scale, duration and continuity of university-based art-science that affords ambition."[551] Artificial Life art in the Sussex neighbourhood, ramifying around a strong and durable academic base, thus presents a configuration favourable to interdisciplinarity on the agonistic-antagonistic mode and in the logic of ontology.

I have a last couple of comments in relation to Barry et al.'s art-science case study. First, they point that university-based art-science is fragile (largely due, in their view, to the inadequacy of academic research evaluation procedures – an issue I will return to later in the chapter).[552] I think that the thickness of networking characterising Artificial Life art at Sussex introduces a measure of robustness in the face of precariousness. It ensures that when some links are severed (for funding shortages, job redundancy, etc), the overall network is more likely to resist. The second comment concerns the approach Barry et al. have adopted. By comparing non-British university-based art-science and British program-based commissioning, they leave in the shadow

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2008/Entries/2007/4/19_Replacing_humans_with_robots.html, consulted 10/12/2009; Blip website, http://www.blip.me.uk/, consulted 10/12/2009.

[551] Barry (2007: 30).

[552] Barry (2007: 30).

the question of the relationships between these two forms of institutional art-science.[553] My own findings in the Sussex case reveal that there are, as may be expected, connections between the two. University-based art-science seems well positioned when competing for awards by funding programmes, thanks to the budding of projects upstream of funding opportunities, as was the case for the Mindscape and DrawBots projects. What is more, the kind of informal and plastic networking encouraged by an enabling environment such as the Sussex neighbourhood may be instrumental in bringing about institutionally funded longer-term research projects.

5.3 MOTIVES FOR DOING ARTIFICIAL LIFE ART

The previous sub-section has demonstrated that Artificial Life art in the Sussex neighbourhood presented a configuration that was favourable to interdisciplinarity on the agonistic-antagonistic mode and in the logic of ontology. So far, my results in the case of artistic interdisciplinary practices concur with the previous case studies of philosophical and historical interdisciplinary practices. Admittedly, not all the artworks I have come across in the course of my fieldwork follow this form of interdisciplinarity. For instance, quite a few Artificial Life scientists, and the Sussex group is no exception, experience a first-degree fascination for their creations that lead them to play around with them outside of the context of their scientific research. Freed from the scientific imperative, they fiddle with the parameters of their simulations to enhance the mesmerizing character of their rendition. They have in general no other driving motive than just sharing their fascination with a willing public. This was typically the case of a CCNR PhD student who on the occasion of an art and science event co-organised by

[553] Weszkalnys (2006: 22): for university-based art-science, the selected case studies were the ACE program at UC Irvine and SymbioticA, a science-art lab at the University of Western Australia (incidentally, in 2009 a team of Symbiotica won the first prize of Art and Artificial Life International Awards, VIDA 12.0); for funding programmes, the selected case studies were the Arts Council England/AHRC Art and Science Fellowships programme and the Wellcome Trust Sciart programme.

Dumitriu, exhibited a computer simulation based on older version of his scientific research, which he deemed less interesting scientifically but more so visually than his latest model.[554] It can lead to crowd-pleasing realisations, as I have had numerous occasions to witness. But these are art forms that trained and professional artists often dismiss as naïve, and criticize for their literalness and lack of actual artistic content.[555] This is obviously not a kind of art-science that follows primarily from interdisciplinary practices on the agonistic-antagonistic mode and in the logic of ontology – although arguably the presence of an artist's critical eye may contribute over time to the education of artistically naïve scientists, and possibly lead to the form of interdisciplinarity that is the object of my inquiry. By contrast, I will examine empirically two categories of motives (ideal types really since they hardly ever come in isolation) driving Artificial Life art in the Sussex neighbourhood, critical questioning and knowledge production, to confirm that those particular motives can indeed give rise to diverse interdisciplinary practices on the agonistic-antagonistic mode and in the logic of ontology.

5.3.1 ART AS CRITICAL ENGAGEMENT

Critical questioning is of special interest for several reasons. It is not only the general motive for doing Artificial Life art that is most obviously leading to interdisciplinary practices on the agonistic-antagonistic mode. It is also, in my experience of the Sussex neighbourhood, frequently put forward by artists themselves as a driver for their work, as well as identified by scientists (those I have questioned at the very least) as the number one motive, beside personal development, for having artists around. That critical questioning and personal development should be the most

[554] Fieldnotes, 29/10/2008.
[555] Fieldnotes, 08/03/2007, 31/05/2007.

popular motives among Sussex Artificial Life scientists for engaging with art is hardly surprising: critical questioning cultivates reflexivity, a cardinal virtue of CCNR's moral economy, which as such is bound to be an important element of personal development in the eyes of its community.

One thing is for sure, though, and it is that collaborating with artists was not felt by Sussex Artificial Life scientists to be a career booster. I have mentioned earlier that for a founding and leading member of the Sussex Artificial Life group, his choice of coming to Sussex in the first place hinged to a large extend to the tolerance that the University was showing towards this type of interdisciplinarity, while it tended to be frowned upon elsewhere. When interviewed by Dumitriu for her blog, O'Shea, another founding professors of CCNR, had a similar appreciation of the impact on a scientist's career of engaging into artistic interdisciplinary projects. He told her that although he really enjoyed collaborating with artists, "he felt that his collaborations haven't really benefited his career, which is more reliant on publishing papers etc, but since he has published so many now he is freer to follow his interests in both art and science […]."[556]

Returning to critical questioning as a motive for bringing in, and doing, art in the Sussex neighbourhood, I have found that although art as critical engagement could target many different issues, science in its many dimensions was a major topic. This particular strand of questioning addresses issues as diverse as the aims, objects and nature of science, scientific method, or public engagement in science. It is very much a science and technology studies kind of questioning, but pursued through vehicles (art and performance), attitudes (playfulness and irony predominantly), and a general methodology (practice of the very science under questioning), that we in science and

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[556] Dumitriu's blog entry, 19/04/2007, "Replacing Humans with Robots", http://web.mac.com/annadumitriu/SOA/2007-2008/Entries/2007/4/19_Replacing_humans_with_robots.html, consulted 10/12/2009.

technology studies are usually unfamiliar, and possibly uncomfortable, with. I will focus on Anna Dumitriu's case to illustrate my point. Not only is she exemplary of this brand of critical engagement with science, but her involvement with CCNR is enduring. At the time of my writing, she has been artist-in-residence there for three years already, and looks as if she intends to go on.

To start with, despite the versatility of her skills, she positions herself deliberately as an artist, not as a hybrid of artist and scientist, and taking this stance is for her a critical move. Although she admits to belonging through her working practices to the narrow band at the blurred intersection of art, science and philosophy, she believes that art, like science and philosophy, is not autonomous or value free but culturally situated. As a result, both artistic and scientific products are situated in culturally specific contexts of conception, and she feels that displacing artefacts from their contexts of conception (for instance, exhibiting into a scientific context an artefact primarily conceived as an art piece, even if it involves interesting science; or presenting as art a product of scientific experimentation) raises problematic issues that should not be dismissed.[557]

Her critical engagement with science works at multiple levels, many of which embodied in the Institute of Unnecessary Research (IUR) that she founded in 2005. She is very clear that the term 'unnecessary' in the name 'Institute of Unnecessary Research' is a meaningful choice and that it should not be equated with 'useless'. 'Unnecessary' in the IUR's name aims at questioning the objects of science: "it's about the nature of epistemology, going beyond the boundaries of what is normally researched".[558] This is a strong theme running throughout Dumitriu's work. For years now, a major research interest of hers has been 'normal flora', the bacteria and moulds

[557] Fieldnotes, 08/03/2009.
[558] Kokoli (2007: 10).

that humans co-exist with, but which are classified neither as pathogens nor as beneficial.[559] As such, and despite constituting around eight kilograms of an average adult human body weight, being more numerous on one's finger "than there are people in the world" and making up around 99% of total bacteria, they are highly under-researched because "considered to be of no medical or commercial interest", i.e. of no scientific interest. For Dumitriu, one of their interests is precisely that "epistemologically they are important, they're about where we draw the line in terms of research."[560]

'Unnecessary' research at the IUR also questions the politics of science from a public engagement perspective, as well as from a feminist critique perspective. The feminist critique in Dumitriu's work is apparent in her deliberate juxtaposing of traditional feminine crafts like embroidery, crochet, baking, porcelain painting, with scientific skills seen as more typically masculine, such as cutting edge biology laboratory techniques and digital media mastery.[561] It is apparent as well in her subject matter of predilection, the domestic ordinary ("Normal flora are kind of domestic and everyday"[562]), which she makes a point of collecting from her private domestic environment (a lab coat in her closet, her chairs, her bed sheets, her cutlery) as it links her work "to the traditional women's domain".[563] At an event organised by the IUR at University of Sussex in May 2007, Dumitriu was wearing a lab coat on which she had stitched in whitework embroidery[564] the microscopic images resulting from a culture of normal flora that she had sampled from the same lab coat, and she was enrolling visitors

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[559] Fieldnotes, 08/03/2007; Kokoli (2007: 5).
[560] Kokoli (2007: 5-6).
[561] Kokoli (2007 : 7-8).
[562] Kokoli (2007 : 5).
[563] Kokoli (2007: 11).
[564] Dumitriu, A., in Kokoli (2007: 7-8): "In historical terms, around the time of the Enlightenment when the 'gentlemen scientists' were out and about calculating the age of the Earth and suchlike, the highest form of achievement for a woman was considered to be an aptitude for whitework embroidery. This is white on white embroidery and you can hardly see what you are stitching but these women would work with candlelight, straining their eyes, hunched over their embroidery hoops, corseted.".

to help her crochet a bedspread inspired by a screen-projected light microscopy image of normal flora from her own bed.[565] As was the case on this occasion, Dumitriu's use of traditional crafts is not only feminist critique but also a way to engage the audience in her performances:

> "[…] especially in non-gallery spaces, like hospital foyers and schools: they are a way of allowing the audience to enter complex ideas in a manner that creates dialogue rather than closing it down. There is a kind of respect amongst the public for skills like embroidery and that allows a way into my work."[566]

In terms of public engagement, one of the main aims of the IUR is to disseminate "innovative research, […] through participatory art and performance, to diverse audiences."[567] For members of the IUR, their alternative approach encapsulates an explicit critique of traditional approaches to the public understanding of science that encourage scientists to explain their work to the public in a one way mode of communication. This tradition underestimates in their view the public's awareness that hidden agendas can lurk behind information dissemination. By contrast,

> "The IUR engages with the very nature of what constitutes scientific research through artistic practice, directly widening participation in those debates as well as bringing about a deeper appreciation of contemporary scientific research. […] The IUR demonstrates that we all can and should debate about the direction of research, its ethical implications, and what exactly science should be."[568]

565 Fieldnotes, 24/05/2007 .
566 Kokoli (2007: 7).
567 Whitby & Dumitriu (2009).
568 Whitby & Dumitriu (2009).

Germane to the critique of traditional approaches to public understanding of science, is the critique of science communication in general. Unsurprisingly, Dumitriu denies the objectivity of science and questions its narratives:

> "The whole way scientific experiments are written up, in the passive tense, reinforces this illusion of objectivity. I want to write up my research in the first person (or third person, in terms of collaboration)."

Collaborative exchange is a strong theme of her work. Her artworks and performances, the events which organisation she involves herself into, are overwhelmingly the result of interdisciplinary collaborations. But her interest in networking through communication, through exchange of information, goes way beyond interdisciplinary human networks, to include the non-human. Part of her work on normal flora bacteria could be depicted as 'conceptual art meets Actor Network Theory'. Starting from the premise that the billions of different bacteria that we have in and on our bodies spend their time communicating messages between themselves, exchanging bits of DNA, talking to our cells, talking to the bacteria of the people around us, etc, her "big hubris" as she describes it is about getting the bacteria to exchange information with humans and computers.[569] This has led to the 'Cybernetic Bacteria' project, "an ongoing transdisciplinary investigation [that] brings together an artist, a philosopher, a microbiologist, an artificial life programmer and an interactive media specialist, to investigate the relationship of the emerging science of bacterial communication to our own digital communications networks". The first artwork in the series, by Dumitriu, involved humans communicating with bacteria as if they were themselves bacteria; the second, 'Cybernetic Bacteria 2.0', combines in real time "the

[569] Fieldnotes, 08/03/2007.

chemical communication of bacteria and the live data streams of our own digital networks […] to generate a brand new artificial life form."[570]

On yet another level, Dumitriu's fundamentally collaborative and interdisciplinary approach to research (I deliberately use the term research without epithet, as I would be seriously hard put to neatly categorize it as scientific, artistic, or otherwise) represents a critical engagement with scientific methodology:

> "[…] Suzi Gablik writes about '*connective aesthetics*', working in this dialogical way, as an inherently feminine methodology. I do think that scientific methodology is something that was for the most part decided without women's participation […] As self-organising, adaptive and evolving, I have a conceptual basis for something that is a completely natural way of working for me: to feed off people, and then to give back. I feel strongly that it's not about the artist using the scientist or vice-versa to their own ends. The end is not pre-determined and it should benefit everyone."[571]

Her idea of what arts-science collaborations ought to be is close to that defended by the Blip project participants in their post-project reflexive analysis, where they draw an analogy between the collaborative process and the biological phenomenon of symbiosis, to denounce parasitic collaborations, "[…] for example, scientists using artists as 'decorators' or 'illustrators' of their scientific project, or conversely artists using scientists as technicians to implement their ideas", in favour of "mutualism, where both entities require each other for survival". [572]

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[570] Informatics_alergic_list Digest 58:5, 08/12/2009; The Normal Flora project website, "Cybernetic Bacteria 2.0", http://web.mac.com/annadumitriu/NF/Cybernetic_Bacteria_2.0.html , consulted 11/12/2009.
[571] Kokoli (2007: 9).
[572] Bird et al. (2005: 65).

I have already highlighted that the critical questioning of research methods is something Artificial Life scientists in the Sussex neighbourhood regularly engage into, for instance through their debates around the epistemological status of simulations, or as part of the naturalization of phenomenology and the enactive approach, which I have put forward as an interdisciplinary practice in the logic of ontology. Occasionally, some of them pursue this reflexive examination through artistic rather than philosophical engagement, even though they may have no formal artistic background (may they be erstwhile artistically naïve scientists who have progressed to linking critical awareness and artistic expression thanks to interacting with artists?). At a public art-science event co-organised by Dumitriu for the Life and Mind seminar group in October 2008, a CCNR PhD student was exhibiting a piece called Visualization, the computer visualization of a simulated Artificial Life agent with which the audience could interact by modifying three of its parameters: introducing a perturbation, altering the agent's simulated environment, changing the visualizing method, with no knowledge of what the agent was meant to represent. The following notice accompanied the installation:

> "Adapted from a scientific work-in-progress, this instalment demonstrates the challenge of investigating and visualizing complex systems. By perturbing the Agent, by manipulating the environment of the Agent or by changing the method of visualization, observers can try to pick apart what this model is. Meanwhile the Agent and environment is itself changing in ways outside of our control. Each way of viewing the system, each perspective, provides different insights into what it is that is happening. But what is truly part of the system and what is an artefact of our perspective? In this sense, this installation represents the scientific process."

When I questioned the author on how he had come up with the idea for this piece, he explained that his PhD project was investigating theories about minimal environmental conditions necessary for the apparition of life processes; as part of his research, he had built a model and got it up and running; the model was doing what he wanted it to do, but he found that as it did so, he was confronted with the realisation that, so now what? What did it mean? How to interpret the results? And it had taken him a couple of weeks, playing around just like he was allowing us to do with the installation, to start figuring it out. What I found striking about this interactive installation was that it was bringing to attention many layers of issues related to representation and interpretation in science, with an efficiency and an immediacy that a paper in the philosophy of science tradition could never rival. The strength of the message was reinforced by the fact that, like most of the participants, I fiddled with the simulation before I read the notice.[573]

In Artificial Life art, the critical questioning of visual representation addresses art as well as science. Dumitriu's laboratory-based work on normal flora is part of her PhD in Fine Art research, "A Practice-Based Investigation into the Relationship of Normal Flora Microbiology to Philosophical Notions of the Sublime", which aim is to "interrogate the possibilities of scientific imagery *as art* – its allegorical, expressive, and social character" and to bring her findings to bear on the conceptualization of the sublime in aesthetic theory.[574] The question of visual representation in both art and science, addressed through the issue of containment, is central to the work of Jon McCormack who was artist-in-residence at CCNR for a short period in 2001. This aspect of McCormack's work has been analysed by Jon Bird, Artificial Life researcher at CCNR and co-founder of Blip, in an essay entitled "Containing reality:

[573] Fieldnotes, 29/10/2008.
[574] Kokoli (2007: 6); Informatics_alergic_list Digest 58:5, 08/12/2009; Dumitriu's CRD research student profile, http://artsresearch.brighton.ac.uk/research/student/dumitriu, consulted 15/12/2009; fieldnotes, 08/03/2007.

Epistemological issues in generative art and science".[575] Bird explains that McCormack "is concerned with 'the conceptual and metaphorical meaning of the bounding container in visual culture, particularly in relation to concepts of the natural and the real' […] McCormack focuses on the constraints that framing devices have on images, or representations, that they display", in art as well as in science.[576] But Bird goes further, and builds from there to reach the conclusion that:

> "We can explore the assumptions that constitute a particular framework, or bounding container, but we cannot escape the fact that we always operate within some framework: it is an epistemic necessity. McCormack's work vividly illustrates how exploratory modelling in AL and generative art can increase our awareness of the influence of our prejudicial nature and how these prejudices are embodied in the artificial systems we construct."[577]

Bird here defends the role of art in Artificial Life, as critical instrument for reflecting on the black boxing of unwarranted assumptions and cultural biases in the models designed by Artificial Life researchers, be they scientists, artists, or both – echoing a concern I have voiced in an earlier chapter.

Overall, my empirical inquiry into critical questioning as motive for doing Artificial Life art in the Sussex neighbourhood shows unambiguously that it leads to practices, which are agonistic-antagonistic towards the cultural canons of both art and science. It remains to examine how they follow the logic of ontology.

5.3.2 ART AS RESEARCH METHOD

I have already pointed that critical questioning, and investigating the interdisciplinary creative process as such, were both stepping stones towards attempting

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575 McCormack et al. (2004: 40-53).
576 McCormack et al. (2004: 41).
577 McCormack et al. (2004: 52).

to establish novel forms of knowledge producing practices. They were also the two motives for engaging into collaborative art-science projects, which the reflexive study of the Blip project that I presented earlier insisted on. The study report concluded that:

> "Arts-science collaborations […] have the potential to be mutually beneficial to both artists and scientists, enabling them to generate and explore more creative opportunities than would be possible alone."[578]

Bringing art into Artificial Life as research method that can be complementary to and mutually beneficial with science, is a motive widely shared in the Sussex neighbourhood, by scientists and artists alike. This is often the case, for instance, when collaborative projects spring from the encounter of individual researchers of different sensibilities who find they are interested in converging research issues. A CCNR researcher, co-founder and co-organizer of Blip, explained that what attracted him to collaborating with artists was that some strands in art, in generative art especially, were asking the same questions that he was asking as Artificial Life scientist, or very similar.[579] Another CCNR researcher said that on some occasions he had experienced big connections with artists, on big questions, which had led to the generation of new ideas.[580] This is also, and paradigmatically, the case with researchers of the active 'voluntary hybrids' variety, whose training and skills enable them to bring both an artistic and a scientific perspective to their research projects – like Alice Eldridge, or Jon McCormack. Beside his own investigation of the frame problem in visual culture (a problem common to artistic and scientific visual representations), McCormack has suggested a number of themes that are open to an artistic mode of research through generative processes, like "the role of subversion; mental models of understanding for

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578 Bird et al. (2005: 65).
579 Fieldnotes, 23/07/2007.
580 Fieldnotes, 17/05/2007.

the artist and audience; the computational sublime."[581] Let us illustrate the use of art as research method through a few projects into which members of the Sussex neighbourhood have got themselves involved.

DrawBots was one such project. This three-year interdisciplinary project, which brought together computer and cognitive scientists, philosophers, artists, and critical art theorists, had an array of objectives attached to it, combining those of individual researchers from different fields to those common to the group. The main overall goals were:

> "[…] the production of machine-created art and the exploration of whether it is possible to develop (minimally) creative artificial agents and the research has two, mutually dependent, contextual frameworks. One concerns methodologies for making an agent that has the potential for manifesting autonomous creative behaviour. The second concerns methodologies for recognising such behaviour. Another emphasis is attempting to place this work in an art historical context."[582]

This passage broadly delimits the part explicitly devolved to art as research in the DrawBots project. It was the production of machine-created art, of which an outcome would be a large-scale art installation of a group of DrawBots, inscribed in a methodological framework that drew on aesthetics and art theory for ideas about artistic autonomy, uniqueness of the experience of art, computational 'meta-medium' as privileged artistic experimental vehicle, precedence of process over object, possibility of signature-free processes, assessment of artistic content, etc.

The passage also points at the interdependence of the scientific and artistic frameworks, and indeed, the co-existence of these two distinct contexts, one scientific

[581] McCormack et al. (2004: 74).
[582] Brown et al. (2007).

and one artistic, framing the same research, implies the construction of a continuous theoretical meta-frame (with for instance, on the one hand, the idea that an artwork can display creative autonomy, and on another hand, that creative autonomy is a hallmark of living systems) without which the project would be inconsistent.[583] Dustin Stokes, philosopher who specializes in philosophy of mind, cognitive science, and philosophy of art, collaborated to the construction of such a theoretical base for DrawBots, while a post-doc at CCNR over the period 2005-2007. In a paper entitled "Aesthetics and Cognitive Science" published in 2009, Stokes explores a general research strategy called 'expansionism', which rests on the two theses that:

> "First, the creation and consumption of art involves the exercise of the same cognitive capacities used to negotiate the environment and engage with conspecifics. […] Second, expansionism suggests that these capacities are extended in novel, art-specific ways when engaging with artworks […]."[584]

His exploration of expansionism highlights the mutual theoretical importance of aesthetics and cognitive science, and leads him to defend the following conclusion:

> "Purely scientific accounts of cognition neglect cultural facts that figure importantly in the cognitive environment. Purely philosophical accounts of aesthetic experience neglect the contingencies of cognition and perception. This, finally, is the basic moral of expansionism: the explanatory goals and resources of both aesthetics and cognitive science should expand to include those of the other."[585]

Expansionism, as developed by Stokes into a general framework for interdisciplinary practices across aesthetics and cognitive science, follows squarely from the logic of ontology.

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[583] Brown et al. (2007).
[584] Stokes (2009: 715, 718).
[585] Stokes (2009: 715, 727).

To finish with DrawBots, the quoted passage outlining the project indicated that an art historical perspective was brought in alongside the theoretical and methodological contexts framing the research. In practice, the research was so organised that three inter-related interdisciplinary teams collaborated. The task of the 'Art and Science team' was to evolve a robot that could demonstrate creative drawing behaviour. That of the 'AI and Cognitive team' was to "provide a theoretical base to the project and examine its implications for the fields of AI, Alife, philosophy, creativity and cognition." That of the 'Art Theory team' was to "relate the project from the perspective of art history and critical theory", under the co-direction of Charlie Gere whom I have introduced in the section on interdisciplinary historical practices as principal investigator and leader of the CACHe project.[586] When DrawBots was presented end 2007 at the MutaMorphosis: Challenging Arts and Sciences conference,[587] it was concluded that:

> "With 15 months of the project still remaining the team are cautiously optimistic that their goal of evolving minimally creative behaviour will be met. However the very significant problem of how to recognise and acknowledge such behaviour remains. There is considerable historical evidence that humans are inept at recognising new creative behaviours amongst themselves. […] It is only recently that humans have been able to acknowledge creativity in other animals so how will they recognise creativity when it emerges from an alife agent?"[588]

As it is, cautious optimism was still too optimistic. The collaborators did not get the DrawBots to do what they had set out to achieve. But here is not my point. This passage reveals how in the DrawBots project, where history was not itself the main focus of the

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[586] DrawBots project page on CCNR website, http://www.informatics.sussex.ac.uk/research/groups/ccnr/research/creativity.html, consulted 20/01/2010.
[587] MutaMorphosis was held in Prague, Czech Republic, November 8-10, 2007; details about the conference and full proceedings are available online: http://mutamorphosis.wordpress.com/.
[588] Brown et al. (2007).

research (contrary to what was the case with The Mechanical Mind in History and CACHe), historical research methods were integrated into an overall framework of interdisciplinary research. DrawBots is exemplary of the interdisciplinary practices that I have been investigating throughout the present chapter, as it brings together all the research intersections between art, science, philosophy and history that I have been examining.

Another project, in which art participated as complementary research method to science in an attempt at developing "an interdisciplinary collaborative approach to problem solving"[589] very much in the logic of ontology, was the EPSRC and AHRC-funded Interdisciplinary Research Cluster (IRC) "Designing physical artefacts from computational simulations and building computational simulations of physical systems-designing for the 21st century", set up by professor of computer science Mark d'Inverno and artist Jane Prophet.[590] It run for a year in 2005/2006 and is accounted for in a paper co-authored by d'Inverno, Prophet, and CCNR researcher Jon Bird who was an active member of the IRC.[591] The IRC followed from the experience of the Wellcome Trust-sponsored CELL project, a collaboration between Prophet and stem cell researcher Neil Theise aimed at discussing new theories of stem cell behaviour:

> "Through Jane Prophet's background in ALife […], the work of Mark d'Inverno in multi-agents systems […] and, moreover, through collective and sustained inquiry, Neil Theise became familiar with the notion of self-organising agent systems. […] It became clear to the CELL team that the most productive way to model stem cells in the adult human body was as a dynamic system of self-organising computational agents. […] What no one

[589] Bird, d'Inverno & Prophet (2007: 11).
[590] Details of grant: http://gow.epsrc.ac.uk/ViewGrant.aspx?GrantRef=EP/C513789/1, downloaded 16/12/2009.
[591] Bird, d'Inverno & Prophet (2007).

> could have predicted at the outset of the CELL project was the massive impact that the collaboration would have on all members. For example, it led Neil Theise to radically change the conceptual framework he uses for thinking about stem-cell behaviour, moving from his practice of looking at stained 2D slides to having a clear conceptual model of dynamic interaction and self-organisation."[592]

The aim of the IRC was "to further investigate the potential of interdisciplinary research especially in the context of agent-based and interactive systems in design",[593] in what cluster members characterize as a 'performative' approach, where they define 'performative' in the following manner:

> "The term 'performative' is applied to diverse activities, ranging from science to curation, and it is used to signify 'the constitution of meaning through an act or a certain practice' […]."[594]

Their approach, very much a heuristic process, is labelled as 'performative' because "both the goals and solutions develop over time through an open-ended process of trial-and-error."[595] They argue in its defence that it may be "the only viable option when trying to design systems with even minimal agency which respond to the environment in which they are situated. This is because it is not often possible to define in advance all the significant parameters of interactive systems and their environments and consequently it is hard to predict the behaviour that will result from system-environment interactions."[596] In their view, all sorts of ill-defined complex systems fall

[592] Bird, d'Inverno & Prophet (2007: 13-14).
[593] Bird, d'Inverno & Prophet (2007: 14).
[594] Bird, d'Inverno & Prophet (2007: 12).
[595] Bird, d'Inverno & Prophet (2007: 11).
[596] Bird, d'Inverno & Prophet (2007: 12).

into this category, like in the areas of “global warming, urbanisation, immigration and terrorism”,[597] hence the relevance of the ‘performative’ approach.

An outcome of the IRC was to produce a simulation prototype of Net Work, a proposed large scale interactive art installation in Herne Bay, UK, aimed at giving the public an understanding of self-organised processes.[598] The production of the Net Work simulation was almost an accessory outcome of the IRC, as although the cluster had started with a general idea of the kind of issues they wanted to explore, there was no real focus or schedule, and after a while it was felt that “it would be best to actually build a physical artefact that had computational and generative elements.”[599] An interesting point regarding the Net Work prototype, in relation to the thesis about non-modernity that I will further develop in the concluding chapter, is that following Bird’s suggestion, the IRC adopted the cybernetic model of Ashby’s homeostat (Ashby, one of the historical figures of British cybernetics whose inheritance is reclaimed by the Sussex neighbourhood) to drive the prototype. There were good methodological reasons for doing so, but the authors have pointed that they had a conceptual reason as well. Quoting Pickering, who has written about Ashby’s homeostat as a device illustrative of the performative ontology whose idiom sees the world as “a lively place full of agency – not something static and dead, sitting around waiting to be represented, as the representational idiom suggests”,[600] they thought that “[u]sing a homeostat control system is also appropriate because it is illustrative of the performative approach to problem solving”.[601]

How does the IRC’s report generalise the importance of art for the ‘performative’ approach to design of agent-based interactive systems? The authors use

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[597] Bird, d’Inverno & Prophet (2007: 21).
[598] Bird, d’Inverno & Prophet (2007: 15).
[599] Bird, d’Inverno & Prophet (2007: 15).
[600] Pickering (2002), as quoted in Bird, d’Inverno & Prophet (2007: 11).
[601] Bird, d’Inverno & Prophet (2007: 15-16).

the empirical evidence of artistic contributions to research in the cases of CELL and Net Work, to vindicate the position of digital artist and art theorist Simon Penny (founding director of the ACE program at University of California Irvine, a main art-science case study in Barry et al.'s investigation), on the value of artistic methodologies for agent design:

> "An artwork, in my analysis, does not didactically supply information, it invites the public to consider a range of possibilities, it encourages independent thinking. So building an interactive artwork requires more subtle interaction design than does a system whose output is entirely pragmatic, such as a bank automat. […] I have emphasized the relevance of artistic methodologies to the design of social agent systems. Typically, artistic practice embraces an open ended experimental process which allows for expansive inventive thinking. Artistic practice emphasises the cultural specificity of any representational act, acknowledging that meaning is established in the cultural environment of the interaction, not in the lab. It emphasises the embodied experience of the user. And it emphasises the critical importance of the 'interface', because the interface of the agent, like an artwork, is where communication finally succeeds or fails."[602]

Akin to the IRC's 'performative' approach, the value of artistic 'performance as research' is defended by artist and computer scientist Alice Eldridge (incidentally, her neural network model for her Fond Punctions improvised audio-visual performance served as basis for the implementation of the Net Work simulation prototype[603]). Her experiences of designing, and interacting with, generative systems for man-machine musical improvisation have led her to defend the view that embodied artistic

602 Penny (2000: 412).
603 Bird, d'Inverno & Prophet (2007: 18).

performance deserves to be investigated as a valid alternative knowledge producing practice:

> "It seems possible that by playing with these systems in musical and other artistic ways, we may gain insights into their behavioural dynamics which evade us when we sit staring at the computer screen. If these insights led to the generation of testable hypotheses, we could begin to take seriously increasingly common propositions of 'performance as research'. There are things you can only learn about someone by dancing with them."[604]

The IRC's 'performative' approach, as well as the idea of performance-as-research presented by Eldridge, strongly resonate with the phenomenological pursuits that I have examined earlier in the chapter. "Emergence of consciousness", a recent all-Sussex collaboration between Dumitriu, philosopher Blay Whitby and neuroscientist Luc Berthouze, is an example of collaborative project based on performance-as-research. It borrows explicitly from the distinct theoretical framework of enactivism:

> "The project draws together rigorous practice-based artistic methodologies and scientific research to attempt to investigate the notion of conscious experience from a philosophical point of view, inspired by perspectives of embodiment (Varela, Thomson and Rosch, 1992) and situatedness (Brooks, 1991) in evolutionary robotics and neural network learning systems. An outcome will be a new performance artwork using sensory and movement deprivation (e.g. blindfolds, physical restraints etc) and augmentation to reflect physical developments in the human body (from infancy to old age). It will create an embodied representation of how experience might be

[604] Eldridge (2005: 140).

constructed, through physical interaction with the environment and other performers, and the emergence of shared beliefs."[605]

This passage makes it clear that artistic performance-as-research intersects with the idea of first-person methodology, of phenomenological pragmatics, that we have seen some enactivists call for. In relation with the taste for role-playing games, which I have found to be part of the culture of simulation that characterizes Artificial Life, Dumitriu has pointed to me that the enactive approach had much in common with role-playing, that it was a kind of 'method playing'.[606]

Enactive Dialectics, an enactive video installation, is another performance-as-research project in the enactive framework, which resulted from the collaboration of Dumitriu with artists John Holder and Pia Tikka. I was first introduced to the latter's work when she gave a presentation of her doctoral research "Enactive Cinema: Simulatorium Eisensteinensis" at the "Between life + mind + art" event co-organised by Dumitriu for the Life and Mind seminar series in October 2008. Enactive Dialectics was presented in October/November 2009 in Katowice (Poland), as part of the second exhibition of the e-MobiLArt (European Mobile Lab for interactive media Artists) initiative:

> "The project 'Enactive Dialectics' investigates human enactment within an environment through an embodied and situated approach. The work is inspired by the current interest in enactive cognitive sciences, which emerged from the autopoiesis theory of Francisco Varela and Humberto Maturana. The philosophical background also reflects Theodor Adorno's notion of 'Negative Dialectics'. The installation embodies the enactive

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[605] http://web.mac.com/annadumitriu/EoC/Home.html, downloaded 19/11/2009; this passage reveals some of the influence that CCNR has had on Dumitriu; when I first met her in March 2007, early in her residency, she was only just starting to discover Varela; plus although she saw how CCNR could nourish her work, she was not convinced of what she could bring them (fieldnotes, 08/03/2007).
[606] Dumitriu, personal communication, 18/10/2008.

> approach, showing that human beings are inseparably connected to their environment."[607]

Dumitriu is basing new work involving locative technologies and bio-sensing on the same enactive theoretical framework[608] as part of a 3-year EPSRC-funded project, a collaboration between University of Sussex departments of Sociology and Informatics entitled "Supporting Shy Users in Pervasive Computing", started in October 2008.[609]

Such projects underline the connection existing, in the Sussex neighbourhood, between performative artistic research and other interdisciplinary practices that cross over analytic philosophy of the mind, continental phenomenology, neuroscience and technology, sociology even, widening further the interdisciplinary scope of the Sussex enactive research programme, which I have already singled out as possessing the kind of disciplinary autonomy that, according to Barry et al., interdisciplinary practices following the logic of ontology can foster.

5.4 MULTIPLE GENEALOGIES

To conclude the section on the art and science nexus in the Sussex neighbourhood, I would like to don once again the historian's cap. The multiple heterogeneities (of forms, sites, motives) of Artificial Life art that I have experienced in the Sussex neighbourhood are congruent with Barry et al.'s conclusion, that "[w]hile art-science is a practical, intentional category for artists, institutions and funding bodies, it forms part of a larger, heterogeneous space of overlapping interdisciplines thrown up

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[607] http://www.media.uoa.gr/~charitos/emobilart/exhibition_pl/enactive_dialectics.html, consulted 26/01/2009.
[608] Dumitriu, personal communication, 29/01/2010.
[609] For details of the projects: http://www.informatics.sussex.ac.uk/research/projects/shyness/Supporting+Shy+Users+in+Pervasive+Computing, consulted 01/02/2010; for more on Dumitriu's participation: http://web.mac.com/annadumitriu/AD/Shyness_Project.html, consulted 01/02/2010.

at the intersection of the arts, sciences and technologies […].”[610] In order to get a better grip on the art-science phenomenon, they propose to understand it as having its genesis “in the mutual interferences set up between three broad and related genealogies: 1) conceptual art and post-conceptual art, including performance, installation, public and activist art; 2) art and technology movements; and 3) certain developments and debates around the computational and bio sciences and technologies.”[611] My analysis of Artificial Life art in the Sussex neighbourhood certainly supports the idea of interwoven genealogies, and the three isolated by Barry et al. are all present in my material. Likewise, it brings support to the claim that Artificial Life has older and more hybrid roots than its generally accepted history would have it, and gives weight to artist Paul Brown’s allegation that in the 1970s, himself and other pioneers of electronic arts were doing Artificial Life before it was ‘invented’.

Only a hybrid history of Artificial Life, reaching further in time than the 1980s, further in space than North America, and weaving together a rich set of concurrent historical strands, can account for the diversity of Artificial Life in general, and for the multiple heterogeneities of Artificial Life art in particular.

Only such a hybrid history can explain why so many artistic movements, some antagonistic to others, are represented in Artificial Life: for instance, Modernism (Paul Brown for one claims he is a Modernist: “[…] historically the computer arts, […] we’re identified with Modernism, and for good reasons”[612]) whose genealogy in Artificial Life art can be traced back through early computer arts to the systems art movement and early 20th-century Constructivists like Kasimir Malevich;[613] post-modern conceptual art, whose genealogy in Artificial Life is multiple, as it follows the many negations that,

[610] Barry, Born & Weszkalnys (2008: 38).
[611] Barry, Born & Weszkalnys (2008: 38).
[612] Interview transcript, 24/05/2007.
[613] Brown (2008a: 274-275); Whitelaw (2000: 347-348); Wright (2008: 119-139).

according to Barry et al., Conceptualism has defined itself through – "negation of material objectivity and the primacy of the visual […]; negation of art's commodity form […]; and negation of the philosophy of art's autonomy […]", which resulted from the generalised critical questioning of art "as object, as site and as social relation": these are all present in my case study of Artificial Life art in the Sussex neighbourhood.[614]

A hybrid history might also give a better grasp on the strand of Artificial Life art that intersects with the agenda of cognitive science on high level cognitive functions like creativity, by investigating such issues as the role played by the pioneering research program in creativity and cognition first set up in the 1970s in Great Britain by Ernest Edmonds, early computer artist in the constructivist tradition who, incidentally, collaborated to the DrawBots project.[615] According to Brown:

> "At the time PhD research opportunities were not available within mainstream art education, so several of the [Slade] EXP students […] went on to pursue PhDs under Edmonds's mentorship and were among the first visual arts students to achieve this award in the United Kingdom."[616]

Here is a historical strand that may provide a major connection between early generative computer art (part of which later developed into a facet of Artificial Life art) and the cognitive science inquiry into creativity.

6. A SPECIFIC FLAVOUR OF INTERDISCIPLINARITY

Following the typology of interdisciplinarity proposed by Barry et al., my three case studies, in the Sussex neighbourhood, of interdisciplinary practices that cross over the 'two cultures' divide, have shown unambiguously that the agonistic-antagonistic

[614] Barry, Born & Weszkalnys (2008: 38-39).
[615] Ernest Edmonds's research program has been running to this day, currently as the Creativity and Cognition Studios at University of Technology Sydney.
[616] Brown (2008b: 281).

mode prevails in their relations to established disciplinary forms of knowledge, while the logic motivating them is to a large extent that of ontology, leading in some cases to real instances of disciplinary autonomy. In the last section of the chapter, I would like to build on this conclusion. I would like to deepen my reading of the form of interdisciplinarity, on the agonistic-antagonistic mode and in the logic of ontology, which appears to be the norm for a large and diverse array of practices in the Sussex neighbourhood, and to do so in relation to results of the “Interdisciplinarity and Society” project that I have not yet discussed.

6.1 INTERLANGUAGE AND TRAINING

The investigators of the “Science and Society” project have highlighted in their conclusions the following issue, linked to the temporality of interdisciplinary research:

> “Our research supports the argument that the development of productive interdisciplinary fields is time dependent. It highlights the importance in developing interdisciplinary fields of the processual generation of rich common languages (or ‘interlanguages’) and understandings over time, as well as the need to support the generational-intellectual trainings and changes that will carry this through.”[617]

How are these two areas covered in the case of Artificial Life in the Sussex neighbourhood? Has an ‘interlanguage’ developed, and how is the question of training answered? First, let us consider the interlanguage issue. On the topic of the development of interlanguages in collaborations across disciplines, the authors refer the reader to Galison’s conceptualization of the ‘trading zone’, of which a characteristic is precisely the emergence of a creolized language enabling communication between the different fields of research that intersect in the trading zone. I have already proposed that the

[617] Barry (2007: 27).

entire field of Artificial Life itself was an extended trading zone. Unsurprisingly, over more than twenty years of existence, it has evolved its own creole, which borrows from complexity sciences, computer science, robotics and biology (and from linguistics, psychology, chemistry, etc). It was one of the first things that struck me when I started reading Artificial Life literature and even more when I begun my fieldwork. ALifers routinely used terms that are seldom used otherwise ('autopoiesis' is one such term); or compound terms of which I understood each single word taken separately but could not figure out what they meant together (for instance, 'cellular automata', 'genetic algorithm' or 'computational morphogenesis'); or terms which specific meaning for the Artificial Life community appeared to be somewhat different from their specific meaning for me as member of the STS community ('agency' and 'constructivism' would fall into that category). Yet even though a creolized interlanguage has developed in Artificial Life, in this respect, being an extended trading zone has its downside, as was highlighted by a member of the Sussex neighbourhood:

> "Alife can be viewed as the Babel of science. Take the word 'autonomous' for instance: in the math of dynamic systems it denotes a complete system (decoupled); in systems biology it can mean self-production (autopoiesis); in engineering it can refer to systems without human control; in philosophy it can have moral implications. We (Froese, et al. 2007)[618] tried to sort out some of this confusion, but that's just the tip of the iceberg. In general, I guess we have similar problems of communication as normal economic trading zones which combine regions with different cultures and languages. It can hinder the expression of full productivity."[619]

[618] Froese, Virgo & Izquierdo (2007).
[619] Froese, personal communication, 14/04/2010.

Inside the creole of Artificial Life, do the Sussex ALifers tend to use a specific set of vocabulary that demarcates their discourse from that of other ALifers? Apparently they do. At ECAL 2007, after a day-long session dedicated to "Embodiment and Cognition", an ALifer who was a complete outsider to the Sussex neighbourhood was exasperated to have had the largest part of the day taken up by Sussex affiliates who according to him were all hammering the same message, in the same 'dialect', about embodiment, dynamical systems, adaptive behaviour and so on.[620]

The second temporality-related component, which according to Barry et al. plays an important role in the development of productive interdisciplinary fields, is the capacity "to support the generational-intellectual trainings and changes that will carry this through." It was principally their case study of art-science at UCI, whose commitment to overcoming the division of labour along disciplinary lines has translated into the Arts Computation Engineering (ACE) masters programme aimed at training interdisciplinary practitioners, which seems to have led to this conclusion. In the case of Artificial Life at Sussex, the Evolutionary and Adaptive Systems master's programme (EASy) has been running since 1996. Until recently it was the only masters programme of its kind in the world, and renowned for being so. When looking at its syllabus, one finds that it is widely interdisciplinary, and crosses over the science-humanities divide; the courses on offer intersect with computer science, artificial intelligence, robotics, developmental biology, theoretical biology, psychology, cognitive science, business, philosophy and history.[621] The case study on Artificial Life art has revealed that EASy MSc dissertations on artistic topics were not uncommon.

[620] Fieldnotes, 12/09/2007.
[621] http://www.informatics.sussex.ac.uk/research/groups/easy/MSc/Syllabus.html, http://www.informatics.sussex.ac.uk/research/groups/easy/MSc/LectureNotes.html , consulted 31/07/2009.

Beside the EASy MSc, in order to increase the diversity of students attracted to CCNR (a founder and leader of the group complained to me that an overwhelming majority of applicants originated from computer science), in 2007 the Artificial Life group has launched, through the Creative Systems Lab, a MSc in Creative Systems. Again, the programme syllabus is highly interdisciplinary, and is a mix of Artificial Life, computer science, music, multimedia, animation, theory of creativity, business, even STS (there is a course entitled "Science, Technology and Culture").[622]

So it appears that with respect to both interlanguage and training, Artificial Life at Sussex meets the conditions required for the development of productive interdisciplinarity, as established by Barry et al.

6.2 THE 'VOLUNTARY HYBRID' PROFILE

This sub-section returns to an aspect of interdisciplinarity in Artificial Life, and especially in the Sussex neighbourhood, that previous chapters have already touched upon. I have highlighted that agency-rich computerized synthetic simulations, as enablers of interdisciplinarity, could play at different levels. First, their traffic across disciplinary boundaries facilitates intersections between the arts, humanities, hard and soft sciences; second, their bridging capacities can hybridize different sets of skills within a single individual and attract individuals who cultivate diverse, eventually conflicting, allegiances. I have argued that the use of simulation could encourage the hybridization of interdisciplinary skills within individuals themselves, resulting in a particular type of 'inner' interdisciplinarity.

The investigators of the "Science and Society" project have similarly distinguished between cooperative interdisciplinarity and 'inner' interdisciplinarity. In

[622] http://www.informatics.sussex.ac.uk/courses/creative-systems/msc.htm, consulted 31/07/2009.

the process of mapping the forms and practices of interdisciplinarity met with in the art-science area, they have clearly recognised that:

> "A distinction may be made between the artist being the locus of interdisciplinarity, combining in him or herself artistic sensibilities and creativity with technology mastery or scientific knowledge; and the process of the production of art as an interdisciplinary endeavour, defined here as a collaboration between people from various disciplines (with all the gradations between the two)."[623]

They have also pointed out that even in the latter kind of interdisciplinary endeavour, there has been a tendency for artists to develop technical / programming skills, as much art-science involve information and communication technologies, and there is a move toward an increased involvement of individuals who combine artistic, scientific and technological skills. Such individuals fit the 'voluntary hybrid' profile, first isolated in chapter 4, then repeatedly met with throughout the present chapter, both in members of the Sussex neighbourhood and in the historical figures whose inheritance they reclaim.[624]

In the previous chapter, the 'voluntary hybrid' profile was exemplified by one of the founders and leaders of Artificial Life at Sussex (who told me that he had always inhabited in part the worlds of science and art and had always been interested in merging the two) and by Roger Silverstone. These two individual cases have led me to observe that the ethos of interdisciplinarity characteristic of the University of Sussex may be an attractor to individuals fitting this kind of profile. As a matter of fact, two prominent mentors whose protection the founders of the Artificial Life group at Sussex have gratefully acknowledged, Margaret Boden and John Maynard Smith, fit the

[623] Weszkalnys (2006: 16).
[624] Weszkalnys (2006: 17).

'voluntary hybrid' profile too. Boden, founding dean of the School of Cognitive and Computing Sciences, holds independent degrees in medical sciences, philosophy and psychology, including a ScD from Cambridge and a PhD from Harvard.[625] Maynard Smith, founding dean of the School of Life Sciences, first graduated as an aeronautical engineer and worked on military aircraft design during World War II, before changing careers and becoming a prominent evolutionary biologist.[626]

The 'voluntary hybrid' profile was brilliantly articulated by Jean-Pierre Dupuy, founder and director of the CREA at the Ecole Polytechnique,[627] research centre devoted to the cognitive and social sciences, where for many years worked Varela who is such a major inspiration to many ALifers in the Sussex neighbourhood. In the Preface to his book The Mechanization of the Mind: On the Origins of Cognitive Science, Dupuy quotes from a speech he made at Stanford, to explain how he finds himself, fundamentally,

> "[…] divided – indeed torn – between a number of conflicting allegiances: between my background in logic, mathematics and physics and my identity as a philosopher committed to the human sciences; between my need to think in terms of formal models and my deeply held conviction that literature is a superior form of knowledge to science; between the two ways of doing philosophy today: 'Continental' philosophy – profound, rich, meaningful, but too often wilfully obscure, elitist, and, at times, dishonest – and 'analytic' philosophy – rigorous, egalitarian, democratic, but too often shallow and tedious – the one pointing toward literature, the other toward science; and, finally, between the narrow professionalism of American academics, […] and the distinguished dilettantism of many French

[625] http://www.sussex.ac.uk/informatics/profile276.html, consulted 06/11/2009.
[626] Husbands, Holland & Wheeler (2008: 373): "An Interview with John Maynard Smith".
[627] Centre de Recherche en Epistémologie Appliquée.

> intellectuals […]. Though I am torn, I refuse to be forced to choose between the Scylla of French intellectualism and the Charybdis of American academicism".[628]

The 'voluntary hybrid' attitude, characterized by the refusal to choose between diverse and possibly conflicting allegiances – to forms of knowledge, to incompatible disciplinary models, to ways of doing philosophy – is something I have repeatedly encountered during my inquiry into the Artificial Life community. The cases of 'misfits' I have portrayed earlier to illustrate the agonistic-antagonistic mode of practicing interdisciplinarity in Artificial Life certainly fit the bill. With regard to the Sussex neighbourhood in particular, my empirical case studies of their interdisciplinary practices has brought substance to the claim that the ethos of interdisciplinarity at the University of Sussex made it a natural home for such individuals. The examples of individual experiences of Artificial Life-as-art-and-science presented and discussed in the present chapter have revealed that collaborative art-science realizations in the Sussex Artificial Life group were hardly ever so in the sense that the different members of a team each bring along specific disciplinary skills which the others utterly lack (for example, an artist in charge of the artistic content, a scientist for the scientific part, an engineer to manage the technology, eventually a philosopher to situate the work in a wider theoretical framework, etc). This would make for a restricted form of collaboration. Rather, the different participants bring in their different sensibilities, while being quite polyvalent in their skills, making for a truly collaborative process. I have also pointed that many Artificial Life artistic realizations in the Sussex neighbourhood were the work of single self-sufficient individuals possessing a versatile array of skills. Further, the inquiry into the anti-dualist Continental brand of philosophy

[628] Dupuy (2000 : xii-xiii).

seen by many outsiders as the hallmark of the Sussex neighbourhood has revealed that the refusal to choose between allegiances can take on a metaphysical undertone when it inscribes itself in the holistic approach promoted by the embedded-embodied current.[629] And the analysis of historical contributions by Sussex ALifers have highlighted that the individuals whose heritage they reclaim overwhelmingly fit the same kind of profile, which shows that they take pride in identifying with such versatile individuals. Versatility is indeed a highly valued trait in the moral economy of the Sussex neighbourhood.

The resonance between the 'voluntary hybrid' profile, the historical ethos of interdisciplinarity of University of Sussex, and interdisciplinary practices in the Sussex neighbourhood, corroborates the results of Barry et al.'s empirical inquiry into the field of art-science. Their case study of UCI art-science initiative and of its ACE master's programme, aimed at developing 'inner' interdisciplinarity in voluntary hybrids whose skills bridge the two cultures chasm, revealed that internalized interdisciplinarity went along with the agonistic-antagonistic mode of interdisciplinarity and the logic of ontology.[630] The Sussex neighbourhood presents a similar configuration. But there is more to it. Together, my three case studies have revealed the conjunction, in the Sussex neighbourhood, of a wide variety of independent interdisciplinary practices that nonetheless all fit the same type. It seems that voluntary hybrids do not just go along with the agonistic-antagonistic mode of interdisciplinarity and the logic of ontology. They may actually build this type of interdisciplinarity into a system – a form of life.

[629] The degree to which this actually reflects, at the level of the individuals involved, explicit metaphysical convictions and hidden socio-cultural determinants is an issue that falls outside the scope of my project.
[630] Barry, Born & Strathern (2007: 30, 40).

6.3 CORRELATING MORAL ECONOMY AND TYPE OF INTERDISCIPLINARITY

Lorraine Daston has rightly recognized that "[…] a moral economy has a certain logic to its composition and operations. Not all conceivable combinations of affects and values are in fact possible. Much of the stability and integrity of a moral economy derives from its ties to activities […], which anchor and entrench but do not determine it."[631] In the case of the Sussex neighbourhood, I will argue that the combination of virtues and values constitutive of its moral economy is very well suited to the type of interdisciplinarity that it predominantly pursues, on the agonistic-antagonistic mode and following a logic of ontology, because of the main issues that such a type of interdisciplinarity runs into.

These main issues, as identified by Barry et al., relate to evaluation and assessment. Against contemporary accounts of interdisciplinarity, which encourage the belief that the growing disruption of disciplinary boundaries by interdisciplinarity goes hand in hand with a loss of autonomy (for Barry et al., an exemplary instance of this problematization is Re-Thinking Science by Helga Nowotny, Peter Scott and Michael Gibbons in 2001, for whom Mode 2 knowledge production, characterized by interdisciplinarity, is accompanied by the displacement of a culture of autonomy in scientific research by a culture of accountability), the investigators of the "Interdisciplinarity and Society" project have recognized that accepting the logic of ontology among the drivers of interdisciplinarity is "to acknowledge the potential inventiveness of research practice in its engagement with particular objects".[632] On the basis of their case studies, they have found that the logic of ontology offered a real possibility of autonomy, and concluded to "the existence of forms of *inter*disciplinary autonomy and rigorous interdisciplinarity that lead to the production of new objects and

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[631] Daston (1995: 4).
[632] Barry (2007: 27).

practices of knowledge, practices that are irreducible both to previous disciplinary knowledge formations and to accountability and innovation."[633] My case studies of interdisciplinary practices in the Sussex neighbourhood have led me to parallel conclusions.

As a corollary, Barry et al. have expressed a concern with the inadequacy of current approaches to interdisciplinary research evaluation:

> "Previous integrative approaches to interdisciplinarity propose that its value can be assessed additively according to the criteria of the 'antecedent disciplines' […]. Our analysis suggests that this is inadequate for the agonistic-antagonistic mode of interdisciplinarity, which stems from a commitment to moving beyond the epistemological limits and ontological basis of former disciplines. Such a shift makes the new interdiscipline irreducible to and incommensurable with its antecedent disciplines."[634]

Along with inadequate evaluation criteria, they have identified the problem of "discrepant temporalities between research cycles and cycles of evaluation and assessment."[635] Developing productive interdisciplinarity, which Barry et al. have typically associated with the agonistic-antagonistic mode and the logic of ontology, takes time, and this dimension is inadequately integrated into research validation procedures.

In the case of contemporary art-science-technology collaborations, the problem of inadequate research evaluation procedures has been recognized and discussed, independently of the "Interdisciplinarity and Society" project, by professor of art history Edward Shanken, in a 2005 paper entitled "Artists in Industry and the Academy: Collaborative Research, Interdisciplinary Scholarship and the Creation and

[633] Barry, Born & Weszkalnys (2008: 21, 42).
[634] Barry (2007: 28).
[635] Barry (2007: 27).

Interpretation of Hybrid Forms". His conclusions at the philosophical level strongly echo the epistemic questioning of the Artificial Life community analysed in chapter 3, when he writes that "[…] if the fruits of hybrid research are not strictly science, or engineering, or art, then one must wonder about the epistemological and ontological status of these hybrid forms: What exactly are they? What new knowledge do they produce or enable? What is their function in the world?"[636] On a practical level, his verdict points towards necessary steps that ought to be taken in order to remedy the research evaluation problem:

> "Despite the wealth of interdisciplinary research being undertaken, and despite the general recognition that there are substantial challenges to collaboration across disciplines, there is scant metacritical research that studies best practices, working methods and contextual supports and hindrances. […] If the academy is serious about interdisciplinary collaboration, then it must dedicate resources to study these issues and to develop guidelines, training methodologies and project management techniques that will help fulfil the promise of interdisciplinarity."[637]

In Artificial Life, the issue of inadequate research evaluation procedures is further complicated, and made more pressing, when taking into account some of my earlier findings. In chapter 3, I have highlighted that the funding imperative could lead to the dressing of interdisciplinary art-science projects as purely scientific in order to get grants from scientific research bodies, which in turn was felt to be a hindrance to the establishment of clear research evaluation criteria and to the improvement of the standards of Artificial Life research. My interlocutors had rightly identified that when Artificial Life interdisciplinarity masquerades as traditional disciplinarity, it contributes

[636] Shanken (2005: 418).
[637] Shanken (2005: 417).

to the existence of grey areas in terms of research standards. This in turn compromises the standing of Artificial Life research, and undermines the call for rethinking evaluation procedures and for recognizing interdisciplinary autonomy.

Coming back to the specific case of the Sussex neighbourhood, if we follow Barry et al., both the criteria and the time cycles for interdisciplinary research assessment appear utterly inadequate when it comes to the type of interdisciplinarity that they privilege. For instance, in their case study of art-science at UCI, it transpired that "despite a strong consensus on the value of ACE [the master's programme] and some art-science output, and forty years of commitment to interdisciplinarity, there was a chronic failure to solve the problem of how they could be validated. The management approach to the evaluation of tenure cases was additive, despite many involved admitting its inadequacy; while ACE was under review and appears at risk of termination."[638] Shanken, for his part, was led by his inquiry to conclude that:

> "If universities are unable to adopt appropriate methods for evaluating and granting tenure to interdisciplinary professors, they will create a disincentive for future scholars to pursue interdisciplinary work, disrupt the ability of existing interdisciplinary faculty to mentor future hybrid researchers and prevent the ascension of interdisciplinary faculty to positions of power and authority in academe, where they can influence infrastructural change and facilitate the creation of new forms of invention, knowledge and meaning."[639]

In these circumstances, it is worth going back to the virtues and values that I have found to be characteristic of the moral economy of Artificial Life at Sussex. I have shown that the virtue of diversity was congruent with its interdisciplinary ethos, and

[638] Barry (2007: 30).
[639] Shanken (2005: 418).

consequently favourable to the type of interdisciplinarity that it privileges. But the moral economy of Artificial Life at Sussex may not be just favourable to the growth of such interdisciplinary practices, it may well be essential to their sustenance. Entrepreneurial skills appear paramount to succeed in negotiations with managerial instances, in the search for sponsors, and in the packaging of ideas into grant applications. In the face of inadequate evaluation procedures, selecting for qualities of reflexivity and independent critical thinking through elitist enrolment is also of prime importance, in order to respond to the need for emerging criteria of value and inventiveness on which the interdisciplinary research community can rely. Individualism and autonomy (in the sense of self-reliance) are clear virtues when it comes to withstand the lack of institutional recognition. Amateurs, who do not derive their main income from their academic pursuits, and more generally individuals who privilege the freedom of following their own interests over a traditionally successful academic career, are assets not just for the diversity of perspectives they may bring to the group but also because they are less likely to become discouraged and give up. Finally, the mentor-protégé mechanism offers new entrants a high level of protection while they grow into their future role, and transmits loyalty as a virtue: these are necessary ingredients to the perpetuation of the community's moral economy in time – the temporality required for the development of productive interdisciplinarity.

6.4 HISTORICIZING INTERDISCIPLINARITY

I would like to conclude my analysis of interdisciplinarity in the Sussex neighbourhood by historicizing it. At the end of their paper "Logics of Interdisciplinarity", Barry et al. defend themselves against a potential charge of internalism:

> "In arguing for the significance of the logic of ontology, it may appear that we are replacing political or economic explanations of the contemporary preoccupation with interdisciplinarity with an internalist one."[640]

Their main line of defence is that they have shown how, in practice, the three logics may be entangled and interdependent, yet were irreducible to one another, and that overlooking the logic of ontology led to a warped evaluation of interdisciplinarity.[641]

My account of interdisciplinary practices in the Sussex neighbourhood, which I have characterized as following predominantly a logic of ontology, runs the risk of incurring a similar charge of internalism. I will argue that such an accusation would fail to recognise that interdisciplinarity is not an a-temporal category but is instead historically and geographically located. This is another aspect of interdisciplinarity that Barry et al. had rightly identified from the start:

> "[…] we wanted to avoid two temptations. The first is to imagine that interdisciplinarity is historically novel. […The second is] to read the contemporary concern with interdisciplinarity too politically in the conventional sense of the term: to view it as entirely an emanation from governmental preoccupations with accountability, the knowledge economy or innovation, or as driven by commercial imperatives."[642]

Such a reading of contemporary interdisciplinarity would only retain the developments that have occurred over the past decade or so, and ignore older historical threads.

In contrast, as I have demonstrated in chapter 4, the moral economy and the ethos of interdisciplinarity of CCNR, the centre of gravity and cultural attractor of the Sussex neighbourhood, are highly localised and embedded into the historical fabric of the University of Sussex. They exhibit a strong historical lineage that goes all the way

640 Barry, Born & Weszkalnys (2008: 41).
641 Barry, Born & Weszkalnys (2008: 41-42).
642 Barry, Born & Weszkalnys (2008: 23).

back to the founding charter of the university in the early 1960s. And the discourse on interdisciplinarity (which did not yet call itself interdisciplinarity) held by the founders of the University of Sussex was very different in terms of logic from the presently dominant institutional discourse that over-stresses accountability and innovation. It was about fighting narrow-mindedness born from un-reflexive overspecialization, breaking the mould of disciplines, taking holistic multi-perspective approaches to objects of research and study, training 'voluntary hybrids' by encouraging latent dispositions to inner interdisciplinarity. In short, it was placing itself squarely in the agonistic-antagonistic mode and the logic of ontology, and preparing fertile grounds in which to breed interdisciplinary practices that would follow the same typology.

I would like to stress that when such interdisciplinary practices become situated, it is easy to dispel the charge of internalism. The ethos of interdisciplinarity imbued in the nascent University of Sussex obeyed a rationale steadfastly located in the context of its appearance, i.e. the creation of new universities in the climate of the post-World War II 'long boom'. The type of interdisciplinarity developed by the Artificial Life group at Sussex is heir to an ethos of interdisciplinarity born from the early 1960s, that is, from an economic, social and cultural context far removed from that of the past decade or so. Contemporary discourses on interdisciplinarity may have influenced the Sussex neighbourhood, but to a large extent it seems to be embracing values and motives that pre-date the current emphasis on accountability and innovation – as if it were rolling on tracks that have bypassed recent trends in interdisciplinarity.

Chapter 6: Conclusions

1. INTRODUCTION

The goal of this concluding chapter is foremost to bring out how my doctoral thesis may be making an original contribution to scholarship in the domain of science and technology studies. Section 2 draws results from former chapters together in order to emphasize the common thread that binds them, and develops the argument, after which my thesis is entitled, that the Sussex neighbourhood is ‘harnessing non-modernity’. Section 3 establishes the scholarly contribution that my thesis brings to science and technology studies. Finally, section 4 discusses the weaknesses that I perceive in my work and the avenues for new research that remedying them may open.

2. HARNESSING NON-MODERNITY

The case study of the Sussex neighbourhood, an instance of native research community in the extended trading zone of Artificial Life, has revealed that the research community who has so consistently thrived that it has come to dominate this particular field is one who is embracing through its interdisciplinary practices the hybridizing potential of the extended trading zone, powered by the agency-rich simulation models of Artificial Life computerized synthetic systems. This leads me to the concluding argument of my thesis: that the Sussex neighbourhood is successfully harnessing, as opposed to resisting and controlling, the non-modern ontology of the extended trading zone – where harnessing corresponds to a form of management that is one of letting go of control, close in analogy to steering a sailboat in the wind, to going along with the flow, or to riding the wave. This claim draws together some of the main findings and conclusions of previous chapters and highlights the common thread that binds them.

In the macro-study part of my work, where I have investigated on the one hand what held Artificial Life together, and on the other hand, why it was failing to achieve a stable disciplinary existence, I have pinpointed and discussed some manifestations of non-modernity, observed at the global field level. How do these relate to the specific case of the Sussex neighbourhood, focus of my argument?

In chapter 2, I have argued that the Artificial Life research community shared a culture of simulation, more precisely, a culture of ‘agency-rich’ simulation, and further, that Artificial Life systems were expected by their designers to display agency in a strong sense. Drawing on Pickering, I have shown how ALifers could wilfully engage their agency-imbued synthetic systems into a ‘dance of agency’. The individual artists and researchers whose work I have used in order to illustrate my point were, beside Ken Rinaldo, all members of the Sussex neighbourhood.

Additionally, I have highlighted that a concept of agency, of “what it is that constitutes a system as an agent”,[643] not fundamentally dissimilar from the notion of agency we use in STS although stricter, played a central role in contemporary cognitive science, and more especially in enactivism; that imbuing systems with agency – understanding, modelling and synthesizing agents – was a major goal for ALifers; and that certain Artificial Life researchers were keen not just to engage their agents in collaborative play, but to build a deeper, refined and stricter, hence more demanding, definition of agency into their research program. As it turns out, the three ALifers who collaborated to “Defining Agency”, programmatic paper aimed at proposing such a definition, are again all members of CCNR, and all three belong to the enactivist strand that I have discussed in chapter 5 as part of my case study of interdisciplinary practices in the Sussex neighbourhood. Overall, the empirical material that I have drawn upon to

[643] Barandiaran, Di Paolo & Rohde (2009: 1).

discuss agency in chapter 2 pertains overwhelmingly to the Sussex neighbourhood; and it shows that in their research, by demanding more of their systems for these to qualify as agents, by engaging their agents into open-ended performative interaction, members of the Sussex neighbourhood deliberately opt for a non-modern ontological attitude towards the human-nonhuman relationship.

In chapter 3, I have discussed non-modernity mostly in relation to the idea of the 'extended trading zone' that I have used to conceptualize the global Artificial Life phenomenon. Here the obvious link to the Sussex neighbourhood is that it has been the locale retained for an in-depth empirical study of the extended trading zone, because of its undisputed centrality in the Artificial Life landscape. The resulting case study went on to show that through its interdisciplinary practices, the Sussex neighbourhood embraced the hybridizing potential, antagonist to the modern process of purification, of the extended trading zone. Yet there are in chapter 3 other connections between a non-modern ontological vision and the Sussex neighbourhood that I wish to underline.

The sub-section entitled "Embodied-embedded cognition, subjects and objects" was devoted to discussing the presence in Artificial Life of a robustly anti-Cartesian continental philosophy current, and I have explained that this current, unusual for a field with aspirations to scientific respectability, strongly overlapped with the embodied-embedded cognitive science current. My main point in this part of chapter 3 was to strengthen the empirical link observed between allegiance to embodied-embedded cognitive science and research interest in the epistemology of simulation, by establishing a causal link between the two. I have argued that this link was a consequence of the rejection of the subject-object divide by embodied-embedded cognitive science, whose phenomenological foundations situate both observer and observed into a constructivist relationship to their environment. I have amply illustrated the radical anti-dualism, rejecting subject-object as well as mind-body and nature-culture divides, of this current of Artificial Life, which thus inscribes itself in a non-modern stance, against the modern ontological vision that takes for granted a dualism of people and things.[644] Again, it turns out that most of the empirical material used to document the involvement of ALifers in the epistemology of simulation and in the embodied-embedded approach to cognition, which chapter 5 has since revealed to be a very 'Sussex' pursuit, originated in the Sussex neighbourhood.

I have concluded chapter 4, first part in the case study of the Sussex neighbourhood, by discussing a manifestation of non-modernity that was, this time, specific to the Sussex Artificial Life community. I have argued that by reclaiming the creative and artisanal dimension of their work, which highlights its individual and non-standardized character, by refusing professionalization and specialization into a respectable 'normal science' activity, by valuing amateurism, Sussex ALifers rejected the work of purification characteristic of modern science; that through its attraction for 'voluntary hybrids' who actively dismantled the boundaries erected by Latour's Moderns between the natural sciences and the human sciences, and who thrived in the resulting gaps, the ethos of interdisciplinarity that prevailed in the Sussex neighbourhood inscribed itself into a non-modern ontological vision.

Chapter 5 is the one part of my work that I have not yet explicitly connected to the non-modern stance. What I intend to establish now, is that the logic of ontology that Sussex ALifers have a predilection for in their interdisciplinary practices is non-modern – that the logic of ontology driving their interdisciplinarity is a logic of non-modern ontology.

[644] Pickering (2009: 199).

In chapter 5, I have focused on interdisciplinary practices in the Sussex neighbourhood that straddled the 'two cultures' divide, that crossed over sciences, engineering, arts, humanities, and bridged traditionally separate schools of thought. Revealing the proliferation of such practices had the dual benefit of giving weight to the idea of an extended trading zone along with the hybridizing power that I claimed for it, and of showing that the research group that had become central to Artificial Life was also one who embraced this hybridizing power. My study of three different areas of interdisciplinary research has revealed not only that heterogeneous forms of interdisciplinarity were actively pursued in the Sussex neighbourhood and could lead to ambitious and consistent research programs such as enactivism, but also that, following Barry et al.'s typology, it was a type of interdisciplinarity that was predominantly in the agonistic-antagonistic mode and in the logic of ontology.

Let us go back to the explanations that Barry et al. have given for what they have termed 'the logic of ontology'. They have described interdisciplinary research as being in the logic of ontology when it is "based on recognition of the limitations of existing ontologies",[645] when it is "explicitly or implicitly driven not only by the rationales of fostering accountability and innovation, but by an orientation towards effecting ontological change. This may be manifest […] in intentions to re-conceive both the object(s) of research and the relations between research subjects and objects."[646] What kind of ontological change(s) are interdisciplinary practices in the Sussex neighbourhood aimed at effecting, explicitly or implicitly? How are they attempting to re-conceive the objects of research and the relations between research subjects and objects?

[645] Barry (2007: 27).
[646] Barry, Born & Weszkalnys (2008: 25).

The second question has been answered already. Sussex ALifers' characteristic brand of continentally inspired anti-Cartesian philosophy, perceived as their hallmark, rejects the subject-object divide, and their position towards nonhuman agency is one of letting go of control, of engaging into open-ended performative collaborations with agency-imbued computerized synthetic systems. The way in which Sussex ALifers re-conceive research objects and relations between research objects and subjects thus belongs to the non-modern ontological vision. Regarding the first question, what kind of ontological changes interdisciplinary practices in the Sussex neighbourhood aim at effecting, I have already pointed that the three distinct aspects of interdisciplinarity examined in chapter 5 openly embraced the hybridizing potential, antagonist to the modern process of purification, of the extended trading zone. Now, what aspects of these areas of interdisciplinary practices would more particularly indicate that they follow a logic of non-modern ontology – that they inscribe themselves into a non-modern ontological worldview?

The first area of interdisciplinary research that I have investigated, associated with the strong continental philosophy streak of the Sussex neighbourhood, is the embodied-embedded approach to cognition and its overall project of naturalizing phenomenology – a project that is situated at the highly improbable intersection (in terms of the Moderns' purified categories) of logical and formal analytic philosophy, of subjective, experiential and performative Heideggerian phenomenology, of naturalistic and experimental cognitive science, of evolutionary robotics engineering techniques. Questioning, like Sussex ALifers in the embodied-embedded current do, whether aliveness = cognition = sociality, interrogates the 'guarantees' that found Latour's Modern Constitution:

> "First guarantee: even though we construct Nature, Nature is as if we did not construct it.
>
> Second guarantee: even though we do not construct Society, Society is as if we did construct it.
>
> Third guarantee: Nature and Society must remain absolutely distinct: the work of purification must remain absolutely distinct from the work of mediation."[647]

Pursuing more especially the Varela-inspired enactive strand of research, which a group of researchers in the Sussex neighbourhood is busy articulating into a robust and coherent research programme for cognitive science, I have highlighted that to be consistent with a Heideggerian phenomenological framework, Sussex enactivists were proposing to integrate first-person lived experience into enactive cognitive science as an accepted source of empirical scientific evidence, alongside approaches in the third-person tradition. In agreement with Varela and Shear's defence of first-person methodologies, which denounces the fallacy of scientific objectivity,[648] some are calling for the establishment of a 'phenomenological pragmatics' that turns first-person subjective experiencing into a valid mode of scientific investigation; and as a first step towards concerted disciplined training for describing such experience accurately, they have devised an easy to replicate and quick to master experimental platform, a tactile-vision perceptual substitution system called the Enactive Torch.[649] By acknowledging the subjective dimension of science that the modern stance erases, by re-integrating subjective lived experience into an alternative way of doing cognitive science, by devising artefacts that will enable them to do so in a performative 'dance of agency',

[647] Latour (1993: 32).
[648] Varela & Shear (1999).
[649] Froese & Spiers (2007).

Sussex enactivists are utterly non-modern. Phenomenological pragmatics and the Enactive Torch undoubtedly belong to the non-modern ontological realm.

The second area of interdisciplinary research under scrutiny was historical. I have targeted the historical projects into which members of the Sussex neighbourhood, turned amateur historians, engaged alongside academic historians from various specialist domains. My inquiry has shown that their main motivations for doing so seemed to be fighting erasure, reclaiming their hybrid roots, and challenging received histories. For them, fighting erasure meant going up against the general amnesia that affected computer science as well as Artificial Intelligence, and more generally "the overlit arena of modern science, where progress must be relentless, leading to pressure to dismiss last year's ideas as flawed".[650] This passage alone shows that the interdisciplinary historical endeavours of Sussex ALifers proceed from a non-modern attitude, as they recognize the obliterating, palimpsestic effects of modern purification and of the march of modern unidirectional progress. From a Latourian perspective, publicly reclaiming impure, hybrid genealogies for their Artificial Life research, genealogies that reach further back in time and wider in spectrum than received histories would have it, is another non-modern move on the part of Sussex ALifers. Moreover, the main historical lineage that they reclaim, the one they appropriate by positioning themselves as its natural heirs, is that of British cybernetics, which Pickering has analysed as archetypal of the non-modern ontology.[651]

Finally, the last distinct area of interdisciplinary research that I have addressed, by far the most conspicuous in the Sussex neighbourhood, was that of art-science. I have pinpointed the multiple orders of diversity that existed in the art and science nexus of the Sussex neighbourhood and in particular, I have highlighted its high crossbreeding

[650] Husbands, Holland & Wheeler (2008: vii).
[651] Pickering (2002); Pickering (2008); Pickering (2009).

potential by exploring in detail the diversity of sites where Artificial Life art was produced and performed. But it is my investigation into motives for doing Artificial Life art that is most revealing of the non-modern ontological vision in which many interdisciplinary artistic practices in the Sussex neighbourhood inscribe themselves. I have found, for instance, that the multi-dimensional critical questioning of science that CCNR artist-in-residence Anna Dumitriu is especially illustrative of, was very much a STS kind of questioning – a kind of questioning apt at bringing to light the non-modern hidden aspects of modern science. Moreover, I have shown that this critical questioning was pursued through performative engagement with the science and its artefacts, which dissolved the distance between subject and object, and enrolled indifferently humans and nonhumans in collaborative networks. Further, the study of art as research method has proved that performance was indeed the key word, be it through the IRC's 'performative approach', through Eldridge's idea of performance-as-research, or through the integration of performative artistic research into the interdisciplinary scope of enactivism. This emphasis on performativity resonates with Pickering's view that the representational idiom belongs to the modern stance while "the performative idiom – a decentred perspective that is concerned with agency – doing things in the world – and with the emergent interplay of human and material agency" is that of the non-modern ontological attitude.[652] To be honest, it does more than resonate with Pickering's view. It occasionally borrows from it. Bird, d'Inverno and Prophet's paper, reporting on the IRC's interdisciplinary performative approach to research, opens with a lengthy quotation from Pickering's "Cybernetics and the Mangle", which both defends the performative idiom for the vision it gives of the world "as a lively place full of agency"

[652] Pickering (2002: 414).

and presents Ashby's homeostat (one of the British cyberneticists reclaimed as forefather by the Sussex ALifers) as "a very nice device to illustrate that ontology."[653]

Overall, my study of the Sussex neighbourhood reveals an impressive convergence in its manifestations of a non-modern ontological vision, and the most appropriate way I have found to describe this convergence is to say that they are 'harnessing non-modernity'. In order to elaborate on this proposition, I would like to tie it with the main argument developed by Pickering in "The politics of theory: Producing another world with some thoughts on Latour".[654]

The first part of the paper examines examples of artefacts and practices that belong to the non-modern ontological vision, "a class of objects and projects that abstain from dualist purification and that instead thematize and take advantage of performative and open-ended dances of agency."[655] A majority of these examples hit close to home for the Sussex neighbourhood, as we encounter cellular automata (CAs are a major modelling method in Artificial Life) and quite a few of the British cyberneticists whose work is an inspiration for Sussex ALifers (Grey Walter and the robotic tortoises; Ross Ashby and the homeostat; Gordon Pask and both the Musicolour machine and the Fun Palace architectural project).[656] The second part of the paper reflects on this list of examples and considers what cues could be taken from them.

First, all examples (with the possible exception, in Pickering's view, of robotics) "point to projects that are relatively marginal to their fields; they somehow seem jokey and not quite proper."[657] This, for Pickering, demonstrates the hegemonic sway of the modern ontology, asymmetric and dualist, on fields such as maths and cybernetics, and on many other fields besides. I have reached much the same conclusion for Artificial

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653 Pickering (2002: 417-418).
654 Pickering (2009).
655 Pickering (2009: 206).
656 Pickering (2009: 201-206).
657 Pickering (2009: 206).

Life, especially regarding its disciplinary instability and epistemological shakiness. But the very existence of these examples also demonstrates that the sway of the modern ontology is not absolute: "there *are* ways of acting in the world that do not feature a *telos* of dualist separation and that thematize open-ended becoming instead." Pickering hopes that his examples "will be read not as one-off historical curiosities, but as moments in continuing traditions of nonmodern practice." My case study of Artificial Life in the Sussex neighbourhood, which on top of the already explicit relation of Artificial Life to the 'cellular automata moment', relates the 'Sussex Artificial Life moment' to the 'British cyberneticists moment' and also to the 'founding of the University of Sussex moment', certainly gives weight to the idea of continuing traditions of non-modern practice.

What Pickering wishes to achieve, is to assemble these continuing traditions, and others like them, "into some sort of unitary practical gestalt"; it is "to elicit a novel gestalt that would challenge the hegemony of ontological dualism *in the domain of practices and objects* as well as that of thought and representation." [658] He has several answers to offer as to why his proposal should be taken up: "A simple answer is variety is good. […] Another is what Latour […] called the return of the repressed. […] It begins to be imaginable that the dark side of ontological purification is natural and social disaster."[659] But the most thought-provoking answer that he proposes brings back Heidegger in the picture:

> "In 'The Question Concerning Technology', Heidegger […] conjured up an image of the contemporary world as characterized by a project that he called 'enframing' somehow setting up the world as a stock of 'standing reserve' for preconceived human projects. […] Asymmetric dualism, as I have been

[658] Pickering (2009: 200, 206).
[659] Pickering (2009: 206).

> calling it is a highly appropriate ontology for enframing, and vice versa. […] As I have been trying to show, there are other scientific and mathematical and technological and artistic ways to go on that do not stage any sort of dualist theatre […]. And, importantly, these other ways of going on are better characterized not as forms of enframing but of Heideggerian 'revealing'. […] So now the political valence of this essay might be clearer. We can see this contrast between two ways of thinking about and acting in the world in terms of the contrast between enframing and revealing. […] Part of the message of this essay is precisely that […] there are other ways to go on – something which is hard even to imagine when we are plunged into so many enormous dualist assemblages all of which echo a dualist ontology back to us."[660]

This is where Pickering departs radically from Latour. At the mundane level of practices and objects, Pickering wants to show that there is another way of doing maths, science, technology, art; whereas Latour values highly the dualist purification of modernity "and wants, not to challenge its hegemony at the ground level, but to maintain it in his new political order."[661] Latour wants to retain everything from the moderns, "apart from exclusive confidence in the upper half of their Constitution", meaning, in the first two of the three guarantees that I have quoted earlier. But the third guarantee, the work of purification between Nature and Society, must be kept absolutely intact.[662] Latour goes as far as stating that "[a]ll concepts, all institutions, all practices that interfere with the progressive objectivization of Nature […] and simultaneously the subjectivization of Society […] will be deemed harmful, dangerous and, quite simply,

[660] Pickering (2009: 207).
[661] Pickering (2009: 208).
[662] Latour (1993: 132-133).

immoral."[663] The remainder of Pickering's paper is largely devoted to discussing this value judgement, trying to puzzle out the reason(s) behind Latour's moral stance. I will not comment on that part of the paper, as it would take me on a speculative tangent.

Now, coming back to the 'harnessing of non-modernity' that characterises the Sussex neighbourhood, how does it fit in with Pickering's call for a non-modern alternative to the hegemony of the modern ontology? Their harnessing of non-modernity concurs *de facto* with the views developed by Pickering, against Latour. Their objects and practices clearly "resist blackboxing, objectivization and subjectivization",[664] and as I have pointed earlier, Sussex ALifers are interrogating not just the first two guarantees of Latour's Modern Constitution but also the third, the one that according to Latour should remain absolutely intact. Moreover, by explicitly inscribing themselves in the historical lineage of the British cyberneticists, and further back, they are from their own initiative establishing the existence of a continuing non-modern tradition (predominantly British) to which they are proud of belonging. Not only that, but they seem to sense without theorizing it (performance over representation) the importance of building ever more widely networked assemblages in the non-modern ontology.

This is the case when they recruit allies outside their field, who are unlikely to count as valid sources of evidence and support in the scientific tradition, like when Bird, d'Inverno and Prophet mobilize Pickering into their proposal for an interdisciplinary performative research method, or when Varela and Shear, who are an inspiration to Sussex enactivists, bring in Shapin and Schaffer to justify first-person methodologies – two instances of allies recruited, of all fields, in STS, which Pickering places squarely in

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[663] Latour (1993: 140).
[664] Pickering (2009: 210).

the non-modern camp.[665] It thus appears that by harnessing non-modernity, the Sussex neighbourhood have anticipated Pickering's call, as they have been quite busy developing and expanding an active hub of non-modern objects and practices.

Finally, why adopt an interpretative filter focused on non-modernity? What is the point of the 'harnessing non-modernity' argument, beside drawing attention to the existence of alternative research hubs such as the Sussex neighbourhood? I have already reported the answers proposed by Pickering in defence of his call for the assemblage of alternative ways of doing research into "some sort of unitary practical gestalt";[666] but I would like to add a few reflexions of my own, to complement Pickering's.

Part of the answer is about doing justice to such collective projects as that of the Sussex neighbourhood. The non-modern interpretative angle appears well suited to the study of interdisciplinary research projects that reach outside the traditional realm of technoscience. Such projects, due to their hybrid 'two cultures' nature, do not lend themselves easily to specialised approaches such as history *of science*, or history *of art*, or philosophy *of science*, or philosophy *of technology*, etc. They thus tend to be under-studied, and mis-represented by inadequately limiting specialist frames, which is an issue that, as I have highlighted, professional historians engaged in interdisciplinary historical projects alongside members of the Sussex neighbourhood have been attempting to address.

Doing justice to such interdisciplinary research projects is susceptible to have very material consequences. For instance, contributing to the establishment of improved research validation procedures is an area of research governance into which STS practitioners implicate themselves. But as pointed by the name 'Science and Technology Studies', we privilege a well-bounded science and technology perspective,

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[665] Pickering (2009: 199).
[666] Pickering (2009: 200).

and tend to limit our scope of inquiry accordingly. What about interdisciplinary practices that straddle the 'two cultures' divide, then? As shown in chapter 5, the conclusions of Barry et al. and Shanken, as well as my own, are all drawn from the study of interdisciplinarity that fall into the 'two cultures' straddling category, and all point that some of these interdisciplinary practices are irreducible to antecedent disciplines. The hybrid products of such research practices thus require evaluation procedures that are irreducible to the current, segregated, repertoires of science, of technology, of art, of philosophy, etc. Asking how we in STS may contribute to the establishment of such evaluation procedures questions, in turn, our own standards of research.

Shanken articulates the same kind of critique, targeted both at art studies and at STS. For him, as for other art historians, the contemporary conjunction of art, science and technology is nothing new.[667] Ever since the birth of the modern age created art and science as separate categories, science and art and technology have had deeply intermingled histories. Shanken argues that throughout history, "artists have created and utilised technology to envision the future, not just of art, but of culture and society in general."[668] He accuses history of art of having "neglected to incorporate this visionary conjunction of art and technology into its canon in any systematic way."[669] As for contemporary history, his view is that the increasing number of "hybrid artist/engineer/scientists" is having an "impact on the centrality of technology and science in the practice of art and design (and vice versa) [which] will also force a reconsideration of the canons of art history and the histories of science and technology."[670] In short, the likes of Shanken, or as we have seen in chapter 5, of Gere,

[667] For instance, Reichle (2009).
[668] Shanken (2005: 417).
[669] Shanken (2005: 417).
[670] Shanken (2005: 417).

are implicitly charging specialist histories of having purified the objects of their respective inquiries, in what could almost be labelled a modern collusion – modern histories for modern disciplines.

The other element of answer I would like to bring is of a more speculative nature. In a case such as the Sussex neighbourhood, I think that if the worldview into which their research takes place is left unarticulated, there is a risk that the results of their research are recuperated, laundered so to speak, by the hegemonic modern matrix in the cracks of which they lodge themselves. According to Latour, this is after all what the moderns are expert at: turning a blind eye on the work of hybridization and purifying its results. While Sussex ALifers dismantle boundaries in order to pursue their research, they leave open the possibility that the outcome of their research is taken out of its context, distorted and purified; that thanks to the erasure and purification processes that moderns are so good at performing on non-modern hybrids, it is severed from Pickering's 'other world'[671] and whitewashed into the modern dualism that keeps Nature and Society well separated. Conceptualizing Artificial Life as an extended trading zone where non-modernity has a strong foothold, may shed some new light, for example, on the boundary work going on with biology, that I have discussed in chapter 3. The active distancing of biology from Artificial Life, allied with the failure of biologists to acknowledge their borrowing of Artificial Life models, now appears as modern purification and erasure at work. Such examples may bring an insight into what happens at the interface between the two worlds of modernity and non-modernity – or since the modern ontology is overwhelmingly dominant, how modernity is dealing with pockets of non-modernity

[671] Pickering (2009: 200).

Pursuing this line of thought, there is a danger inherent to anti-dualist projects that attempt to naturalize phenomenology, or that equate sociality to a natural attribute, when their products are reconfigured into the dualist modern matrix of disciplines – a risk of strengthening the alliance between the natural and social sciences to enforce their respective objectivity claims, which Latour has rightfully identified and denounced.[672] To counter-balance this danger, it seems to me that the non-modern ontological worldview framing these project should be made explicit and thoroughly articulated. I am not keen to have ever more naturalization of the social in the modern dualist ontology. Considering the current appetite for complex systems and agent-modelling approaches in the social sciences, I believe that my worry is not an idle one. Jumping hungrily on the new tools (simulation models, algorithms, etc) that complex systems and computer science make available to social scientists should be accompanied by some serious critical reflexion on these very tools: on the worldviews that they are rooted into, the historical genealogies from which modern purification has severed them, the assumptions and biases that have been black-boxed in the process. This is typically the kind of critical reflexion that a non-modern interpretative focus can bring about.

3. CONTRIBUTION TO SCIENCE & TECHNOLOGY STUDIES

What relevance does the research I am bringing to a close have for science and technology studies? What is the original contribution of the present thesis to STS scholarship? My intent is not to establish a detailed list of achievements. It would uselessly repeat some results and conclusions that the thesis has established as it progressed. I would rather take a step back, and return to the main aim of my project. In

[672] Latour (1993: 52-53).

the opening of chapter 1, I have stated that I aimed at capturing some of the subtle yet profound aspects in which the elusive and much canvassed ‘information revolution’ may influence research cultures and knowledge production practices. In this light, what most stands out of my thesis is, I think, a methodological framework.

I have justified in chapter 1 the adoption of a hybrid approach combining the micro-level perspective of a detailed local case study to a macro-study at the research field level. Through a mix of quantitative and qualitative tools, the macro-study has achieved the expected goals. First, it has validated that Artificial Life, largely born from its practitioners’ familiarity with, and skilled mastery of, informatics and from their sharing a culture of simulation, was indeed a field which study was relevant to the main aim of the project. Second, it has established that the Sussex neighbourhood was a highly pertinent locale for a micro-study. The macro-study has also achieved an unexpected goal: by refuting the widely held belief that Artificial Life was quintessentially a North American phenomenon, it has confirmed that we should be wary about generalising the results of stand-alone micro-studies without first properly situating them, which post-justifies my choice of a hybrid approach.

Meanwhile, the micro-study part of my work has yielded results that run counter-intuitively to some general conclusions about the impact of ICTs, making these general conclusions somewhat over-generalised. First, against the supposed homogenising influence of cyberspace over local particularisms, against the ironing out of geographical diversity into the global cyber-village, my case study of the Sussex neighbourhood has shown instead the importance of Real Life localisation, even for research communities whose members are natives of cyberspace. Further, it has highlighted the amplifying effect that cyberspace can bring to local singularities. In the Sussex neighbourhood, cyberspace is an essential medium of day-to-day networking that strengthens the community, be it through the ALERGIC mailing list, the Life and Mind wiki, the collaborative e-research conducted between members of the community who are physically distant, etc. Second, against the view that trafficking into de-materialized virtual environments leads to embracing neo-Platonist informational worldviews and mind-body dualism, my study has shown that deep familiarity with informatics could have the unexpected result of developing a worldview that is anchoring the mind into the body and anchoring cognition into the senses; what is more, with an artefact like the Enactive Torch, it is rehabilitating senses that have historically been under-valued, 'low' senses, such as touch. This last insight, which goes against prevailing ideas of technological transcendence, agrees with the re-definition of the concept of 'digital image' and the privileged position of the human body defended by philosopher Mark Hansen in "New Philosophy for New Media".[673]

Overall, the thesis demonstrates the benefits that a hybrid approach integrating macro and micro levels of inquiry can bring to an empirical research project in an understudied and poorly mapped area of study. Here I should point that my hybrid approach is very similar to that adopted by Barry et al. in the "Interdisciplinarity and Society" project. Their project started with a macro-study, a general survey of interdisciplinarity that allowed the research team to identify three areas of particular interest along with representative sites in each; this survey element of the project was followed by a micro-study, comprised of case studies, conducted through the sites identified as representative, of the three areas of interest.[674] Although our two projects end up presenting a strong intersection, our main aims were very different and the two projects have run mostly in concurrence ("Interdisciplinarity and Society" between 2004 and 2007, my project between 2005 and 2009). Yet we have independently adopted

[673] Hansen (2004).
[674] Weszkalnys (2006).

similar hybrid approaches, to target research areas (interdisciplinary research objects and practices in one case, relationship between informatics and research cultures and practices in the other) that both suffer from a serious deficit of empirical studies. If anything, these parallel methodological choices, made in different yet comparable research contexts, are mutually reinforcing.

A second methodological contribution pertains to the actual articulation of the thesis' analytical framework. It borrows heavily from Pickering, Galison, and Barry et al, also from authors like Kohler and Daston who have adapted and developed the idea of moral economy to STS, and there is not much apparent originality in doing so. Although Barry et al.'s conclusions about interdisciplinarity are still too recent for the followers that they may inspire to have become visible, Pickering's ideas of alternative ontologies, through the concept of the mangle, have already framed a number of case studies, as have Galison's 'trading zone', and there are quite a few case studies of moral economies. What I believe is original to my thesis, though, is that I have identified how these different perspectives could work complementarily and strengthen one another, and I have integrated them into a consistent methodological framework.

Pickering's conceptualisation of the contrast between modern and non-modern ontological visions provides a filter through which research practices and objects are easily qualified between two modes of human-nonhuman relationships. Given my specific interest, it is a convenient way of broadly classifying how researching subjects manage the agency of their informatically-enabled research objects, that is, whether they are in a 'command-and-control' or a 'harnessing' mode of management.

Galison's notion of the 'trading zone', in the extended version that I have proposed, can be transposed to all research activities (not just the scientific ones) that involve modelling and scenarios. By focusing on the nonhuman element of the human-nonhuman relationship that is the focus of Pickering's filter, the extended trading zone makes it possible to study the 'quality' and 'quantity' of agency effectively belonging to the nonhuman, independently of the human element of the relationship.

Barry et al.'s typology of interdisciplinarity is, on its own, a useful grid for the empirical assessment of interdisciplinary practices. In association with the analytical lenses provided by Pickering, Galison and the concept of moral economy, it becomes a powerful tool for evaluating how consistent is, overall, the form of life adopted by a given research community.

Granted, it is not just any research community that can be apprehended through the methodological framework I have presented. It is particular to interdisciplinary assemblages associating humans and ICTs. Yet this is not as restrictive as it may sound. My study, in agreement with Galison's historical study of Monte-Carlo simulations that gave rise to the idea of the 'trading zone', has shown that the intensive use of simulation modelling was indeed a strong factor of interdisciplinarity, and this points at a whole array of research fields which could potentially lend themselves to a similar methodological approach. Additionally, at a time when scientific governance is actively promoting interdisciplinarity and collaborative e-Research, while ICTs are becoming ever more ubiquitous and diverse, it is paramount to gain a better knowledge of the corresponding research fields, in order to figure out how the research produced may be adequately evaluated (we have seen that the inadequacy of assessment procedures was a major issue for interdisciplinarity in the logic of ontology), which research configurations can be expected to be most successful, or which institutional contexts are more favourable to their development. The methodological framework that I have articulated is well suited to this purpose. Simulation models are certainly neither the only agency-rich nor the only highly versatile tools in the ever expanding informatics toolbox, and the concept of the 'trading zone' could easily be adapted to study some of the ever more numerous ICT-enabled interdisciplinary endeavours (to name but a few, computational creativity, virtual architecture, virtual archaeology, climate change modelling, e-Research initiatives, etc).

Finally, having demonstrated the wider applicability of my methodological framework, I would like to insist, at the risk of repeating myself, that it has already demonstrated its original value. It has brought to light that the research community who has so consistently thrived that it has come to dominate the field of Artificial Life is one who is successfully harnessing the non-modern ontological vision, and this is a result that is at loggerheads with prevailing ideas about informatics, this paradigmatic realm of neo-platonistic transcendence – of modern dualism.

4. PERCEIVED WEAKNESSES AND RESEARCH OPENINGS

The present thesis has its weaknesses, some of which I am aware of, some of which I may not. My work would be incomplete unless I briefly discussed the perceived points of weakness that most concern me, and the avenues for new research that remedying them may open.

First and foremost, methodology-wise, I find there is a missing piece to my empirical case study of the Sussex neighbourhood, which would have deepened and enriched it, and that is a much longer, immersive fieldwork. To actually engage into collaborative work, in the way that Anna Dumitriu, paradigmatically, has been doing, would have provided an invaluable addition to the field material I have collected. The timeframe required by such immersive fieldwork was incompatible with that of my doctoral research project. Yet the lack of it is a source of inconsistency in the perspective of the phenomenological, performative engagement that I have been defending. At the same time, it is only in the light of the conclusions reached by the present thesis that this lack is glaring; and without the knowledge that I have gained while working on the present thesis, the collaborative projects I could have engaged into would have wanted direction on my part. The potential value of an immersive fieldwork in the Sussex neighbourhood, during which I would actually engage into collaborative work, is thus to a large extent conditioned by the existence of the current work, which acts as necessary preliminary study. Having completed it, doing a residency in the Sussex neighbourhood would be the obvious step that could take the present project to the next level.

The second source of weakness that I have identified is not a feature of the present thesis *per se*, but rather of the present thesis in relation to the lack of comparable studies. As I have explained in the previous section, I have tried to make up for this deficit by adopting a hybrid approach associating macro- and micro- studies. Even though I have found this approach to be quite successful, it remains the issue that my empirical study is but one isolated project in an understudied and poorly mapped area of study. Despite the precautions that I have taken to ensure that my study was not an irrelevant anecdotal blip, its relative isolation makes it quite hard to come up with robust, well-substantiated answers to the questions that I have been asking, about the consequences of skilled uses of simulation, about native research cultures and their interdisciplinary practices in the extended trading zone, etc, solely on the basis of the case study of the Sussex neighbourhood. There is a clear need for more empirical projects in the same area of study. Two evident candidates for such studies, because of their overlap with Artificial Life, are virtual architecture and computational creativity. Archaeology and climatology are other hot points.

In the same vein, I think that Pickering's 'other world', the non-modern ontology, requires some thorough empirical investigation. First, there are too few examples so far of such projects, to attempt a geographical and historical mapping of continuing non-modern traditions. Yet, from Pickering's study of (mostly British) cybernetics and from my own study of Artificial Life at University of Sussex, we get a feeling that these are but episodes in a strong British tradition, of which we have but a patchy knowledge at best. One may argue that it is a historical lineage that has remained largely obscure, because it is of little interest. But it could be also that it has remained obscure because, and this is not an unlikely hypothesis considering some conclusions of the present thesis, it is a bastardized lineage that hybridizes many genealogical strands, which specialist histories are not keen to address. Second, there is an area of the non-modern ontology that, I believe, requires special attention, and this is an issue that I have alluded to earlier in this chapter. It is the articulation between the non-modern 'other world' and the hegemonic modern ontology. Only a better empirical knowledge of continuing (or interrupted, for that matter) non-modern traditions may help figure out what is happening at the interface between the two worlds – or since the modern ontology is overwhelmingly dominant, how it is dealing with pockets of non-modernity. And since this articulation is a time-dependent dynamical process, we may wonder how it has evolved over time – and if the proliferation and affordability of ICTs may be affecting its evolution.

The last perceived weakness is of a theoretical nature. On this one I have no avenue for future investigation to propose as palliative, only a debate to open that will hopefully give food for thought to others in STS. There is a potential circularity to my work, caused by interactions between my own theoretical framework and that of the very community that I have been studying, which I cannot overlook. It is an issue that has already been acknowledged in Risan's ethnography of Artificial Life at Sussex.[675] It results from the strong kinship between phenomenology-inspired approaches in philosophy of mind and cognition, in philosophy of technology (of information technology in particular), in philosophy of art (of new media art more precisely), in sociology.[676] They all draw to some extent on the same authors: Heidegger, Husserl, Merleau-Ponty, also Bergson. They also draw occasionally on each other, in particular on Varela. There is an obvious kinship, for instance, between first-person methodology in enactive cognitive science, and ethno-methodology in laboratory studies. In an ANT perspective, this looks like the constitution of a network of allies, where non-human informatical agents play an important role. And in the perspective, defended by Pickering, of assembling a "unitary practical gestalt", this looks like getting down to the job. By contrast, in a Popperian perspective, and in the analytic philosophy of science tradition more generally, the circularity is unacceptable and I am shooting myself in the foot by defying logic, by blurring subjects and objects, and so on and so forth. I may be partial to some of these perspectives more than to others, yet none fully satisfies me. The issue of cross-referencing between theoretical frameworks is worth some more reflexive thinking.

[675] Risan (1997a: Introduction).
[676] For instance, non exhaustively and in no particular order, some of the authors that have informed my thesis: Michael Wheeler, Ezequiel Di Paolo, Francisco Varela, Hubert Dreyfus, Bruno Latour, Andrew Pickering, Mark Hansen.

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