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# PREFACE

The Prague College Research Centre (PCRC) was founded with the idea of developing interdisciplinary research crossing several fields and subject areas underlying the academic curricula at Prague College, its main purposes are:

- To promote a medium of participation and discussions by means of regular interdisciplinary workshops and seminars.
- To promote and to encourage the collaboration among different Schools and programs in the design and creation of multidisciplinary courses in the College.
- To provide a means of publishing research work for both students and staff as part of a quarterly academic bulletin and e-journal.
- To cooperate with other education institutions and organizations in the development of common projects of interest

The Centre was developed from projects initiated by Stefano Cavagnetto in the context of his role as Head of the School of Business and the School of Computing, by Bruce Gahir, Principal Lecturer in the School of Business and Computing, and by Pascal Silondi, Director of Libat and Principal Lecturer in Interactive Media. Beginning in 2009 research in the following areas has been initiated:

1. Game theory and its application to economics, business, philosophy and international relations.
2. The history of programming languages and history of computers.
3. Experimental media (Prague College and the PCRC is an associate partner for Underground City XXI, an international interdisciplinary EU project).
4. The history of cryptology and the science of enciphering.
5. Art and mathematics: a profitable relationship in history-from classical geometry to fractals and topology.

By combining academic study with practical training the PCRC aims to create an environment where personal achievement goes hand-in-hand with social responsibility. Strategically, this offers students the chance to actively collaborate in several research areas with the support of faculty members and lecturers of the College.

Since 2010 a quarterly Bulletin has been published detailing progress in relevant research activities of lecturers and students. This bulletin forms an integral part of the PCRC and provides a medium whereby the research activities of the centre can be documented. Faculty members, Lecturers and students belonging to every School of the College are welcome to submit their work for publication.

You can find the published Bulletins of PCRC in Prague college library and in six Prague's libraries (Národní knihovně, Knihovně Národního muzea v Praze, Ministerstvu kultury ČR, Parlamentní knihovně, Městské knihovně v Praze, Knihovně a tiskárni pro nevidomé K. E. Macana) and digital version in the electronic library "Ebrary".

Deadlines for 2011 issues are: • 28<sup>th</sup> February • 30<sup>th</sup> May • 30<sup>th</sup> August • 30<sup>th</sup> November .

**PART I**

# **UNDERGROUND CITY PROJECT**

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# UNDERGROUND CITY XXI PROJECT

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The European Interdisciplinary Platform Underground City (XXI) originates from a long-term project 'Underground City XXI'. The aims of this project include the protection of an ex-coal mine in Labin and Rasa, in the Region of Istria, Croatia and the conservation of its industrial and architectural heritage. This project was initiated in 1998 by the cultural and art association Labin Art Express (L.A.E.) and the Region of Istria. The goal of the project is the transformation of an ex-coal mine into a modern, underground town, with streets, bars, galleries, a swimming pool, shops, restaurants, children play-grounds, Museum of Coal Mining, and other components of a modern town including Government, Statute, Mayor, police, laws and regulations, following the historical tradition of the Republic of Labin in 1921.

The main idea of the project was to provide an ample and true testimony of the nearly 400 year old tradition of mining, transforming an ex-coal mine's heritage into an avant-garde cultural and art project with a strong economic and social impact and potentially to become one of the leading Croatian cultural and tourist attractions, and a generator of future local / regional development. Construction of the first underground town in the world in the 8th 'horizon' (level) of the ex-coal mine (10 km long, app. 50.000 m<sup>2</sup> of space, 160 meters below ground surface), would demonstrate how space exploitation can be treated as environmental preservation.

In the summer of 2007 the cultural & art association L.A.E.(Croatia) in cooperation with art association LIBAT (France), NOMAD theatre (Austria) and Prague College (Czech Republic), established the project 'Interdisciplinary Internet Platform Underground City XXI (UC XXI)' – the creation of a virtual, 3D futuristic underground town and establishment of a specific European cultural and interdisciplinary community.

Internet platform UC XXI, a 3D multi-user environment shared and distributed on Internet, will consist of: an interactive tour through highly developed spatial/urban plans and experimental architectural models of fundamental city buildings including the Museum of Industry and Mining, a City Hall, an exhibition gallery, a movie theatre, a cultural centre, public spaces, public institutions and executive bodies (in the form of specific avatars). The Underground City community with citizens and residents, Statutes, regulations and laws, moral and ethical

codes will form permanent communication and social networks. Mixed media art works and hybrid performances will be created by the residents and guests of the virtual underground town.

In 1993 Podlabin (Labin Downtown) pit was officially recognized as a national monument of culture. In September 1998 Cultural Centre "Lamparna" (future entrance of the "Underground City") was opened in one of the abandoned mine buildings. In December 1998 the Assembly of the Region of Istria proclaimed Underground City XXI "millennium regional project". In the year 2000 the Faculty of Mining, Geology and Oil in Zagreb provided technical expertise, which proved the technical feasibility of the project in the areas of security, ventilation, water, electricity, lifts and other means of transport. The entire project development is divided into six different phases from conceptual work on the definition of the interdisciplinary platform to the dissemination of the project's eventual results.

## PHASE 1. DEFINITION OF THE INTERDISCIPLINARY PLATFORM (ARTISTIC, SOCIAL AND TECHNOLOGICAL)

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The virtual community's statutes, regulations, moral and ethical codes, terms for citizenship, beneficiary's rights and obligations, technical and other requirements, as well as different tools, services and facilities to be offered on the platform, will be discussed internationally and interdisciplinary by inviting European artists, scientists, programmers, other experts and officials to propose the first model for the future platform. This will be accomplished with a regard to artistic, social, political, legal, economical and technological issues. Available tools, technologies and already existing communities such as blaxxun, Second Life, or Active Worlds will be studied and evaluated to enable the definition of a strategy that meets the requirements of the UCXXI community relating to collaborative work, art production and implementation of mixed media content within interactive 3D real time environments on the Internet, in particular:

• Various tools will be presented relating to 3D modeling techniques as well as open source, gnu, or other well known software. These tools will be evaluated from the perspective of usability.

- Various languages and applications like VRML/X3D, Java, 3D games engines, OpenGL, DirectX, will be presented and evaluated for quality and network usability.
- Various communication technologies will be evaluated to meet the requirements of the UCXXI network, regarding interactivity, collaborative work and virtual Internet communities. Functionalities being explored include real time content manipulation, audio/video streaming, chatting and shared database management.

## PHASE 2. DEFINITION OF ARCHITECTURAL AND SPATIAL/URBAN MODEL OF THE FUTURE 3D ENVIRONMENT

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The basic virtual city infrastructure will be defined, synthesizing various already realized studies from the Faculty of Mining in Zagreb and using existing digital data provided by laser measurements of the coal mine provided by VIAS in Vienna. An interdisciplinary European expert team will be established to develop proposals for some spatial/urban units

with streets, squares, parks, buildings, to design fundamental 'public' buildings like museums, theatres, City Hall, galleries, cultural centres, to propose and integrate various means of transport such as lifts, railways, cycle and walking tracks, as well as some other infrastructure, in preparation for the 3D model construction Phase.

## PHASE 3. CREATION OF THE 3D MODEL

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3D artists and programmers in a close relationship with architects and designers will create the first 3D model of the Underground City XXI based on the real dimensions and situation of the ex-coal mine, using advanced CAD techniques and the results of the previous mine studies and measuring.

They will collaborate in experimentation and integration of architectural studies, installations and utopian architecture projects as well as in adaptation of gained proposals and ideas to be optimally integrated into the future 3D virtual environment.

## PHASE 4. DEVELOPMENT AND IMPLEMENTATION OF THE REAL-TIME MULTIUSER PLATFORM FOR DELIVERY OF SHARED INTERACTIVE 3D CONTENT ON THE INTERNET

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Programmers will directly collaborate with an expert team to enhance the potential of virtual 3D environments and provide an advanced multiuser server platform. A server for computer aided architectural design within real-time multiuser 3D platform will be provided, enabling users and community members to visual-

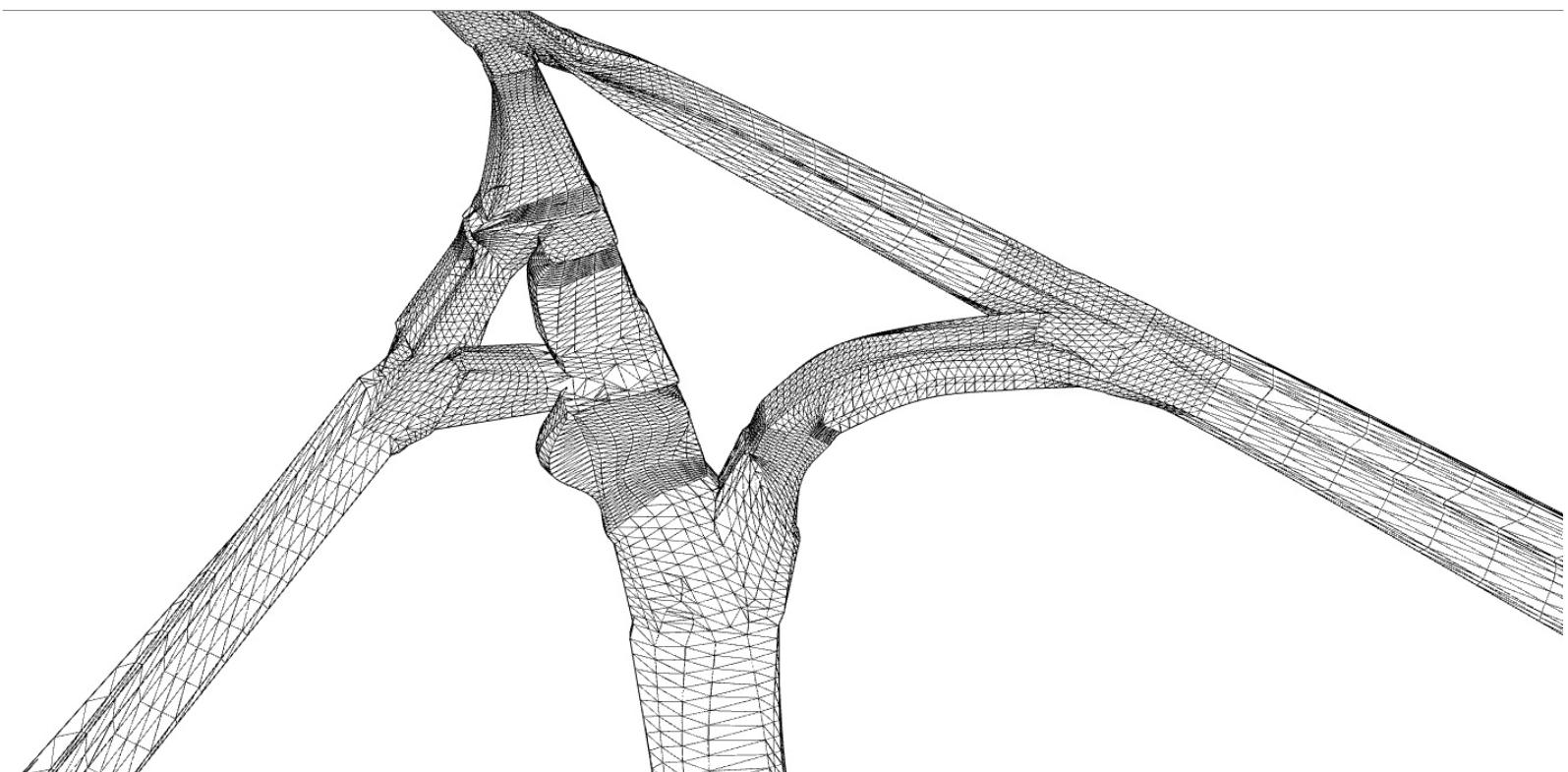
***Programmers directly co-operating with expert groups and artists will integrate 3D models developed during Phase 3 into multiuser environment shared and distributed on the Internet.***

ize and communicate their proposals. The UCC XXI platform will provide community communication tools such as chatting, forums, message boards and clubs as well as extensive multiuser functions with membership members and profile management and will integrate web 3D formats such as 3D, 2D, audio, video and streaming media. Regarding technology, UC XXI platform will utilize networked 3D rendering engines, with performance comparable to 3D game engines, which support character animation(avatars), which will enhance social experiences as well as web 3D content visualization. Programmers directly co-operating with expert groups and artists will integrate 3D models developed during Phase 3 into multiuser environment shared and distributed on the Internet.

## PHASE 5. DISSEMINATION (A): CREATION & PUBLIC PRESENTATION OF MIXED MEDIA ART WORKS & PERFORMANCES, IN BETWEEN REAL & VIRTUAL SPACES

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Artists will experiment and create mixed media works in sound, video, 3D volumes, 3D architecture, texts, images, 2D and 3D animations, for example, that will be implemented in the UCXXI platform, in order to stimulate and promote the artistic and cultural dimension of the project. Artists will thus also initiate interconnection with other artistic forms, based on real-time experimentation with image processing, contemporary poetry, performance, contemporary music events, broadcasting of independent radio programs, robotic installations and other experimental media. This inter-connectivity will help to modify existing creative strategies and make the revolutionary step into the age of mixed reality.



## PHASE 6. DISSEMINATION (B): COMMUNICATION/PROMOTION

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The public communication strategy is based on the establishment of a trademark 'Underground City XXI' and use of different promotional tools. The organisation of seminars, festivals, internationally announced conferences; website (such as [www.undergroundcityxxi.com](http://www.undergroundcityxxi.com), [www.artservis.org](http://www.artservis.org), [www.artfactories.net](http://www.artfactories.net), and other European cultural web sites) and banners on some internationally popular web sites, announcements and press releases for each project's activity in regional, national, and European printed and electronic media, production

and public presentations of multimedia art works and performances, digital and printed brochures for UCXXI, flyers and posters, T-shirts, caps, stickers, badges and similar products with UC XXI logo. Endorsements from UCXXI supporters such as well known artists, musicians, actors, models, sportsmen and other popular public figures, and public presentations of the initial and finalized platform will take place in Zagreb, Prague, Venice, Ljubljana, Belgrade, Vienna, at new media/electronic art festivals and events in Europe. ■

# MULTIPLE PERSONALITIES AND THE PROTEUS EFFECT IN COLLABORATIVE VIRTUAL ENVIRONMENTS

A WITTGENSTEINIAN VIEWPOINT

STEFANO CAVAGNETTO  
BRUCE GAHIR

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This paper was presented at the 8th International Cyberspace Conference, November 2010, Brno, Czech Republic. It builds upon the ideas in an earlier paper presented in the same conference last year.

Some important questions that concern the nature of identity and personality in virtual environments lead to interesting consequences. For example, what does it mean to be you in a virtual environment? How drastically can a person change and still remain, in the eyes of either themselves or their peers, the same person when being involved in collaborative virtual environments? Until recently, these questions were typically asked in the context of philosophy, psychoanalysis, or science fiction. However, the increasingly common use of avatars during computer-mediated communication and collaborative virtual environments (CVE's) in particular, are quickly changing these once abstract questions into practical quandaries. Such quandaries are fascinating, thought-provoking and potentially paradigm-shifting for those who study social interaction, and could be devastating to the traditional concept of human communication.

Given the advent of collaborative virtual reality (CVR) technology, researchers have begun to systematically explore the phenomena of *Transformed Social Interaction*<sup>1</sup> (TSI). The *Proteus effect* is a particular application of TSI in which a user's self-representation is modified in a meaningful way that is often dissimilar to the physical self. When the user then interacts with another person, the user's behaviour conforms to the modified self-representation regardless of the true physical self or the others impressions<sup>2</sup>. In an earlier introductory paper<sup>3</sup> we detailed a conceptual framework that illustrated the idea of the self as composed of information in multiple cyber-worlds, this tentative framework was utilised to explain a "layering" feedback process that may occur as a result of the self interacting in a CVE, in addition we expanded this framework to integrate an anthropological viewpoint of the self<sup>4</sup>.

In this paper we provide a further understanding of the relationship between the Proteus effects and the conceptual model of multiple virtual personalities interacting in CVE. Using the Wittgensteinian language-games framework, we expand our earlier paper to incorporate the notion of a "virtual personality" and "virtual game grammar" to explore the earlier framework from a conceptual point of view, it is our intention that this may hopefully bring a refreshing approach to examining the Proteus effect. When people play video games and interact in virtual environments, they adopt social stereotypes and roles (e.g., soldier, doctor, mafioso, wizard) and interact in situations that go beyond real life (Shapiro, Pena, & Hancock, 2006)<sup>5</sup>. In doing so, people "become" someone else by employing digital bodies or *avatars* that serve as users' self-representation in a virtual setting (Eastin, 2006; Yee & Bailenson, 2007)<sup>6</sup>.

In most cases, the morals of multiuser game characters are implied by the appearance and the stereotypical associations raised by their avatars (Isbister, 2006)<sup>7</sup>. For instance, one visual stereotype is that evil characters are portrayed by pale avatars dressed in dark clothes (e.g., Arthas in the lore of World of Warcraft), while good characters are usually depicted in light and vivid colours. We employ avatars to represent ourselves in computer-mediated settings, but does our cognition change in relationship to our virtual persona? And if so, what mechanisms underlie the influence of avatars on users cognition?

Initial studies have uncovered reliable evidence that avatars can affect users behaviour. Consistent with the prediction that attractiveness bestows more confidence in social interactions, Yee and Bailenson (2007) found that, in an immersive 3D environment, participants using avatars with more attractive faces walked closer to each other and disclosed more information when compared to those using avatars with less attractive faces.

<sup>1</sup> Bailenson, J.N., Bealle, A.C., Loomis, J., Blascovich, J., and Turk, M. (2004). Transformed Social Interaction: Decoupling representation from behaviour and form in collaborative virtual environments. *Presence: Teleoperators and Virtual Environments*, 13(4): 428-444.

<sup>2</sup> Yee, N., and Bailenson, J.N., (2007) The Proteus Effect: Self transformation in virtual reality. *Human Communication Research*, 33, 271-290.

<sup>3</sup> Cavagnetto, S., and Gahir, B., (2009). The Conception of the Self in Multiple Cyberworlds, paper presented at the 7th International Cyberspace Conference, Brno, Czech Republic.

<sup>4</sup> Turkle, S. 1997, Construction and Reconstruction of Self in Virtual Reality: Playing in the MUDS. See also Turkle, S.1996, "Virtuality and Its Discontents: Searching for Community in Cyberspace" available at [http://www.hermeneia.net/sala\\_de\\_leitura/s\\_turkle\\_virtuality\\_and\\_its\\_discontents.htm](http://www.hermeneia.net/sala_de_leitura/s_turkle_virtuality_and_its_discontents.htm).

<sup>5</sup> Shapiro, M. A., Pena, J., & Hancock, J. T. (2006). Realism, imagination, and narrative video games. In P. Vorderer & J. Bryant (Eds.), *Playing computer games: Motives, responses, and consequences* (pp. 275-289). Mahwah, NJ: Lawrence Erlbaum.

<sup>6</sup> Eastin, M. S. (2006). Video game violence and the female game player: Self- and opponent gender effects on presence and aggressive thoughts. *Human Communication Research*, 32, 351-372.

<sup>7</sup> Isbister, K. (2006). *Better game characters by design: A psychological approach*. San Francisco, CA: Morgan Kaufmann.

In addition, consistent with the assumption that tallness confers higher status, participants using taller avatars tended to negotiate more forcefully in comparison to those using shorter avatars. Yee and Bailenson (2007) referred to the effects of virtual self-representations on users as the Proteus effect (PE). Building on self-perception theory (Bem, 1972), Yee and Bailenson (2007) hypothesized that the Proteus effect is explained by people evaluating themselves as an imaginary third party would, observing their own behaviours to explain what attitudes may have caused them.

In such virtual environments, an avatar is defined as "a perceptible digital representation whose behaviours reflect those executed, typically in real time, by a specific human being" (Bailenson & Blascovich, 2004, pg. 65). A CVE is a digital system that allows geographically-separated individuals to interact via networking technology, oftentimes with graphical avatars. Thus, CVE's encompass both digital environments created for communication applications as well as online games created for entertainment purposes. The manner in which a user navigates and interacts with others in a CVE is dependent on the particular system itself. This can range from a joystick or a keyboard in a video game to a headset with translation and rotation tracking in an immersive virtual reality system. CVEs allow us to tailor our digital self-representation with a degree of control not possible elsewhere. This encompasses both visual and behavioural changes. First of all, CVE's, whether a 3D online game or just a text-based world, give us a great deal of control over our self-representation. Everything from our age, gender, ethnicity, or height can be dramatically altered or subtly tweaked with a few mouse clicks. Analogous changes to our physical bodies are much more difficult (or impossible) to accomplish. Because digital systems mediate all interactions in a CVE, the digital system can also be programmed to strategically filter and alter our behaviors. This has been referred to as Transformed Social Interaction (TSI, Bailenson, Beall, Loomis, Blascovich, & Turk, 2004).

Research in computer-mediated environments (Walther, 1996) has shown how the technical affordances of these environments can lead to more intimate interactions. For example, the limited communication channel together with self-presentation biases leads to a positive bias in impressions among interactants. Instead of focusing on the structural affordances of the computer-mediated environment, studies in TSI have shown how strategic changes in an avatar's appearance or behavior can affect how other users interact with that avatar, such studies TSI show that subtle changes in an avatar's appearance or behavior can influence how other users interact with the transformed avatar. The current work of Yee and Bailenson (*The Proteus Effect: Implications of Transformed Digital Self-Representation, on Online and Offline Behavior* Nick Yee & Jeremy N. Bailenson), has explored an interesting variation of this effect. Instead of exploring how an avatar's appearance can change how other people behave, they were interested instead in how an avatar's appearance can change the user's own behavior.

Bruckman's work (1993) in MUDs has shown how avatars can change a user's behavior. In the case of gender-bending, "many people, both male and female, enjoy the attention paid to female characters. Male players will often log on as female characters and behave suggestively, further encouraging sexual advances" (Bruckman, 1993). The same observation has been noted by Suler (1996) in his participant observation study of the Palace, a graphical avatar space that was a precursor to the avatar-based online environments available today, that expanded on the technological capabilities of existing MUDs. As such, the Palace blended the features of graphical CVEs and the ad-hoc communities of MUDs. In the Palace, "a seductive, sexy, or simply 'attractive' avatar can have a powerful impact on other members". These anecdotes suggest that a two-way process may be at play. A seductive avatar elicits more attention from other users, but, as Bruckman suggests, the seductive avatar may also enable or embolden the user to act in a more flirtatious manner. This is also reported by Suler. He notes that "many members have told [him] that what they are wearing affects how they behave, as well as influences how others will react to them" (Suler, 1996). These studies suggest that our avatars can change our personalities by changing how others interact with us, and more intriguingly, by changing how we behave directly by enabling certain behaviours.

Studies in self perception have shown that altered self-representations can directly lead to changes in a person's behaviour. Self perception theory argues that people infer their own attitudes and beliefs from observing themselves as if from a third party (Bem, 1972). For example, when participants were made to believe that their own heartbeat increased while viewing certain photographs, they rated the people in those photographs as being more attractive (Valins, 1966). This is because participants assumed that a photograph of an attractive person causes heightened arousal which in turn led to an increased heartbeat. When participants observed their heartbeat increase, they inferred that it must have been due to heightened arousal, which in turn implied that the person in the photograph was attractive. Thus, an observation of their own behaviour led participants to modify their attitudes.

In addition to observations of one's own behaviour, it has also been demonstrated that observations of one's own appearance can lead to changes in behaviour. Frank and Gilovich's (1988) paper on the effect of wearing black uniforms best illustrates the causal chain underlying this process. They were interested in whether wearing black uniforms causes athletes to behave more aggressively. In a set of four studies, they first demonstrated that blind coders rated athletes wearing black uniforms as being more aggressive than athletes wearing uniforms of other colours. In the second study, they explored whether athletes wearing black uniforms were more aggressive in actual athletic events. They analysed past records from the National Football League and the National Hockey League to show that teams wearing black uniforms received more penalties than teams wearing uniforms of other colours. We may now invoke Wittgenstein's language games as a possible framework for CVE's.

Through his articulation of language and its practice as a type of game, Wittgenstein has been both adopted and critiqued for purposes of circumscribing what are now commonly held as the necessary constituents of games. These include a games systemic nature and the acquiescence of the participants to an agreed-upon rule structure: a set of rules which Wittgenstein likens to the "grammar" of language. However, the relatively recent consideration of Wittgenstein's work as a contributor of modern game theory and its application to virtual environments is intriguing given that it was Wittgenstein who originally turned to games as a model for the dynamics, boundaries and rule-based activities of language. Wittgenstein's view of language in the *Philosophical Investigations* seems to be as an activity that involves the uses of words as tools. In this interpretation words have a multiplicity of uses. If one wants to understand the meaning of a word then one has to understand the uses to which it is put. It is confusing, therefore, to consider words as merely standing for objects. According to Wittgenstein, philosophy does not bring out theories, nor does it attempt to find objects for words as labels. A constant position in Wittgenstein's philosophy is that "philosophical problems" arise because language is misconceived, misunderstood. For him the expression "to investigate philosophically" means to attend to the uses of language and to come at a problem from numerous directions. Understanding language on the model of games, Wittgenstein asserts that games, like languages, are rule-based modes of practice that are to be considered part of their own "form of life" (1953, p. 11)<sup>8</sup>. This is not to say that "form of life" is a designation exclusive to games or even languages, but acknowledging games as being embedded within "forms of life" is undoubtedly the first step in using Wittgenstein's concept of language-games as a means to conceptually examine "virtual game play"<sup>9</sup>. Wittgenstein's detailing of language-games and forms of life supports the idea that a language-game itself is not only a culmination of words and utterances, but a meaningful activity: a practice that intones a particular organic quality and which is ontologically rooted in the dynamism of those participating. It is an activity capable of changing, evolving and growing through its very conduct. A nebulous and yet fundamental concept, "forms of life" to Wittgenstein are what

<sup>8</sup> Wittgenstein, L. (1953) *Philosophical Investigations*. Oxford: Basil Blackford.

<sup>9</sup> We are here using the term "virtual game play" to stand for game playing in CVE specifically of the types examining the role of the Proteus effect.

enable language-games to function as they do: They are the fertile soil that allow the growth and development of language-games and act as the basis from which language grows and develops. Forms of life are thus the underlying foundation for human understanding and meaningful exchanges within particular conditions and cultural contexts and thus for language-games themselves (Brenner, 1999)<sup>10</sup> (Finch, 2001)<sup>11</sup>. They are the "common behaviour of mankind" (Wittgenstein, 1953, p. 82)<sup>12</sup>.

Virtual games may therefore be viewed as being constantly protean and culturally situated phenomena rooted in action and in practice, and this notion is exemplified by Wittgenstein's allegory of the "builder's language": a series of fictional exchanges in Wittgenstein's *Philosophical Investigations*, which depict two individuals communicating with one another in an effort to build a structure from a collection of materials. Builder scenarios feature one individual who gives instructions to the other, who through a common understanding, must retrieve the appropriate materials and supply them as asked. Wittgenstein makes use of the builders' language vignettes in order to explicitly bring the resulting praxis that stems from language exchange to the fore, but he also does so to accentuate in particular how the use of language constructs and reinforces meanings within a particular language-game. To Wittgenstein, language moulds and massages the contextual reality shared by its users and it is here where the notion of epistemology begins to emerge in Wittgenstein's discussion of language-games. Language becomes the form with which we express and describe our knowledge and which subsequently reinforces it. The meanings and descriptions that become associated with words through the use of rules consequently shape conventions: the shifting rule-based foundations of language-games.

With a sense of Wittgenstein's epistemology in tow, outlining what constitutes "virtual game play" is crucial. What can we learn by mobilizing Wittgenstein's "language games" approach to epistemology as a way to interrogate virtual game play and the intentional structuring of games themselves? At first glance, as with many other processes, activities and rituals, virtual game play has its own language: its own terminologies, its own discourses, its own way of addressing phenomena within the "space" of the game, within a genre and within a method of development (i.e. programming tools).

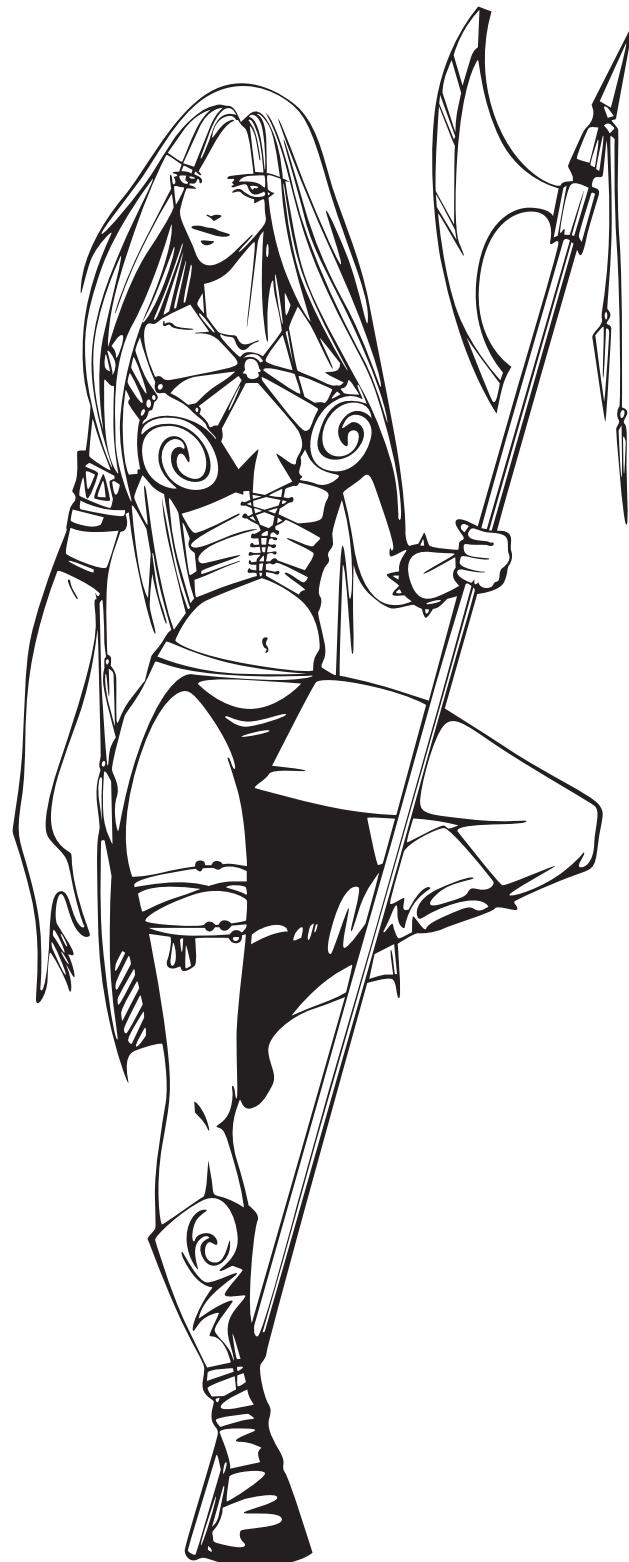
There are also the languages of play within a "virtual community": the manipulation and exchange of formal language transformed into action, the following of rules, the abidance of etiquette, colloquial banter and the development of terminology. These elements are simultaneously situated within and contribute to the very act of play: they are the languages and the activities constitutive of the language-game of "virtual game play". The idea of looking at the way which language shapes the way we speak and ask questions within any 'form of life' as outlined in Wittgenstein's example of Greek philosophy already demonstrates a glimmer of relevance to game design--but what is it that "virtual game players" are actually doing?

First, there is a literacy involved in the participation in a given domain , a kind of semiotic domain, including the linguistic and practical conventions and knowledge of the rules, signs and meanings of those signs (Gee, 2001). Secondly, we can consider semiotic domains as designed spaces, and much like Wittgenstein's language games. Gee places great emphasis on the practice that has gone into the construction of, and participation in, semiotic domains. A semiotic domain then can denote the practice of anything from "baseball" to "stamp collecting" to "stock market investing" and although Gee would note that CVE's give access to their own semiotic domains, these domains have the potential to be designed and laden with subject matter that carries with them their own set of practices and multiple modalities.

<sup>10</sup> Brenner, W. H. (1999) *Wittgenstein's Philosophical Investigations*. New York: State University of New York Press.

<sup>11</sup> Finch, H.L. (2001) *The Vision of Wittgenstein*. London: Vega.

<sup>12</sup> Wittgenstein, L. (1953) *Philosophical Investigations*. Oxford: Basil Blackford.



***"avatars with more attractive faces walked closer to each other and disclosed more information when compared to those using avatars with less attractive faces"***

Lloyd Rieber<sup>13</sup> argues that these domains, or "microworlds" as he terms them can be designed or changed and he cites the example of a child's sandbox where different elements can either be added (such as buckets, shovels) or even changed (larger buckets, differently shaped shovels).

We could adopt the phrase "virtual game player's grammar", which could refer to the rules that organize elements in a "virtual game player's space", a kind of semiotic participation space that sets the standards and rules for participation in that virtual domain. Wittgenstein describes grammar much in the same way theorists frequently describe play itself: the rules, degrees of freedom and the loopholes that support potentiality and possibility within language (Wittgenstein, 1953; Salen and Zimmerman, 2001)<sup>14</sup>. Grammar serves as the fundamental groundwork in the creation, negotiation and comprehensibility of semiotic domains. One could consider such semiotic domains as virtual communities, according to semiotician Yuri Lotman, "every culture begins by dividing the world into 'its own' internal space and 'their' external space"; this is the main function of the boundary, which he defines as "the outer limit of a first-person form" (Lotman 2001: 131). Analogously, virtual communities delimit their semiotic space through topics of interest, which can be expressed by keywords that have the function of outlining the relevant field of communication of the community, i.e. of establishing the topics members are allowed to discuss about or the way players are supposed to play the virtual game.

<sup>13</sup> Rieber, L. P. (1996). Seriously Considering Play: Designing Interactive Learning Environments Based on the Blending of Microworlds. *Educational Technology Research and Development*, Vol. 44 No. 2.

<sup>14</sup> Salen, K. and Zimmerman, E. (2004). *Rules of Play*. Cambridge, MIT Press.

<sup>15</sup> Cavagnetto, S., and Gahir, B., (2009). The Conception of the Self in Multiple Cyberworlds, paper presented at the 7th International Cyberspace Conference, Brno, Czech Republic.

Following our earlier work<sup>15</sup>, we could model the above as information content  $I_{rw}$  contributing to the formation of a personality  $P(W)$  of the player in the real world  $W$ , what Gee has referred to as the real person. If we now assume  $C_1$  to represent a virtual gaming community, a semiosphere, then we could define  $P(C_1)$  to represent the “altered” personality of the player while being immersed in such a community, being referred to above as the virtual character. The feedback of certain information from activity in the cyber-world influencing the personality of the player, eventually leading to the Proteus effect, could be described as the projective identity; this is depicted in figure 1.

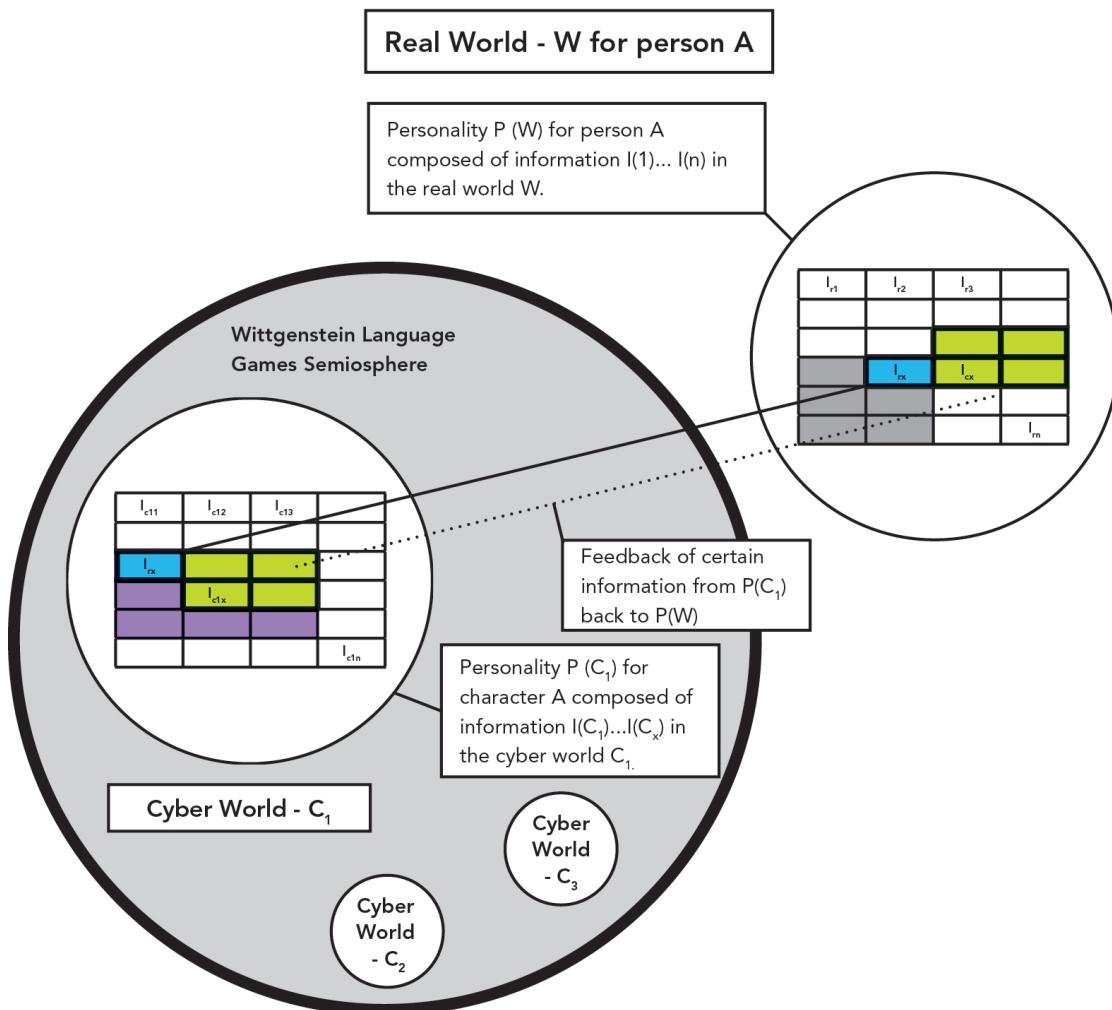


Figure 1: Depicting the analogy of personalities in cyberworlds and James Paul Gee's Identities

<sup>16</sup> Schiano, D. J. (1999). Lessons from LambdaMOO: A social, text-based virtual environment. *Presence: Teleoperators & Virtual Environments*, 8(2), 127-170.

<sup>17</sup> Day, R. E. (1999). The virtual game: Objects, groups, and games in the works of Pierre Levy. *Information Society*, 15(4), 265-272.

<sup>18</sup> Goffman, E. (1969). *The presentation of self in everyday life*. London: Penguin.

<sup>19</sup> Geertz, C. (1973). *The interpretations of culture*. New York, NY: Basic Books.

<sup>20</sup> Turkle, S. (1997). Computational technologies and image of self. *Social Research*, 64, 1093-1110.

Thus, conduct within a language-game can be conceived of as the crafting and constant refining of semiospheres that can be viewed as virtual communities with their respective virtual grammars. What Wittgenstein essentially adds to our own conceptualization of a "virtual game player's space" is the epistemological ramifications of the "grammar of play". Being thoroughly entrenched in the language of a given language-game is to be bathed in the conventions, accepted modalities and ideologies that support a way of knowing and taking part in the language-game itself.

Virtual personality, created through the transmission of knowledge and values in semiospheres, through education and virtual communities, through virtual remembrances, and through our own ideals and symbols, can therefore be viewed as more shifting, fluctuating, mobile, and protean than ever. The opportunity for social interaction in virtual communities therefore creates a sense of immersion and engagement different from anything that sensory or motor realism alone can provide (Schiano, 1999)<sup>16</sup>. Personality cues are few in the virtual world; they still exist, but in a different ways. For instance, people adjust themselves to the nuances of email addresses and signature styles. Virtual reputations are developed and maintained or challenged and blasted. By looking closely at these cues, at how they work and when they fail, we can learn a great deal about interaction within vibrant on-line environments.

From a semiotic perspective, the difference between the look and the self is important for the construction of virtual personality, taking on a new symbolic form in the virtual world. The idea that virtual identities are divergent from identities in the real world is common sense. Indeed, on the Internet, identity is occupied by an outside beyond itself (Day, 1999)<sup>17</sup>, that is, an Other, a "self" online that cannot be denied because the very existence of consciousness in the real world also implies the existence of consciousness in cyberspace, where the self takes on a different meaning and where every personality is represented rather than real. This justifies the existence of Otherness. Otherness dwells in identities and systems – both in their production of meaning and in their interpretation. Personality does not exist without meaning and interpretation, even in cyberspace. Therefore, in order to play the role of the Other, one has to produce meaning and interpretation.

However when dealing with interaction between humans and machines, individuals are confronted with a compound system of personalities, language, and (visual) communication, all of which are part of a web. Goffman<sup>18</sup> describes the web as a medium that represents a separation from previous modes for the presentation of self in everyday life (Goffman, 1969). Geertz<sup>19</sup> adds that the human being is an "animal suspended in webs of significance he himself has spun" (Geertz, 1973, p. 5). The virtual world is a world of opportunities for intrapersonal and interpersonal semiosis to occur.

Given the magnetism and power that the Internet has on our perception and on our semiotic practice, it is obvious that not only our personalities but also space and time are being modulated in the virtual world. Indeed, the traditional demarcation between image, language, and writing is beginning to move in a radical way. Virtual environments such as the Internet have the power to create personalities and enable us to explore very new forms of authorship in a way that expresses emergent meaning. These environments can be navigated, engender new forms of experience, and be modified or radically restructured. Consequently, our personalities begin to fluctuate or, more accurately, to float in that new space, a semiotic space. As a matter of fact, one of the unique qualities of the virtual environment is that it enables the web user to have a more free-floating experience of perception. In the virtual world, he or she might choose to occupy various positions that would not be possible within actual space, where the individual's identity has a physical component.

As we have seen, virtual masks and nondisclosures of identity are part of the grammar of cyberspace. Deception on the Internet, however, is not always acknowledged as such, by the receiver or the sender of the message. Philosophers like Turkle<sup>20</sup> (1997) argue that human beings are not deceptive on-line if only because they do not really become someone else (what they actually do is split their personalities into real life and on-line parts. An individual's personality, she contends, "is the sum of his or her distributed presence" (p. 110). The personality no longer simply plays different roles in different settings. Rather, the personality exists in many worlds and plays many roles at the same time (Turkle, 1997). Having multiple personalities in cyberspace is not a deception but extends the range of selves that are available, what we term as the layering effect, as depicted by figure 2. People self-fashion and self-create. They "are able to build a self by cycling through many selves" (Turkle, 1995, p. 178). From this critical perspective, there is an extension rather than a different order of existence because personality is "something complex and decentered" (Turkle, 1995, p. 20), as well as dispersed and multiplied in continuous instability (Poster, 1990). This is why we should talk about "alterity" instead of difference. The belief that individuals are unitary is itself an illusion (Turkle, 1997).

From all this, we may conclude that the boundaries between the virtual and the real are blurred, that cyberspace is a myth with its own reality and its own place (or "space"). Myth symbolizes the relationships among human beings and "real" multiple personalities. In doing so, myth establishes a rapport between communication and understanding. As Barthes<sup>21</sup> (1972) puts it so nicely: from the beginning, myth is a communication system and a message.

Thus, with these new forms of space and time, specifically in reference to cyberspace, a provocative model through which to consider the process of personality evolution is being presented. The changes of personality begin to converge under the sign of the virtual environment. We enter the nature of the real that enables the virtual, and the virtual that enables the real. Personality then becomes a flux between the virtual and real depicted by our model, a flux or, as Rheingold<sup>23</sup> (1998) suggests, a "fluid" (p. 84) in the sense that we take a fluid role in the construction of real and virtual personalities through different levels and qualities of interaction within the semiosphere and its language games. The Proteus effect therefore becomes a consequence of such fluidity within a semiosphere and since fluidity implies that something can be manipulated on the whims of its creator; it also implies fragmentation - a term of post-modern identity construction - fluidity and fragmentation therefore co-exist within the grammar of virtual games. While modernist conceptions of personality are based on the ideal of a stable, unchanging personality, post-modernism sees personality as continuously being reconstructed (Deibert, 1997). In other words, in the construction of virtual personalities, the disembodied worlds of the Internet and cyberspace seem to be a symbol of post-modernism, where many of the basic cues to personality and the social roles we are accustomed to in the physical world are absent. As a result, individuals lose their consistency, and their real lives suffer because they are living a lie and further, suspect that those with whom they communicate are also guilty of deception. (In a similar vein, individuals are in contact with people from different cultures and with people they have met only as virtual constructs). Consequently, by interacting beyond the stigma of real life, it is difficult to determine how personality is to be projected and what role it plays in our grammar of virtual games.■

<sup>21</sup> Barthes, R. (1972). *Mythologies*. New York, NY: Hill and Wang.

<sup>22</sup> The ideas presented here relating to Liminal and Liminoid states are detailed in our earlier paper, Cavagnetto, S., and Gahir, B., (2009). The Conception of the Self in Multiple Cyberworlds, paper presented at the 7th International Cyberspace Conference, Brno, Czech Republic

<sup>23</sup> Rheingold, H. (1998). *The virtual community*. New York, NY: Simon & Schuster.

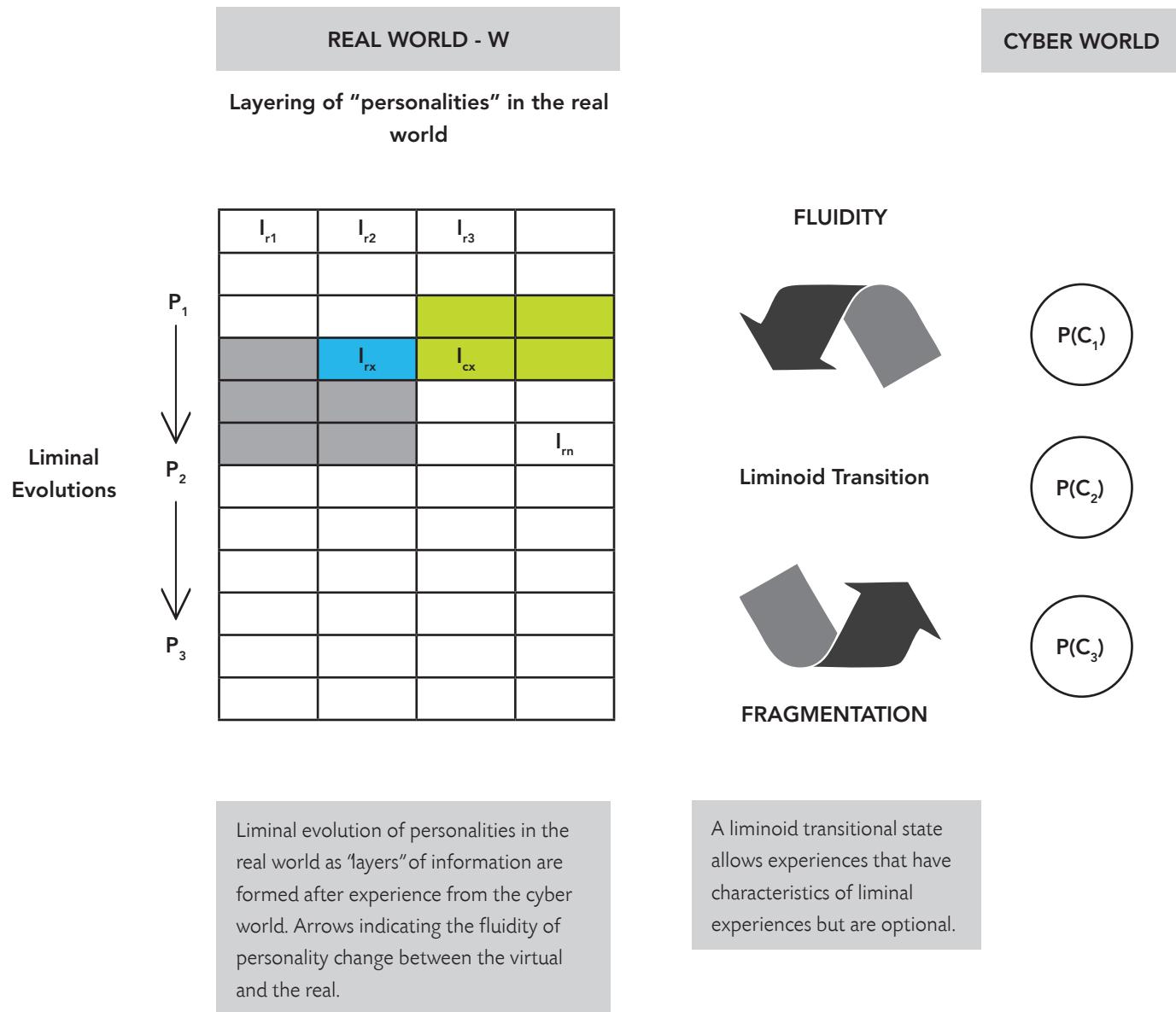


Figure 2: Illustrating the fluidity of personality and its relationship with Liminal and Liminoid States<sup>22</sup>.

— **PART II**  
**BUSINESS,**  
**ECONOMICS &**  
**PHILOSOPHY**

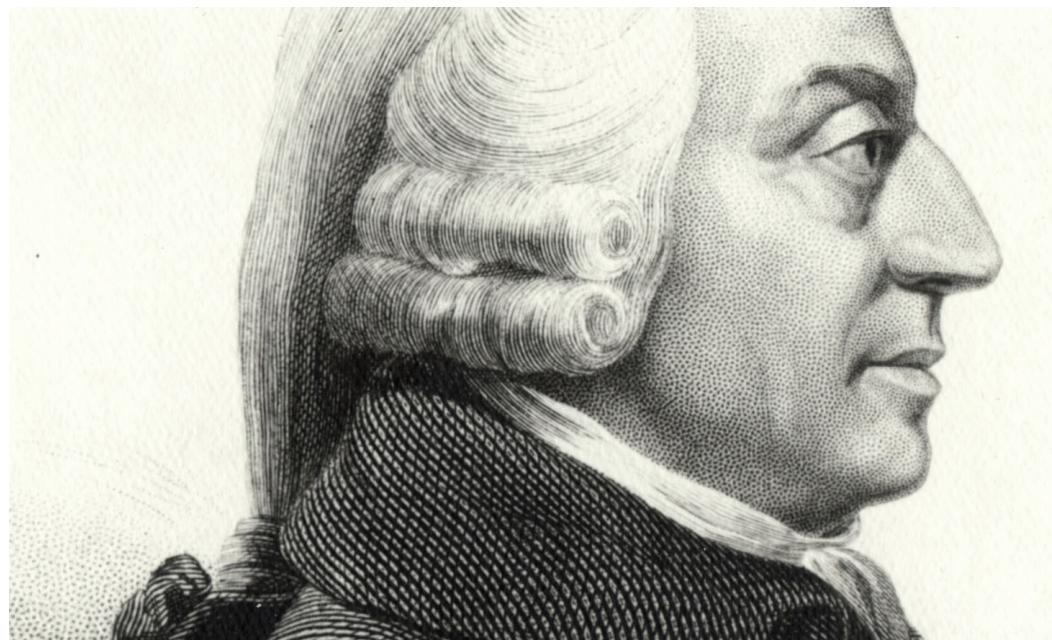
# **AN INTRODUCTION TO ADAM SMITH**

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Adam Smith was born in 1723 in the town of Kirkaldy in Scotland. He was the son of Adam Smith and Margaret Douglas. His father had died before he was born and he was raised by his widowed mother. Poverty was the acceptable norm for the majority of people in a society based on mercantilism, who had little choice in the destination of their life or their contribution towards society in the latter part of the 18th century. With local guilds dictating the production and distribution of such necessities as wool, textiles and grains, market competition did almost not exist.

Adam Smith began a course of study in moral philosophy at Glasgow University at the age of fourteen in 1737. He was profoundly influenced by a famous philosophy lecturer and philosopher named Francis Hutcheson and by living in a Glasgow that was at the centre of the so-called 'Scottish Enlightenment'. Adam Smith graduated in 1740 having been chosen for a prestigious scholarship which facilitated his heading to study at Oxford University's Balliol College.

At Oxford Adam Smith incurred in the university authorities disappointment because of his taking an approving interest in the philosophical works of David Hume. David Hume was held by influential opinion at Oxford University to be guilty of promoting an "atheistic" philosophy. As a result of the situation, Adam Smith relinquished his scholarship in 1746 and returned home to base himself in Edinburgh. Back in Edinburgh, Adam Smith moved in intellectual circles and gave a number of public lectures that brought him to the attention of the wider intellectual public such that at the age of twenty-eight he became Professor of Logic at Glasgow University in 1751. Shortly thereafter, in 1752, Adam Smith secured the more richly rewarded professorial chair of Moral Philosophy at the University of Glasgow.



Smith was a reserved and absent minded individual much inclined to enjoy the books in his own library and continuing to live in the same house as his ageing mother. He acquired a great reputation as an interesting and animated lecturer. In this he was perhaps aided by following Francis Hutcheson in giving his own lectures in English rather than the previously more expected scholarly medium of Latin. In his spare time Adam Smith had opportunities to meet with many influential persons in intellectual and business circles in a city still under the influence of the "Scottish Enlightenment" and which even had its own Political Economy Club.

In 1759 a major work by Adam Smith entitled *Theory of Moral Sentiments* attracted much attention even beyond British shores giving him an intellectual reputation in foreign countries such as France and Germany. Adam Smith's enhanced reputation resulted in his being able, in 1763, to resign from the University of Glasgow to take on the very well paid role of private tutor. This role also offered him the possibility to travel across the continent for several months.

As tutor Adam Smith found that he had much time to himself and seems to have embarked on what was to become his influential masterpiece *An Inquiry into the Nature and Causes of the Wealth of Nations*, in 1764 (often called simply *The Wealth of Nations*).

During his travelling in Europe, Adam Smith met intellectuals such as Voltaire, several economic theorists such as Quesnay and economic administrators like Turgot and Necker. After his service as a tutor to the Duke of Buccleugh, Adam Smith was awarded with an annuity. He then returned to Scotland to his native town and occupied himself in study and writing up his *An Inquiry into the Nature and Causes of the Wealth of Nations* then published in 1776. In 1777 he was named lord rector of the University of Edinburgh and in 1778 was appointed as commissioner of customs in Scotland. This post was well paid and Adam Smith even contacted his former aristocratic pupil volunteering to relinquish the annuity that he had been awarded. In the event, however, the young nobleman preferred to continue with the annuity. He passed away on the 17th of July, in 1790, at Edinburgh and was buried some days later in that city.

Smith's work has been influential in several areas such as political and moral philosophy and economics and has been a seminal source for more than two centuries. He therefore deserves to be regarded as one of the most dramatically influential philosophers and thinkers of modern times.■

# ADAM SMITH WITHOUT HOMO ECONOMICUS

SERGIO CREMASCHI

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## ABSTRACT

Starting with a reading of Adam Smith's oeuvre that I have sketched in previous papers, I discuss first the reasons why the 19<sup>th</sup> century mythology of homo economicus involved Adam Smith and Bentham in a constellation named 'utilitarianism' made of individualism, harmony of interests, hedonism, rationalism. Secondly, I try to reconstruct the main lines of Adam Smith's philosophy of action, stressing the role of imagination, deception, and limited rationality. I argue that the limits-to-knowledge thesis plays an essential role not only in Smith's epistemology, ethics, and natural theology, but also in his philosophy of action. In more detail, I argue that according to Smith action is prompted by limited knowledge of future events while the full knowledge of a (fully) ideal spectator would make choice and action impossible. Thus, Smith's agent, even when he is not irrational, is steered by passions, sentiments, a degree of sympathy, self-interest (with limited knowledge of the real character of one's own interests), and blindness to remote consequences. Thirdly, I discuss in this light the figures of the prudent man and the wise man. Fourthly, I try to shed light, on the basis of Adam Smith's philosophy of action, on his characterization of landlords, labourers, merchants and manufacturers, and people in the middling ranks.

## THE MYTH OF HOMO ECONOMICUS<sup>1</sup>

John Stuart Mill first declared that "political economy does not treat the whole of man's nature" but instead man "solely as a being who desires to possess wealth, and who is capable of judging the comparative efficacy of means for obtaining that end... It makes entire abstraction of every other human passion or motive in acquiring and consuming wealth"<sup>2</sup>.

The English term *economic man* showed up if not the first time at least one of the first times in John Kells Ingram with reference precisely to Adam Smith, who allegedly "consciously, though tacitly, abstracted from the benevolent principles in human nature, and as a logical artifice supposed an ' economic man' actuated by purely selfish motives":<sup>3</sup>. Henry Sidgwick introduced a distinction between the *economic man* as a maximizing agent understood as the result of an abstraction carried out for explanatory purposes and axiological individualism understood as a sort of prescription . He argues that the proposition according to which the best possible result will be attained if the individual is left free to regulate his own activities for the supply of his own wants does not follow from the proposition according to which "the ' economic man' – that is, the human being that Political Economy assumes to be normal – always prefers a greater apparent gain to a less, and prefers to attain any desired result with the least possible apparent expenditure"<sup>4</sup>, and that these two propositions 'belong to entirely different departments of inquiry – the first gives information as to what happens, without pronouncing whether it is good or bad; the second judges that what happens or would happen under certain conditions is the best thing that could happen'<sup>5</sup>.

Alfred Marshall used the phrase just in order to disclaim that such an abstraction may be what economists are talking of, who consider instead "man in flesh and bones" in his full complexity albeit while considering activities where selfish motives play a prevailing role<sup>6</sup>. The Latin phrase was introduced by Vilfredo Pareto who argued that it points at an entity that "is neither more nor less real than the mathematician's lines and surfaces, the mechanician's or astronomer's material points, the chemist's absolutely pure bodies, the naturalist's types, etc. [...] If you are to do something valuable, you have to abstract, separate, and take into account non-real entities such as lines and geometrical surfaces"<sup>7</sup>. If you want to work out a true economic theory, you should as well abstract, separate, and take into account a non-real entity such as *homo economicus*<sup>8</sup>, for any study of concrete phenomena is bound to proceed by analysis and abstraction, by insulation of certain proprieties and their study, with the final result of a system of "successive approximations".

*Homo economicus*, understood in Pareto's terms, has become a matter of course for mainstream twentieth-century economic theory. It is the model of a rational agent who has a complete and consistent ordering of preferences, full information and unlimited computing capacities. In so far as preferences are the agent's own preferences and they are not influenced by other agents's preferences, such a rational agent is an "egoist"<sup>9</sup>.

Critics of political economy, romantics, evangelicals, socialists, and members of the German Historical School, ascribed this abstract rationalist-selfish view of human nature to the Classical School as a whole. The German Historical School's claim was that the Classical School's assumptions were 'atomism' and 'egoism'. Indeed what they actually did was mix up some Adam Smith with a bit of Malthus and lots of Bentham (taking only the Hobbesian psychology and missing the meaning of Utilitarian ethics as ethics of benevolence) in order to cook up an odd doctrine named most of the time *Utilitarismus*, resulting from a sum of individualism, selfishness, the doctrine of the harmony of interests, hedonism, rationalism (that is, as an anthropological doctrine, undervaluing of sentiments, as a methodological doctrine, undervaluing of history). This spectre is haunting Europe since one and half a centuries and it has not completely vanished. Obviously enough, ascribing such views to Adam Smith, the putative founder of the classical School, meant paying the price of ascribing anti-historical ' rationalism' to the father of the four-stages theory and a selfish doctrine to the proponent of an ethics of sympathy. This was the starting-point of the *Adam Smith Problem*,

that is, the problem of reconciling the 'selfish' doctrine of 1776 with the 'altruistic' doctrine of 1759. All this was a problem created out of nothing, since there is nothing to reconcile, provided that nowhere does *The Wealth of Nations* endorse egoism and, quite to the contrary, it makes rather heavy irony about, or occasionally vehemently denounces, greed and avidity, which it assumes to have been the constant mark of merchants and master-manufacturers, slave-owners, and more in general the rich and the powerful. Read the following:

All for ourselves and nothing for other people, seems, in every age of the world, to have been the vile maxim of the masters of mankind<sup>10</sup>. And ask yourself whether this sentence could have come out of Richard Godwin's, Gracco Babeuf's, or Michail Bakunin's pencil.

### THE WEALTH OF NATIONS AS EMPIRICAL SCIENCE OR AS MORAL PHILOSOPHY

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In a phase previous to the 1976 Adam Smith renaissance, the phase of the logico-empiricization of Adam Smith, William Grampp noted that in the 19th century Adam Smith's idea of economic motivation had been under attack for the three following reasons: (i) he was believed to assume that men were invariably rational and that their rationality was centred on achieving fixed economic desires; (ii) he was believed to have assumed that men were governed by a superhuman power, the natural law or the invisible hand, in their relentless conquest of income and in their accumulation of wealth; (iii) he was believed to have assumed that the outcome of such a behaviour was a highly desirable state of affairs. From the above assumptions the image derived of a homo economicus is more similar to an ogre than to a man, and Adam Smith himself was assumed to have endorsed such an image of the economic agent<sup>11</sup>. What Grampp and his contemporaries had to offer in terms of alternative interpretations was not much more plausible. In fact their 'discovery' was that Adam Smith could not be charged with being a dogmatic metaphysical social theorist as it had been the fashion to do in the nineteenth century because he had emancipated himself from metaphysics between 1759 and 1776 while shifting from 'natural law' to empiricism. *The Wealth of Nations*, according to this view, is an empirical social theory<sup>12</sup>.

An even more strange result is derived from the following move. This was made by Thomas Campbell who argued in the early seventies that not only *The Wealth of Nations* but also the *Theory of Moral Sentiments* could be read as empirical theories – even one based on Popperian methodology – and accordingly it was, more than philosophical ethics, an exercise in empirical social psychology<sup>13</sup>.

More sensible views started being spread at the times of the Adam Smith Renaissance, that is, in the Seventies when the Glasgow edition of his works started appearing and there was an increasing flow of secondary literature. For example Ronald Coase recognized that there is no decisive reason for assuming that Smith's view of human nature changed from 1759 to 1776 and concluded that 'it is wrong to believe, as is commonly done, that Adam Smith had as his view of man an abstraction, an 'economic man' rationally pursuing his self-interest in a single-minded way'<sup>14</sup>.

The idea that the view of human nature in both Smith's works is basically the same is not tantamount to the claim – adopted by David Raphael and Alec Macfie – that the *Theory of Moral Sentiments* presents Smith's view of human nature in full while *The Wealth of Nations* starts with a reduced number of hypotheses<sup>15</sup>. This is the 'containment' view, which has been criticized effectively by Lawrence Dickey<sup>16</sup>. In fact – I would add – the *Theory of Moral Sentiments* is not a more general theory of human nature meant to 'contain' the theory in *The Wealth of Nations* but a practical system of morality built precisely on so restricted a number of assumptions as could eventually not be denied even by the sceptic, namely on the fact that 'however selfish man may supposed to be"there is evidently in him some principle (no matter what its eventual nature)

that makes him interested in his fellow-beings lot<sup>17</sup>. Adam Smith does not believe in the real possibility of working out an abstract theory of human nature. He was ‘more concerned to vindicate our common-sense picture of human nature against various challenges than to offer an alternative to that picture’<sup>18</sup>. In more detail, on my interpretation, the *Theory of Moral Sentiments* works out just a theory of sentimental moral judgements meant to show how, even granting the sceptics all they contend for, yet it is possible to show a general and constant system of spontaneous reactions to human behaviour is spontaneously generated, so that it may act as a token for a system of natural laws<sup>19</sup>.

### ADAM SMITH ON HUMAN ACTION

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I suggest that a way out of interpretative problems may be found travelling the most obvious path. This path is the following: keeping in mind that Adam Smith was neither a forerunner of twentieth-century empiricism nor one more system-builder like the Cambridge Platonists, but just a new kind of post-rationalist and post-sceptical philosopher. Not unlike his near-contemporary Kant, he was trying to find a third way in epistemology, ethics, and politics that could yield minimal but hard to refute conclusions that could partly satisfy the rationalist and could force the sceptic to be on the defensive.

His general claim is that we cannot have any direct access to the principle Nature employs in connecting the phenomena we observe, we cannot formulate any ultimate criterion based on reason in order to distinguish virtue from vice, and we cannot establish ultimate and unchanging principles of law and government. We are constantly deceived in believing that we have lifted the veil of Nature’s secrets or have reached a firm ultimate ground in any field, since we are unavoidably the victims of deception. And yet this is not tantamount to scepticism, since deception is necessary in order to make life possible, and, even without a sure foundation there are more and less plausible accounts of natural phenomena, there are sensible – albeit not so systematic as we would like – political doctrines, and there are quite obvious and evident moral judgments, even if ethical systems may be more or less baffling<sup>20</sup>.

Both in our knowledge of the natural world and in our moral knowledge, imagination plays a basic role; indeed what we call reason is just an ability of grouping phenomena into sets on the basis of similarities and analogies, and of filling up gaps into the series of phenomena by creating imaginary connecting links through transfer of more familiar ideas (the invisible hand itself is a most typical example of such a link)<sup>21</sup>.

Smith’s philosophy of action stresses the role of imagination, deception, and limited rationality. The reasons lie in his overall epistemology. In fact, the limits-to-knowledge thesis, an essential item of his anti-sceptic and anti-systematic strategy, plays an essential role not only in epistemology, ethics, and natural theology, but also in his view of human action. In more detail, action is prompted by limited knowledge of future events while the full knowledge of a (fully) ideal spectator would make choice and action impossible. In the following passage Smith provides the reasons why any rationalist system of ethics is self-defeating. He writes:

The ancient stoics were of opinion that as the world was governed by the all-ruling providence of a wise, powerful, and good God, that every single event ought to be regarded, as making a necessary part of the plan of the general order and happiness of the whole: that the *vices and follies* of mankind, therefore, made as necessary a part of this plan as their wisdom or their virtue: and that by the eternal art which educes good from ill, were made to tend equally to the *prosperity and perfection* of the great system of nature. No speculation of this kind, however, how deeply soever it might be rooted in the mind, could weaken our natural abhorrence for vice, whose immediate effects are so destructive, and whose remote effects are too distant to be traced by the imagination<sup>22</sup>.

Thus, unavoidable limits and distortions in our vision are a precondition not only for human folly and wickedness but also, happily enough, for moral reactions, that would turn impossible were we endowed with too far sighted vision and were such vision able to motivate us. Thus, Adam Smith's agent, albeit not simply irrational, is steered more than by reason, by passions, sentiments, a degree of sympathy, self-interest (with limited knowledge of the real character of one's own interests), and blindness to remote consequences.

There is a number of principles of human nature that play a function in several fields, ranging from religion, knowledge of nature, art, morality, money and commerce. Principles are basically the same in all fields, but Adam Smith never provides a list of such principles. As a fact, he never intended to spell out the "science of human nature" that Hume had tried to sketch out in his *Treatise of Human Nature*. One reason was that Smith believed that we never meet human nature as such in a void, since our basic capacities are modified, developed or hindered by circumstances or by our prevailing activities, the other is that Smith differs from Hume more deeply than received wisdom assumes in so far as he is a critic of Hume's naturalism in both senses of a primary and unchanging character of common sense and of a reduction of ethics, epistemology etc. to sub-chapters of an empirical science of human nature<sup>23</sup>. On the contrary, Smith does not need a full-fledged science of human nature because he does not need a 'foundation' for ethics and epistemology. And he can do without it for the reason that in both fields, and indeed in every field, he may avail himself of semi-transcendental arguments like the one that has been illustrated with regard to the 'foundation' of our abhorrence for vice.

There are indeed, in Newtonian jargon, "original qualities" of human nature, but we do not need to account for observed phenomena on these qualities, since there are 'principles', whose ultimate nature is still under discussion but that we may take as corroborated through observation and thus take as legitimate principles of explanation.

The principles of human nature at work in *The Wealth of Nations* are the following:

- a) the propensity to truck and barter,
- b) a desire of bettering our condition,
- c) self-interest,
- d) the selfish passions (basically distinct from the former, which is calm and predictable, while the latter are wild and irregular),
- e) a sense of justice,
- f) a sense of dignity or a desire for equality,
- g) a sense of liberality and humanity.

Smith has recourse to such principles as hypothetical causes of phenomena<sup>24</sup>, that is, he assumes them as principles or hypotheses to be corroborated by observation, not as arbitrary conjectures whose validity should be assumed a priori, independent from facts, like the infamous unverifiable "conjecture" of vortexes in Cartesian physics<sup>25</sup>. These principles are perhaps original qualities or perhaps only schemes of regular behaviour that can be reduced to more basic mechanisms and can be detected behind human behaviour in other circumstances. They make for a system of principles that can perhaps be reduced to those principles of human nature that are mentioned in the *History of Astronomy* and the *Theory of Moral Sentiments*. The main preoccupation is not producing a unified science of man, which would be useless were it possible – but instead in introducing principles that are corroborated by experience and may help in accounting for human behaviour when facing work, money, and wealth. Let me remark that the intermediate character of the principles is made explicit in the *Lectures on Jurisprudence*, where Smith declares that the propensity

to truck and barter is a result of the action of basic principles of the human nature such as the faculties of reason and speech<sup>26</sup>. In *The Wealth of Nations* he declares that the ongoing investigation was not the right place and time for inquiring whether this propensity is a last principle of the human nature or something that is possible to analyse into more basic principles<sup>27</sup>.

This remark is a kind of "*hypotheses non fingo*" clause not unlike Newton's, by which Smith intends to stress the hypothetical status of the principles on which the theory is based. Let me note that the same reduction is possible also, for example, for desire to improve our condition, that can be reduced to the imagination and sympathy, since we wish those goods that make so that others envy ourselves<sup>28</sup>.

### EVERY MAN A MERCHANT

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In a commercial society, that is a society where the division of labour has taken place to a considerable extent and money is the normal means for carrying out most exchanges, there is one feature that marks all the members of society, namely "every man thus lives by exchanging, or becomes in some measure a merchant". Commercial society, and every man's character as a merchant, arises out of the institution of money. The latter arises in turn out of one "principle of human nature", namely "the power of exchanging"<sup>29</sup> which is probably the same as "the propensity to truck and barter" mentioned in the *Lectures on Jurisprudence*. Let me recall that this propensity, and intermediate principle, derives probably from the faculty of language, as I discuss in what follows. One more trait of human nature lies at the root of the institution of money (an unintended result; let me note): prudence. Every "prudent man" in a society where exchange is governed by barter learns how expedient it is to keep a certain amount of those commodities that may be more easily exchanged, cattle, or silver and gold.

An interesting remark in the *Lectures on Jurisprudence*, omitted in *The Wealth of Nations*, which makes Smith look like a follower of Max Weber, is that commerce carried "probity and punctuality", characteristics that do not derive by nature, or by national character, but from habit, which in turn derives eventually from "self interest, that general principle which regulates the actions of every man"<sup>30</sup>. Is there a reason for that omission? One suggestion could be that Smith had become more and more sceptical about the beneficial effects of commercial society and, toward the end of his career was, more than an apologist of Capitalism – what he never was actually – a radical critic of the evils carried by commercial society<sup>31</sup>. Yet, there are two sides of the coins, and while Smith had always been aware of the dangers of corruption, and he had even become more aware of those dangers toward the end of his career, he still was keeping in mind a view of moral advantages carried by the growth of civilization, and his preoccupation was at most that on balance gains would not be overwhelmed by losses<sup>32</sup>.

Let us consider the most often quoted sentence by Smith, the so-called 'self-interest axiom'. In his first work Smith declares that 'every man is, no doubt, by nature, first and principally recommended to his own care'<sup>34</sup>. In the second work the claim that we may normally expect our lunch from the butcher's and the baker's self-interest and this is a more reliable way than appealing to their benevolence<sup>35</sup> is introduced as a plausible generalization, holding within a certain context, namely that of a "civilized" or "commercial" society. Here an individual comes into relationships with hundreds of his fellows, and we cannot expect that intercourse between different individuals be regulated by benevolence); man has not time enough to behave upon every occasion as a dog who tries to obtain food from his master. 'In civilized society he stands at all time in need of the cooperation and assistance of great multitudes [...] it is in vain for him to expect it from their benevolence only. He will be more likely to prevail if he can interest their self-love in his favour'<sup>36</sup>.

**To sum up, one particular version of the propensity to truck and barter , that is, a propensity to sell and buy goods and services by means of money, seems to be the sole peculiar and generally shared characteristic of economic agents in commercial society. Besides, there is number of peculiar characteristics of four basic different groups.**

Before going into a reconstruction of cognitive and communicative attitudes peculiar to members of each social group, it may be useful to repeat that for Smith human nature cannot be investigated in a void and that such an investigation if possible would be disappointing. One reason is that it could teach us little about the origins of men's attitudes. Intellectual characteristics of human beings depend on circumstances and 'the difference of natural talents in different men is, in reality, much less than we are aware of; and the very different genius which appears to distinguish men of different professions, when grown up to maturity, is not upon many occasions so much the cause, as the effect of the division of labour'<sup>87</sup>. A philosopher and a street porter differ from each other because the different occupations during the whole of their lives, "habit, custom, and education", have developed different qualities<sup>88</sup>, since "the understanding of the greater part of men are necessarily formed by their ordinary employment"<sup>89</sup>.

**Nowhere in the *The Wealth of Nations* do we meet unchanging human nature. For none of these social groups human nature is that of a rational self-regarding maximizer of wealth. And finally, no overall harmony of interests is produced by interaction of rational and selfish wealth-maximizers.**

One important remark is that Smith's description of the characteristics of different social groups is by no means a result of untutored experience. Smith is sketching a tentative sociology of knowledge based on hypotheses taken from his toolbox, that is, his 'hidden' doctrine of human nature. In different groups, such as merchants, clergy, country gentlemen, manual labourers, and philosophers, general principles such as pleasure and pain, association of ideas, imagination, sympathy come into action in different ways according to varying circumstances. And these different groups come to interact with each other in different ways due to complementarity of opposed characteristics they have developed.

## THE QUADRANGLE OF COMMERCIAL SOCIETY

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The characteristics of those Smith believes to be the four main classes in commercial society seem accordingly to diverge. I will discuss now Adam Smith's reconstruction of the characters of (i) farmers, (ii) landlords, (iii) mechanical labourers, (iv) merchants and master manufacturers.

### PLOUGHMEN, FARMERS, AND LANDLORDS

Both farmers and their subordinate labourers, "ploughmen", are more similar to people living in the rude and early state of society<sup>40</sup>. They have occasion for observing a comparatively wide number of different situations and for carrying out a comparatively wide amount of operations, and this makes their understanding much more developed than that of mechanical workers. 'The common ploughman, though generally regarded as the pattern of stupidity and ignorance, is seldom defective in his judgement and discretion'<sup>41</sup> as are required by the variable condition of the materials which he works upon as well as that of the instruments which he works with. Both farmers and country gentlemen are well-disposed to favour the cultivation of their neighbours' farms, and they have no secrets, but "are rather fond of communicating to their neighbours [...] any new practice which they have found to be advantageous"<sup>42</sup>.

Landholders are greedy people, but they are so to the same extent as human beings in general: "like all other men", they "love to reap where they never sowed"<sup>43</sup>. Their condition, more than that of the merchants, seems to encourage liberality, but it also encourages ignorance; indeed their ignorance goes along with spendthriftiness and with "conceit of superior knowledge"<sup>44</sup>. Apparently their indolence "which is the natural effect of the ease and security of their situation" carries ignorance, and both make them "incapable of that application of mind", which would be required to understand the interest of society and even their own true interest. Thus, even if their true interest would be coincident with that of society they would not be able "to foresee and understand the consequences of any public regulation"<sup>45</sup>. Note that lack of mental application is caused by ease and security for landholders, but it is occasioned by an opposite situation in the case of labourers.

### MERCHANTS AND MASTER MANUFACTURERS

It has often been remarked in the post-1976 literature that the putative father of capitalism did not love "merchants" and "master manufacturers" or "those who live by profit"<sup>46</sup>. This class of people had – not unlike the clergy<sup>47</sup> – the opportunity of receiving an education, and then of exerting their minds in a variety of occupations. Thus they do not suffer from the disadvantages of mechanical workers and even of those of country gentlemen. They do not suffer intellectual disadvantages, arising from indolence and lack of occasions to learn, but suffer – not unlike the clergy – from moral disadvantages. They tend to be reliable on judgements concerning their own interest, but unreliable on judgements concerning the public interest: "their judgement, even when given with the greatest candour (which it has not been upon every occasion) is much more to be depended upon with regard to"<sup>48</sup> their own interest than the public interest. This class is the one from which "projectors" come: they are engaged most of their lives with their "plans and projects"; as a consequence "they have frequently more acuteness of understanding than the greater part of country gentlemen" not so much in their knowledge of the public interest, as in their having "a better knowledge of their own interests than he has of his"<sup>49</sup>.

The problem with this class is that they have generally "an interest to deceive and even to oppress the public"<sup>50</sup>. Being collected into towns and accustomed to an "exclusive corporation spirit"<sup>51</sup>, they tend to be subject – like the clergy – to a narrow spirit of monopoly from which country gentlemen and farmers tend to go exempt – except a contrary instance in England where also country gentleman tend to follow the bad example provided by merchants<sup>52</sup>. This spirit has been elevated by their "clamour and sophistry" into political maxims; thus "nations have been taught that their interests consisted in beggaring all their neighbours" and commerce instead of "a bond of union and friendship" as Smith, echoing Montesquieu's lesson, believes it naturally should be, has become "the most fertile source of discord and animosity"<sup>53</sup>.

Both merchants and clergymen, being the two social groups who enjoy better understanding and greater chances of communication, tend to develop an alliance with the social group that has the lowest degree of understanding, the mechanical labourers. It is the private interest of the clergymen like the private interest of the merchants what lies at the root of the public's prejudices, and it is monopoly in both fields what has turned both religion and commerce into the arena of superstition and folly<sup>54</sup>.

### MECHANICAL LABOURERS

For labourers the division of labour, which makes monetary exchange and commercial society possible and carries as a consequence a satisfactory provision of goods that makes so that a mean labourer is better provided with goods than the king of savages, also carries an undesirable consequence. Division of labour carries repetitive operations by the worker, and lack of occasions of exerting his understanding, and thus stupidity and ignorance.

This is what makes so that labourers in the most developed societies, such as the Netherlands, or England more than Scotland become "as stupid and ignorant as it is possible for a human character to become"<sup>55</sup>. They are incapable of joining any "rational conversation", unable of any noble and delicate sentiment, not in a position to form any "just judgement concerning ordinary duties", not to mention the "great and extensive interests of his country"<sup>56</sup>. In less developed societies there is a good deal of variety in "the occupations of every individual, there is not a great deal in those of the whole society", and as a consequence every man may develop a greater amount of mental capabilities, even if nobody cannot acquire that "improved and refined understanding which a few men sometimes possess in a more civilized state"<sup>57</sup>. In agriculture, since the division of labour cannot go as far as in manufactures, the workers are in a much better position<sup>58</sup>. It may be noted yet that – notwithstanding those negative effects of the division of labour – mechanical inventions may have been made by labourers in order to spare work as well as by philosophers who are accustomed to see connections between unconnected appearances<sup>59</sup>.

The mental mutilation of which the labourer suffers carries inability of understanding his interest, as well as the connection with that of society as a whole<sup>60</sup>. In order to develop these capabilities and understand his own true interests he would need more time to receive required information, and more education in order to handle this information properly, and proper habits that would make him able to judge in a better way. Thus, in public affairs his voice is little heard of "except upon some particular occasions, when his clamour is animated, set on, and supported by his employers. Not for his, but their own particular purposes"<sup>61</sup>.

### PEOPLE IN THE MIDDLING RANKS OF LIFE

As such, no social class may be relied upon as the natural carrier of the appropriate response to the challenge of commercial society. Ease as such is not enough to obtain both intellectual abilities and moral qualities as would be required. What is required, besides ease, education, opportunities for accumulating the right kind of experience, is probably also the constant "conversation" with other human beings. Those who come closer to enjoying all these assets are probably those who spend their life in towns and exert the liberal professions, who enjoy the benefits of education, leisure, and varied occupations and do not suffer the disadvantages suffered by landholders and merchants. Smith does not put forth any claim concerning a possible function of such people, but what he seems to have in mind when he contrasts the intellectual abilities of the common people in a civilized and commercial society with those of "people of some rank and fortune"<sup>62</sup> is that this group may provide a public space where conversation may develop and, most of all, a mirroring effect may take constantly place where the man of government may feel himself exposed to the eye of public opinion and sophistic arguments manufactured by the clergy as well as by merchants and master manufacturers may be constantly unmasked.

Thus, society may be described in terms of a quadrangle where four groups are defined by their ability to understand and their disposition to communicate as follows:

- a) Ploughmen understand a little, farmers understand something, landlords understand less than famers; farmers and landlords tend to communicate;
- b) Manual labourers do not understand and do not communicate;
- c) Merchants and master manufacturers and the clergy do understand but do not communicate;
- d) People in the middling ranks of life do understand and do communicate<sup>63</sup>.

## ABOVE THE QUADRANGLE: LEGISLATORS AND PHILOSOPHERS

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While in a rude society everybody "has a considerable degree of knowledge, ingenuity, and invention; but scarce any man has a great degree. The degree, however, which is commonly possessed, is generally sufficient for conducting the whole simple business of the society"<sup>64</sup>, in "a civilized state, on the contrary, though there is little variety in the occupations of the greater part of individuals, there is an almost infinite variety in those of the whole society. These varied occupations present an almost infinite variety of objects to the contemplations of those few, who, being attached to no particular occupation themselves, have leisure and inclination to examine the occupations of other people"<sup>65</sup>. As a result, "their understandings" become "in an extraordinary degree, both acute and comprehensive". These, that is, "philosophers", may afford better comprehension of the collective interest than anybody else, and represent themselves a peculiar asset, which a civilized society may enjoy. Yet, "their great abilities, though honourable to themselves, may contribute very little to the good government or happiness of their society".

In order to obtain this result, society needs a legislator, or a man of government who is so enlightened to place them "in some every particular situations"<sup>66</sup>. It is important to remind that philosophers are hardly a social group, and that on the contrary they come from different social groups<sup>67</sup>.

Legislators in turn do not belong to the above description of society. Smith's quadrangle describes in a sense what was typically called after him "civil society" as contrasted with political society. Needless to say, in the Scottish enlightenment this opposition had not yet appeared and civil society was still contrasted with a society devoid of legal and political institutions as well as of politeness or refinement. Yet the dichotomy is there, without the terminology to point at it, and the world of the state is for Adam Smith a world living its own life, over and above the life of civil society. The politician, the man of government, and the legislator are different characters available to people from upper ranks, that is, from the aristocracy. The man of public spirit he contrasts with the man of system, who can aspire to assume the noble character of a "reformer and legislator", displaying "wisdom"<sup>67</sup>, is not the philosopher and is not a member of middle ranks but a member of the aristocracy, one who is called by birth, in the circumstances of the time, to carry out such a task. In other words, no less than *the economic agent*, also *the political actor* is absent from Adam Smith's picture. Society is the framework for action by classes and social groups, not individuals, and it is an ironic story the one that saw Smith enthroned the father of modern economic individualism.

## CONCLUSIONS

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### **The above reconstruction may give some support to the following claims:**

1. Adam Smith's views may be consistently understood, in all of his oeuvre, only when read as those of a post-sceptical thinker, who concedes almost everything the sceptic contends for on human knowledge, human rationality, and the deceptive character of human goods; he is a post-sceptical thinker not only about human rationality and the goodness of human nature, but also in his own theory of human nature; that is, he is always working with a set of hypothetical "principles" of human nature, which he does not believe them to be ultimate and unchanging; Smith's views on human action in general focus on a tension between two opposite poles: truth without action and action prompted by deception;

2. Smith's human being is not a maximizer, since he is not rational enough to conduct his own action on the basis of calculations; he is not selfish enough to direct his conduct on the basis of some good he would like to maximize; when taken at his best in terms of knowledge and rationality, he tends to sympathize with the whole world, and accordingly not to judge and not to act; when taken at his worst, he tends to attach excessive weight to others' sympathy, and accordingly to attach undeserved worth to deceptive goods, such as power, honour, wealth;
3. Smith argues that in a complex society such as commercial society, social groups tend to develop opposite, and indeed symmetric, characteristics in matters of knowledge and virtue; such a society (unlike the 'panoptical' Benthamite society where everybody is a maximizer of happiness, and there is accordingly a shared currency against which social losses and gains may be measured) faces the predicament of precarious coexistence between diverging patterns of behaviour, which may afford positive contributions to social life as well as originate destructive tendencies; in commercial society everybody is up a degree a merchant and this should not be deprecated, since it allows for equalitarian relationships and creates "moral canals" of reciprocal trusts between strangers, which are only possible in a society where relationships of personal dependence are limited; on the other hand this circumstance is dangerous, in so far as it tends to promote greed, vanity and corruption;
4. Existence of a remarkable amount of people in the middling ranks of life provides an asset for facing the predicament of commercial society and fighting corruption, since this group may provide a public sphere where communication and mirroring may take place, thus creating counterbalances to losses carried by commercial society; the man of public spirit, the would-be legislator, has much to learn from the philosopher, and yet he is not a philosopher himself nor is he not a member of the middling ranks; his destiny yet is bound to that of philosophers on the one hand and of people in the middling ranks on the other, in so far as philosophers may provide useful advice, and the middling ranks only may create that public space where mirroring effects may carry out an indispensable function in steering – by action at a distance – the conduct of the man of government.

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# GAME THEORY AND ITS APPLICATIONS TO ETHICS

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The value of advancing game theory to understand ethical behaviour seems clear: it is widely agreed that game theory has become one of the cornerstones of the social sciences (Hargreaves Heap and Varoufakis, 1995). There are widespread claims that it "provides solid micro-foundations for the study of social structure and social change" (Elster, 1982), and that it "may be viewed as a sort of umbrella or 'unified field' theory for the rational side of social science" (Aumann and Hart, 1992). More recently, Gintis (2000) has stated that "game theory is a universal language for the unification of the behavioural sciences". Even in the biological sciences it has been argued that some game theoretical concepts represent "one of the most important advances in evolutionary theory since Darwin" (Dawkins, 1989).

However, while extremely informative, game theory is at present somewhat limited in the sense that it is dominated by assumptions of full rationality, it generally ignores the dynamics of social processes, and it often requires disturbing and unrealistic hypotheses about individuals' assumptions about other individuals' cognitive capabilities and beliefs in order to derive specific predictions. Furthermore, it is often the case that even with heroic assumptions about the computational power and beliefs that every individual attributes to every other individual, game theory cannot reduce the set of expected outcomes significantly.

Our intention, in this paper, is to first provide a historical development of game theory and its application to ethics and secondly to provide the reader with developments and applications of evolutionary game theory that has advanced our understanding of ethical norms.

## GAME THEORY: SOME BASIC CONCEPTS

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Game theory is the study of the ways in which strategic interactions among agents produce outcomes with respect to the preferences (or utilities) of those agents, where the outcomes in question might have been intended by none of the agents. The meaning of this statement will not be clear to the non-expert until each of the words and phrases that we are using have been explained and featured in some examples.

The mathematical theory of games was invented by John von Neumann and Oskar Morgenstern (1944). However, since at least the late 1970s it has been possible to say with confidence that game theory is the most important and useful tool in the analyst's kit whenever one confronts situations in which what counts as one agent's best action (for oneself) depends on expectations about what one or more other agents will do, and what counts as their best actions (for them) similarly depend on expectations about oneself. Let us first explore the concept of utility that is prevalent in game theory.

An economic agent is, by definition, an entity with preferences. Game theorists, like economists and philosophers studying rational decision-making, describe these by means of an abstract concept called utility. This refers to some ranking, on some specified scale, of the subjective welfare or change in subjective welfare that an agent derives from an object or an event. By 'welfare' we refer to some normative index of relative well-being, justified by reference to some background framework. For example, we might evaluate the relative welfare of countries (which we might model as agents for some purposes) by reference to their per-capita incomes, and we might evaluate the relative welfare of an animal, in the context of predicting and explaining its behavioural dispositions, by reference to its expected evolutionary fitness. In the case of people, it is most typical in economics and applications of game theory to evaluate their relative welfare by reference to their own implicit or explicit judgments of it. This is why we referred above to subjective welfare. Consider a person who adores the taste of pickles but dislikes onions. She might be said to associate higher utility with states of the world in which, all else being equal, she consumes more pickles and fewer onions than with states in which she consumes more onions and fewer pickles. Examples of this kind suggest that 'utility' denotes a measure of subjective psychological fulfilment, and this is indeed how the concept was generally (though not always) interpreted prior to the 1930s.

The most important link between neo-classical economics and game theory is rationality. In the perspective of neo-classical economics, human beings are expected to be absolutely rational in their economic choices. To be more precise, the main assumption is that each economic agent maximizes his or her rewards - profits, incomes, or subjective benefits - in all the circumstances he/she faces. This assumption has a double purpose. On one side it narrows the range of possibilities because in general the rational behaviour is more predictable than the irrational one. On the other side it might provide a good criterion for evaluation and measurement of the efficiency of an economic system. Thus, in a very simplified manner, if the system leads to a decrease in the rewards for some people, without producing more compensating rewards to others (costs greater than benefits, broadly) then something is wrong. In the same way, for example, pollution, the over exploitation of fisheries, and inadequate resources committed to research can all be examples of this. In neo-classical economics, rational individuals confront some system of institutions; this might include property rights, money, and highly competitive markets. These are the elements, the external "circumstances" that the rational individual takes into account in maximizing rewards. The implications of property rights, a money economy, and ideally competitive markets is that the individual needs not consider her or his interactions with other individuals. He or she needs to consider only his or her own situation and the "conditions of the market". But this leads to two problems. First, it limits the range of the theory. Wherever there is no monopoly and competition is restricted, or property rights are not fully defined, consensus neo-classical economic theory cannot be applied, and neo-classical economics has never produced a generally accepted extension of the theory to cover these cases, (McCain, 2010).

The main aim of the theory was to confront this problem: to provide a theory of economic and strategic behaviour when people interact directly, instead of “through the market”. In this respect the word game assumes a different meaning; it is a metaphor for more serious interactions in human society. Game theory may be about poker and baseball, but it is not about chess, and it is about such interactions as market competition, arms races and environmental pollution. But game theory addresses the serious interactions using the metaphor of a game: in these serious interactions, as in games, the individual’s choice is essentially a choice of a strategy, and the outcome of the interaction depends on the strategies chosen by each of the participants (McCain, 2010).

During that decade, however, economists and philosophers under the influence of behaviourism objected to the theoretical use of such unobservable entities as ‘ psychological fulfilment quotients.’ The economist Paul Samuelson (1938) therefore set out to define utility in such a way that it becomes a purely technical concept. Since Samuelson’s re-definition became standard in the 1950s, when we say that an agent acts so as to maximize her utility, we mean by ‘ utility’ simply whatever it is that the agent’s behaviour suggests to her so as to consistently act to make more probable. If this looks circular to you, it should: theorists who follow Samuelson intend the statement ‘ agents act so as to maximize their utility’ as a tautology, where an ‘ (economic) agent’ is any entity that can be accurately described as acting to maximize a utility function, an ‘ action’ is any utility-maximizing selection from a set of possible alternatives, and a ‘ utility function’ is what an economic agent maximizes. Like other tautologies occurring in the foundations of scientific theories, this interlocking (recursive) system of definitions is useful not in itself, but because it helps to fix our contexts of inquiry.

Since game theory involves formal reasoning, we must have a device for thinking of utility maximization in mathematical terms. Such a device is called a utility function. The utility-map for an agent is called a ‘ function’ because it maps ordered preferences onto the real numbers. Suppose that:

*Agent x prefers bundle a to bundle b and bundle b to bundle c*

We then map these onto a list of numbers, where the function maps the highest ranked bundle onto the largest number in the list, the second-highest ranked bundle onto the next-largest number in the list, and so on, thus:

bundle a = 3

bundle b = 2

bundle c = 1

The only property mapped by this function is order. The magnitudes of the numbers are irrelevant; that is, it must not be inferred that x gets 3 times as much utility from bundle a as she gets from bundle c.

Thus we could represent exactly the same utility function as that above by:

bundle a = 7 326

bundle b = 12.6

bundle c = - 1 000 000

The numbers featuring in an ordinal utility function are thus not measuring any quantity of anything. A utility-function in which magnitudes do matter is called 'cardinal'. Whenever someone refers to a utility function without specifying which kind is meant, you should assume that it is ordinal.

All situations in which at least one agent can only act to maximize her utility through anticipating (either consciously, or just implicitly in his behaviour) the responses to her actions by one or more other agents is called a game. Agents involved in games are referred to as players. We assume that players have capacities that are collectively referred to in the literature of economics as 'rationality'. An economically rational player is one who can:

- (i) Assess outcomes, in the sense of rank-ordering them with respect to their contributions to her welfare.
- (ii) Calculate paths to outcomes, in the sense of seeing which sequences of actions would lead to which outcomes.
- (iii) Select actions from sets of alternatives (which we'll describe as 'choosing' actions) that yield her most-preferred outcomes, given the actions of the other players.

We might summarize the intuition behind all this as follows: an entity is usefully modelled as an economically rational agent to the extent that it has alternatives, and chooses from amongst these in a way that is reliably motivated by what seems best for its purposes. The philosopher Daniel Dennett would say: we can usefully predict its behaviour from 'the intentional stance'. (Dennett, 1995)

Economic rationality might in some cases be satisfied by internal computations performed by an agent, and she might or might not be aware of computing or having computed its conditions and implications. In other cases, economic rationality might simply be embodied in behavioural dispositions built by natural, cultural or market selection. In particular, in calling an action 'chosen' we imply no necessary deliberation, conscious or otherwise. We mean merely that the action was taken when an alternative action was available, in some sense of 'available' normally established by the context of the particular analysis or 'programme of play'. Each player in a game faces a choice among two or more possible strategies. A strategy is a pre-determined 'programme of play' that tells her what actions to take in response to every possible strategy other players might use.

A crucial aspect of the specification of a game involves the information that players have when they choose strategies. The simplest games (from the perspective of logical structure) are those in which agents have perfect information, meaning that at every point where each agent's strategy tells her to take an action, she knows everything that has happened in the game up to that point. A board-game of sequential moves in which both players watch all the action (and know the rules in common), such as chess, is an instance of such a game. Games of perfect information are the (logically) simplest sorts of games. This is so because in such games (as long as the games are finite that is, terminating after a known number of actions) players and analysts can use a straightforward procedure for predicting outcomes. A player in such a game chooses her first action by considering each series of responses and counter-responses that will result from each action open to her. She then asks herself which of the available final outcomes brings her the highest utility, and chooses the action that starts the chain leading to this outcome. The distinctions described above are difficult to fully grasp if all one has to go on are abstract descriptions. They're best illustrated by means of an example. For this purpose, we will use the most famous game: the Prisoner's Dilemma (PD).

Games with the structure of the prisoner's dilemma were invented and discussed by Merrill Flood and Melvin Dresher in 1950 as part of the Rand Corporation's investigations into game theory (which Rand pursued because of possible applications to global nuclear strategy). The game theorist Albert Tucker created the version with prison sentences as payoffs and the title of the game Prisoner's Dilemma. Tucker prepared this version of the game for an audience of psychologists at Stanford while he was visiting. It should be noticed that although the original ideas of Flood and Dresher were not so publicized in journal articles, the game itself attracted attention in a variety of disciplines ranging from philosophy, psychology to mathematics and operations research.

The name 'Prisoner's Dilemma' is derived from the following situation typically used to exemplify it. Suppose that the police have arrested two people whom they know have committed an armed robbery together: the situation is represented in the pictorial diagram in Figure 1. Unfortunately, they lack enough admissible evidence to get a jury to convict. They do, however, have enough evidence to send each prisoner away for one year for theft of the getaway car. The chief inspector now makes the following offer to each prisoner: If you will confess to the robbery, implicating your partner, and she does not also confess, then you will go free and she will get twenty years. If you both confess, you will each get 5 years. If neither of you confess, then you will each get one year for the auto theft. This is illustrated in the diagram below; such a diagram may be thought of as a matrix.

|            |               | PRISONER 1  |   |
|------------|---------------|---|---|
|            |               | confess   | remain silent   |
| PRISONER 2 | confess       | <br> | <br> |
|            | remain silent | <br> | <br> |

Figure 1: Pictorial representation of the Prisoners Dilemma

Our first step in modelling the two prisoners' situation as a game is to represent it in terms of utility functions. Following the usual convention, let us name the prisoners 'Player I' and 'Player II'. Both Player I's and Player II's utility functions are identical:

$$\text{Go free} = 4$$

$$1 \text{ year} = 3$$

$$5 \text{ years} = 2$$

$$20 \text{ years} = 0$$

The numbers in the function above are now used to express each player's payoffs in the various outcomes possible in the situation. We can represent the problem faced by both of them in a single matrix, shown below, that captures the way in which their separate choices interact; this is the strategic form of their game.

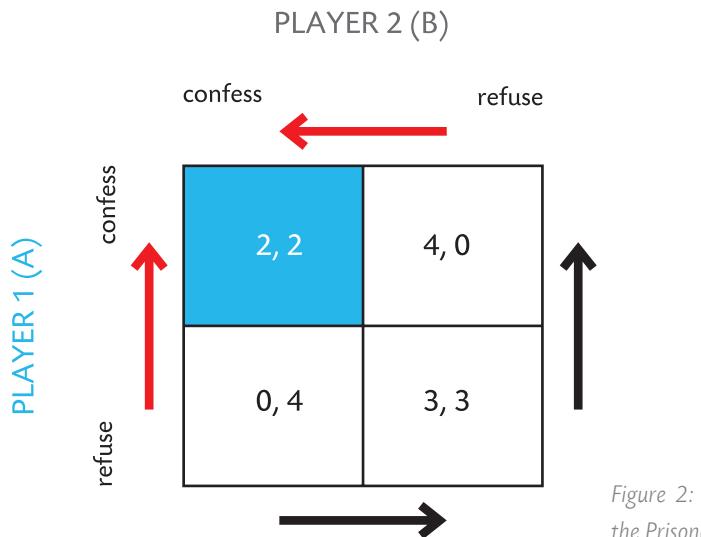


Figure 2: A Payoff Matrix for the Prisoners Dilemma

Each cell of the matrix gives the payoffs to both players for each combination of actions. Player I's payoff appears as the first number of each pair, Player II's as the second. So, if both players confess then they each get a payoff of 2 (5 years in prison each). This appears in the upper left cell. If neither of them confesses, they each get a payoff of 3 (1 year in prison each). This appears as the lower-right cell. If Player I confesses and Player II doesn't then Player I gets a payoff of 4 (going free) and Player II gets a payoff of 0 (twenty years in prison). This appears in the upper-right cell. The reverse situation, in which Player II confesses and Player I refuses, appears in the lower-left cell.

Each player evaluates his or her two possible actions here by comparing their personal payoffs in each column, since this shows you which of their actions is preferable, just to themselves, for each possible action by their partner. So, if Player II confesses then Player I gets a payoff of 2 by confessing and a payoff of 0 by refusing. If Player II refuses, then Player I gets a payoff of 4 by confessing and a payoff of 3 by refusing. Therefore, Player I is better off confessing regardless of what Player II does. Player II, meanwhile, evaluates her actions by comparing her payoffs down each row, and she comes to exactly the same conclusion that Player I does. Wherever one action for a player is superior to her other actions for each possible action by the opponent, we say that the first action strictly dominates the second one. In the PD, then, confessing strictly dominates refusing for both players. Both players know this about each other, thus entirely eliminating any temptation to depart from the strictly dominated path. Thus both players will confess, and both will go to prison for 5 years.

Players and analysts can predict this outcome using a mechanical procedure, known as iterated elimination of strictly dominated strategies with higher payoffs domination in each cell. Player 1 can see by examining the matrix that his payoffs in each cell of the top row are higher than his payoffs in each corresponding cell of the bottom row. Therefore, it can never be utility-maximizing for him to play his bottom-row strategy, viz., refusing to confess, regardless of what Player 2 does. Since Player 1's bottom-row strategy will never be played, we can simply delete the bottom row or move along the orange arrow to the higher payoff along the matrix.

Now it is obvious that Player 2 will not refuse to confess, since her payoff from confessing in the two cells that remain is higher than her payoff from refusing. So, once again, we can delete the one-cell column on the right from the game or again move along the orange shaded arrows which will now converge to point to the equilibrium cell. This converging technique is a useful methodology to determine the strategy that will dominate, in this case (confess, confess) for both prisoners. This methodology will be utilised in later examples.

Since we now have only one cell remaining, that corresponding to the outcome brought about by mutual confession, and the reasoning that led us to delete all other possible outcomes depended at each step only on the premise that both players are economically rational – that is, will choose strategies that lead to higher payoffs over strategies that lead to lower ones. There is very strong grounds for viewing joint confession as the solution to the game, the outcome on which its play must converge to the extent that economic rationality correctly models the motivations of the players. You should note that the order in which strictly dominated rows and columns are deleted does not matter. Had we begun by deleting the right-hand column and then deleted the bottom row, we would have arrived at the same solution.

The reader will probably have noticed something disturbing about the outcome of the PD. Had both players refused to confess, they would have arrived at the lower-right outcome in which they each go to prison for only 1 year, thereby both earning higher utility than either receives when both confess. This is the most important fact about the PD, and its significance for game theory is quite general. When people introduce the PD into popular discussions, one will often hear them say that the police inspector must lock his prisoners into separate rooms so that they can not communicate with one another. The reasoning behind this idea seems obvious: if the players could communicate, they would surely see that they are each better off if both refuse, and could make an agreement to do so. When we represent the PD as a strategic-form game, we implicitly assume that the prisoners can not attempt collusive agreement since they choose their actions simultaneously.

Suppose that, contrary to our assumptions, they do value each other's well-being as well as their own. In that case, this must be reflected in their utility functions, and hence in their payoffs. If their payoff structures are changed so that, for example, they would feel so badly about contributing to inefficiency that they would rather spend extra years in prison than endure the shame, then they will no longer be in a PD. All this shows is that not every possible situation is a PD; it does not show that selfishness is among the assumptions of game theory. It is the logic of the prisoners' situation, not their psychology that traps them in the inefficient outcome.

The outcome we have represented on page 41 (2, 2), indicating mutual defection, was said to be the 'solution' to the game. Following the general practice in economics, game theorists refer to the solutions of games as equilibria. However, what is 'equilibrated' about some game outcomes such that we are motivated to call them 'solutions'? When we say that a physical system is in equilibrium, we mean that it is in a stable state, one in which all the causal forces internal to the system balance each other out and so leave it 'at rest' until and unless it is perturbed by the intervention of some exogenous (that is, 'external') force. This is what economists have traditionally meant in talking about 'equilibria'; they read economic systems as being networks of mutually constraining (often causal) relations, just like physical systems, and the equilibria of such systems are then their endogenously stable states. So what we referred to as its 'solution' is the unique Nash equilibrium of the game ('Nash' here refers to the mathematician John Nash that in Nash (1950) extended and generalized von Neumann & Morgenstern's pioneering work). Nash equilibrium (henceforth 'NE') applies (or fails to apply, as the case may be) to whole sets of strategies, one for each player in a game. A set of strategies is a NE just in case no player could improve his/her payoff, given the strategies of all other players in the game, by changing his/her strategy. Notice how closely this idea is related to the idea of strict dominance: no strategy could be a NE strategy if it is strictly dominated.

Therefore, if iterative elimination of strictly dominated strategies takes us to a unique outcome, we know that the vector of strategies that lead to it is the game's unique NE. Now, almost all theorists agree that avoidance of strictly dominated strategies is a minimum requirement of economic rationality. A player who knowingly chooses a strictly dominated strategy directly violates clause (iii) of the definition of economic agency given earlier. This implies that if a game has an outcome that is a unique NE, as in the case of joint

confession in the PD, that must be its unique solution. This is one of the most important respects in which the PD is an 'easy' (and it must be said also atypical) game. We can specify one class of games in which NE is always not only necessary but sufficient as a solution concept. These are finite perfect information games that are also zero-sum. A zero-sum game (in the case of a game involving just two players) is one in which one player can only be made better off by making the other player worse off. (Tic-tac-toe is a simple example of such a game: any move that brings me closer to winning brings you closer to losing and vice-versa.). Having elaborated upon some of the basic applications of the terminology that is applicable to game theory, we will now focus on the application of game theory to ethics.

## GAME THEORY AND ETHICS

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The application of game theory to ethics began in 1954 when the British philosopher Richard Braithway gave his inaugural lecture entitled 'Theory of Games as a Tool for the Moral Philosopher'. In his lecture Braithway argued that many questions about distributive justice have the same structure as "the bargaining problem". This problem had been analysed some years earlier by John Nash, the later Nobel Prize winner, using game theory (Nash 1950). The introduction of game theory to ethics was not entirely a new development. Game - theoretic ideas can be found, for instance, in the works of Tomas Hobbs and David Hume (see Gauthier 1969, Kavka 1986, Hampton 1986, Vanderschraaf 1998). Nevertheless Braithway's prediction has not come true. Game theory has not yet fundamentally changed ethics. Ten years after Braithway, Brian Barry published "Political Argument", and a few years later David Lewis' seminal work "Convention" came out (Barry 1965, Lewis 1969). In the late 1960's, the first of a series of publications by David Gauthier (Gauthier 1967) appeared characterizing the bargaining situation in greater detail.

One can distinguish three distinctive kinds of inquiries in literature relating to the application of game theory to ethics. The first is called the functionalist approach. Game theory is used to identify the functions of morality. It is used to describe the problems that would occur in the absence of morality. The second approach, contractarianism, uses game theory (especially bargaining theory) to formalize social contract theory. Bargaining theory has been used to establish, first, that there will be agreement in conditions where social contracts exist. Third and finally, game theory, especially evolutionary game theory, is used to "recover" many traditional moral norms. In what follows we shall consider these approaches and elaborate upon the results and problems they have encountered.

From the point of game theory being used to analyze the functions of morality, a good example is Edna Ullmann-Margalit's (Ullmann-Margalit 1977) "The Emergence of Norms", in which she argues that moral norms enable agents to cooperate and coordinate their actions in situations where the pursuit of self-interest prevents this from occurring. Her now classic example is that of two artillerymen who face the choice to flee from the advancing enemy or stay and operate their gun. Their gun is located in a strategically important pass. If both stay, they have a significant chance of being injured, but it is certain that the advance of the enemy will be halted. If both flee, the enemy will be able to take the mountain pass, overtake and capture them. If just one of them stays while the other flees, the brave artillerist will die in battle, but the other gunner will have just enough time to escape safely. Supposing that both try to survive this ordeal, preferably unhurt, each soldier has reason to flee. The reason for this is that they are engaged in a Prisoner's Dilemma (see Figure 1). Each gunner has the choice between fleeing and staying and fighting. This choice is represented in the rows for Gunner No.1 and the columns for Gunner No.2. Each cell in the matrix represents the outcome of each possible pair of choices. Each cell has a pair of numbers, as before, the first number in each cell represents how Gunner No.1 ranks this outcome, relative to the other possible outcomes—ranks represented by "utility" numbers. The second number represents the ranking of this outcome by Gunner No 2.

## GUNNER NO. 2

GUNNER NO. 1

|      | stay | flee |
|------|------|------|
| stay | 2,2  | 0,3  |
| flee | 3,0  | 1,1  |

*Figure 3- Illustrating the Ullmann-Margalit Example*

Consider the case for No.1. Suppose No.2 decides to stay and fight. In that case, No.1 is best off by fleeing. He will survive without getting hurt. In the formal representation of the matrix, he will secure a higher ranking (3 rather than 2). Suppose No.2 decides to flee. Again, No.1 does best by fleeing.

He will survive the battle, although he will be imprisoned for the duration of the war. If he were to stay and fight, he would certainly die; by fleeing he will secure a higher ranking (1 rather than 0). Gunner No.2 is in the same position as No.1: for him as well, whatever the other does, he fares best by fleeing. In short, each individual gunner would be better off fleeing, regardless of what the other does. However, it remains true—and to some a paradoxical situation—that both would be better off if both stood their ground. This goes to show that the outcome of individually rational action is Pareto-inefficient or sub-optimal. Suppose that both understand the structure of their predicament. Since they would see that each has good reasons to flee, they could try to rule out this possibility. For example, they could chain each other to the gun, thus preventing flight. Ullmann-Margalit argued that the situation of the gunners (i.e., the Prisoner's Dilemma) is structurally equivalent to many everyday interactions governed by morality. Furthermore, just as the mutual chaining commits the gunners to stay and fight, morality commits agents to avoid Pareto-inefficient or sub-optimal outcomes. Morality binds individuals to their guns, as it were. On this view, the function of morality is to prevent the failures of rationality (Mackie 1977).

There are several problems with this functional analysis of morality. First, there are some well-known problems with functionalist explanations in the social sciences. The fact that a practice or an institution has a particular function need not explain either its emergence or its maintenance. It might be argued, for instance, that the function of the public education system is to educate the young, the function of the state to serve the interests of the ruling classes, or that of religion to serve as the opiate of the masses. However, until it can be shown that these apparent functions are causally effective in bringing into existence and maintaining the educational system, the state, or religion respectively, no explanation has been provided. Similarly, even if moral norms and practices serve to bring about Pareto-superior outcomes not realizable through

uncoordinated individually rational action, no explanation of the existence and persistence of morality is provided unless it is shown that this function somehow motivates human action and or in some other way is causally effective in bringing about mutually beneficial outcomes.

Secondly, it is open to question whether morality coincides with mutually advantageous or Pareto-superior outcomes in the manner suggested. Many thinkers have argued that we often are morally required to act in ways which are disadvantageous to all. An obvious example is the often affirmed prohibition against selling oneself into slavery. It might very well be advantageous to both slave and master (the slave would be able to pay off his debts and the master would have a practical solution for the daily housework), yet it is morally and legally prohibited.

Third, the functionalist account clearly assumes that the demands of morality conflict with individual rationality. Morality is supposed to correct problems of threatening Pareto-inefficiency which would be the result of unfettered (interdependent) individual rational action. On the functionalist account the moral agent seems ipso facto to be irrational (barring considerations of guilt-avoidance or regret). This then begs the question 'why be moral?'. Functionalism precludes an answer to this question.

Fourth and finally, the objective of functionalist accounts is of limited interest to moral theorists. Functionalism appears to seek explanations of the emergence and persistence of moral norms and practices. Moral theorists are not interested principally in such explanations. Rather, they usually seek to understand morality with the aim of ascertaining what we should do or what we are obligated to do. It is morality as a guide to action and to life that is the principal interest of the moral philosopher. Morality here is normative, a source of guidance. Suppose that there were a plausible functional explanation of particular moral norms. Does that explanation show that I am, in fact, obligated to follow these norms when they apply to me? There seems to be a difference between (a) determining the function(s) of morality and (b) ascertaining whether a particular set of norms and practices are, in fact, the ones we should follow. It is not clear how this question is answered by functionalist accounts.

As we discussed earlier, one of the criticisms of functionalism is that it does not explain the connection between individual choice and the emergence and persistence of moral norms. Morality is introduced as something outside of individual rational choice. In response to this difficulty, many theorists have tried to understand morality as the result of individual rational choice. Roughly, we can distinguish two strategies. First, there are those who model morality as the result of a one-time choice of a very large collection of agents, the moral community. Secondly, there are those who approach morality as the result of a series of repeated small-scale interactions. Here we discuss the approach that regards morality as the intended result of the interactions between rational agents under equally ideal circumstances.

This is an old idea in moral and political philosophy: it is the idea of the social contract. Morality is interpreted as the outcome of a bargaining process. The introduction of game theory, especially those parts of the theory that are concerned with bargaining (so-called co-operative game theory and bargaining theory), has stimulated interest in social contract theory over the last decades. John Harsanyi, Richard Braithwaite, John Rawls, Brian Barry, and David Gauthier have used the game and decision theory to formulate versions of the theory (Harsanyi 1955; Braithwaite 1955; Barry 1965; Rawls 1971; Gauthier 1986). Invoking bargaining theory, they attempted to show (1) that rational agents in a suitably idealized bargaining situation will agree on a specific, unique distribution of the benefits of cooperation, (2) what this distribution looks like, (3) that this distribution determines what is just, and (4), in case of Gauthier, that rational agents will comply with the terms of the bargain.

It is important for these theories to understand exactly how the bargaining situation is characterized. Gauthier, as well as many others, thinks of it as a Prisoner's Dilemma. That is, the predicament of the parties in the ideal bargaining position is structurally equivalent to the situation of the artillerists as we described above. Without any cooperation the gunners are doomed to flee and spend the remainder of the war in captivity. Suppose that it is possible to make binding agreements in this situation. Does this solve the problem of threatening Pareto-inefficiency? It does not because it is not obvious how the benefits of cooperation will be distributed. It might seem that in this case there is only one way in which these can be distributed, but appearances deceive. The artillerists could decide to follow a mixed strategy. A mixed strategy is a lottery over the available strategies of each individual. For example, the gunners could decide to flee with a probability of, say, 1/3 and stay and fight with a probability of 2/3. (It should be noted that the idea of a mixed strategy usually is introduced in the context of so-called cardinal utilities. Whereas before the numbers in the matrix (0, 1, 2 and 3) only signified the ranking of the outcome, here it is assumed that the numbers provide some information about the relative ranking of the outcome. For example, the utility of "2" of the cooperative outcome means that the agent is indifferent between this outcome and a gamble which offers his/her "0" (the worst outcome) with probability 1/3 and "3" (his/her best outcome) with probability 2/3. The gunners realize that they each individually can realize at least the one but worst outcome of non-cooperation. This means that the outcome of their agreement should be at least as good as the non-cooperative outcome. Therefore, the distribution that they will agree to should at least be 1. Suppose that the gunners have a pair of dice. Now they can realize cooperative distributions other than 2 each. For example, if they agree to throw both dice and if a total of 6 or less comes up #1 will flee (thus realizing a utility value of 3). However, if the total of both dice is more than 6, #1 will stay and fight the enemy (realizing his worst outcome of 0). The expected utility of this deal for #1 is  $5/12 \times 3 + 7/12 \times 0 = 1.25$ , while #2 can expect 1.75 from this deal. In this way the gunners can realize a whole range of outcomes by varying the chances that improves on the non-cooperative outcome. These outcomes form the bargaining area (see Figure 4).

Intuitively it may seem straightforward that the outcome of the agreement between Number 1 and Number 2 will be (2,2). Formally this is anything but straightforward. Every outcome that gives each gunner an expected utility of more than 1 seems rationally acceptable. Which one will rational gunners select? Within bargaining theory, the part of game theory that deals with these problems, there are two approaches that seek to answer this question (Binmore 1998, chapter 1). First, there is the traditional axiomatic approach as developed in the context of cooperative game theory. This branch of game theory assumes that, once rational agents have come to an agreement, they will comply with it. This approach has been very influential in gametheoretic social contract theory. Harsanyi, Rawls, Barry, and Gauthier all have used axiomatic approaches to justify their favorite version. Their verdict in the case of the gunners is the same: the rational thing to agree to is a distribution that gives each gunner an expected utility of 2. (Note that this verdict does not tell the gunners how they should realize this outcome. There are two ways in which they could secure an expected outcome of (2, 2). They could both stay and fight or they could flip a fair coin to decide who gets to stay and who is allowed to flee.)

We now need to focus our attention on contractarianism, one of the most influential contractarian theories currently around is that of David Gauthier. His theory, however, is different from other contractarian approaches, not only in its extensive use of game and bargaining theory, but also in the following respect. One of the difficulties we signaled with regards to the functionalist approach is that it provides no answer to the question "Why be moral?". It is here that Gauthier's contractarian theory distinguishes itself from those of Rawls, Harsanyi, and others. Gauthier not only uses bargaining theory to determine, as Rawls and Harsanyi sought to do, the content of fundamental moral principles; he also tries to show that rational agents will act morally. For this reason we discuss it in more detail than the others.

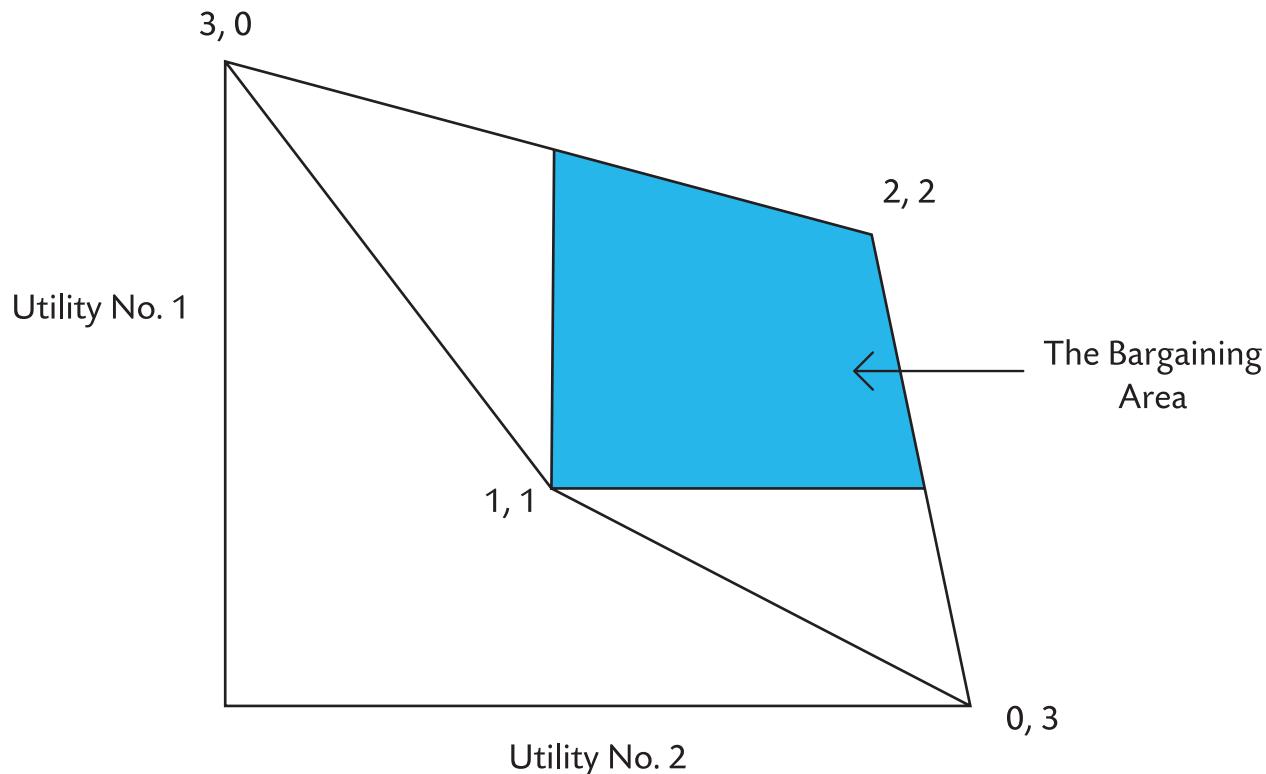


Figure 4: Illustrating the Bargaining Area

Gauthier's moral theory, "morals by agreement" (Gauthier 1986), is a theory about the nature and rationality of morality. It consists of four parts. The first is an account of practical reason and the natural condition of humankind, much of it familiar to rational choice theorists and to contractarian moral theorists (Gauthier 1986, chapters 2–4). Next is an account of the principles of conduct that rational agents would hypothetically agree to - a kind of "social contract" (Gauthier 1986, chapter 5). The third element is a controversial revisionist account of practical rationality essential to his argument aiming to show that virtually everyone under normal circumstances has reason to accept and to abide by the constraints imposed by these principles (Gauthier 1986, chapter 6). Lastly, Gauthier argues that the principles in question are principles of morality, an argument which makes implicit reference to a functionalist account of moral norms (Gauthier 1986, chapters 7–8). The third part is Gauthier's answer to the question "Why be moral?". It touches upon some very fundamental issues in game and decision theory, which is why we discuss it a bit further here.

As Hobbes already realized, it is one thing to come to an agreement; it is quite another thing to perform one's part of an agreement. Morality, at least as it is traditionally conceived, often requires us to sacrifice our interests or aims. This is, at least on the face of it, contrary to what rationality requires. Gauthier's response to this is to argue that we misconceive practical rationality, even instrumental rationality, if we think the aim of rationality determines in any straightforward way the manner in which we should reason or deliberate. The aim of rationality - to do as well as possible - does not necessarily determine our principle of decision—for instance, to choose the best alternative at each moment of choice. In terms of the utility-maximizing conception of rationality which he has accepted until recently (Gauthier, forthcoming), Gauthier argues that the aim of maximizing utility does not mean that we should, at each decision point, maximize utility. Instead we should reason in ways which are utility maximizing. Just as it is sometimes the case that we do best or at least well by not aiming to do the best or well, so it may sometimes be that the utility maximizing course of action is not to maximize utility at each decision point. Given that our mode of reasoning or deliberation itself affects our prospects, our aims or purposes are sometimes best served by our not seeking to do the best at every decision point.

Gauthier's discussion in *Morals by Agreement* is conducted in terms of "dispositions to choose" and specifically of "constrained maximization", the disposition to cooperate with other cooperators even in circumstances where defecting is more advantageous. In his later work, Gauthier develops his revisionist account of practical rationality in terms of rational plans and intentions and of modes of deliberation. If we grant that agents may do better in any number of circumstances by acting in ways that are not "straightforwardly maximizing", the problem is to determine how acting as a constrained maximizer is rational. In the book *Morals by Agreement*, Gauthier assumes that if our dispositions to choose is rational, then our choices determined by these dispositions are also rational. Gauthier thinks that if a course of action is better than any other in its effects, then it may under certain conditions be rational to adopt it and to intend to carry out its element even if some of them are not, from the standpoint of the moment of execution, the best thing to do in terms of one's aims or purposes. He seeks therefore to establish that if a mode of deliberation or a plan of action is rational, then acting according to it can be rational even if so acting requires doing things that are not, considered from the standpoint of the moment of action, optimal. Principled action constrains one's action, and it is rational to be so constrained. Thus, if Gauthier is right, it can be rational to abide by certain norms or principles, even when they require acting in ways that are not best from the standpoint of the time of action. Much of Gauthier's work since *Morals by Agreement* develops and defends this revisionist account of practical rationality (See Gauthier 1994, 1996, 1998a and b. For an alternative revisionist account, see McClenen 1990).

Gauthier's defense of "constrained maximization" constitutes a major revision of standard game- and decision theory. Orthodox theory focuses upon the rationality of actions at the time of choice. The mode of deliberation itself about actions falls out of the scope of the theory. (Or rather, orthodox theory presents itself as such a mode of deliberation.) Some critics have argued against including the mode of deliberation in the scope of the theory (for example, Velleman 1997). Most game theorists, however, argue instead that if it is feasible to choose the mode of deliberation, this choice itself can be modeled as a move in a more complex decision game, thus including Gauthier's proposal into standard theory (for example, Binmore 1994, p. 179–182). There are reasons to doubt that the game-theoretic approach to bargaining can really help us predict the outcome of the negotiations of rational agents. Both the axiomatic approach and the non-cooperative game approach proceed from the assumption that there is a unique, rational outcome of such negotiations. While that may be plausible in some situations, it is far from obvious that this is always the case. That is, the outcome of negotiations often seems rationally underdetermined (Sugden 1991). Non-rational factors, such as salience, precedence, etc., are far more important for determining the result of such negotiations than standard bargaining and game theory lead us to believe.

There is also another concern, one which leads naturally to the third major movement in game theory and ethics. Contractarians like Gauthier understand the fundamental norms that govern us as issuing from a (hypothetical) choice situation which would have a very large number of agents bargaining over different principles or social arrangements. However, it is an open question whether that is an appropriate way to model the rational choice process that leads to the emergence of morality. Presumably this is true of some of our actual norms—social, legal, or moral. They may be deficient relative to other norms, especially those that issue from the sorts of idealized social choice situations of contractarian moral theory. However, most of our actual norms are often stable, and it is not clear that we have reason to depart from them. Therefore, we are left wondering if the norms discovered by game theoretic bargaining theory are norms that are feasible for most societies, communities and groups. Since "ought" implies "can", we have reason to doubt that the contractarian approach gives us a correct account of the morality we ought to follow. At this point we consider Evolutionary Game Theory (EGT), the third way in which game theory had been applied to ethics.

## EVOLUTIONARY GAME THEORY

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The development of Evolutionary Game Theory (EGT) and its application to ethics has provided some of the most important insights during recent years. Gintis (2000) feels justified in stating that "evolutionary game theory is a universal language for the unification of the behavioural sciences." This may seem to many as if it must be a considerable rhetorical exaggeration, but in our opinion it is entirely plausible. There are good examples of such unifying work. Binmore (1998, 2005a) models social history as a series of convergences on increasingly efficient equilibria in commonly encountered transaction games, interrupted by episodes in which some people try to shift to new equilibria by moving off stable equilibrium paths, resulting in periodic catastrophes. (Stalin, for example, tried to shift his society to a set of equilibria in which people cared more about the future industrial, military and political power of their state than they cared about their own lives. He was not successful; however, his efforts certainly created a situation in which, for a few decades, many Soviet people attached far less importance to other people's lives than usual.) Furthermore, applications of game theory to behavioural topics extend well beyond the political arena.

EGT has been fruitfully applied in evolutionary biology, where species and/or genes are treated as players, since the pioneering work by Maynard Smith (1982) and his collaborators. Evolutionary (or dynamic) game theory now constitutes a significant new mathematical extension applicable to many settings apart from the biological. What is novel about evolutionary game theory is that moves are not chosen by economically rational agents. Instead, agents are typically hard-wired with particular strategies, and success for a strategy is defined in terms of the number of copies of itself that it will leave to play in the games of succeeding generations, given a population in which other strategies with which it acts are distributed at particular frequencies. In this kind of problem setting, the strategies themselves are the players, and individuals who play these strategies are their mere executors who receive the immediate-run costs and benefits associated with outcomes.

Our discussion here will closely follow Skyrms's on the matter. We begin by introducing replicator dynamics. Consider first how natural selection works to change lineages of animals by modifying, creating and destroying species. The basic mechanism is differential reproduction. Any animal with heritable features that increase its expected number of offspring in a given environment will tend to leave more offspring than others so long as the environment remains relatively stable. These offspring will be more likely to inherit the features in question. Therefore, the proportion of these features in the population will gradually increase as generations pass. Some of these features may go to fixation, that is, eventually take over the entire population (until the environment changes).

How does game theory enter into this? Often, one of the most important aspects of an organism's environment will be the behavioural tendencies of other organisms. We can think of each lineage as 'trying' to maximize its reproductive fitness (= expected number of grandchildren) through finding strategies that are optimal given the strategies of other lineages. In evolutionary game theory, we no longer think of individuals as choosing strategies as they move from one game to another. This is because our interests are different. We are now concerned less with finding the equilibria of single games than with discovering which equilibria are stable, and how they will change over time. So we now model the strategies themselves as playing against each other. One strategy is 'better' than another if it is likely to leave more copies of itself in the next generation, when the game will be played again. We study the changes in distribution of strategies in the population as the sequence of games unfolds.

Rather than regarding morality as the intended result of a complex large scale bargaining process between fully informed and fully rational agents, the evolutionary approach moves away from all these assumptions. First, morality is seen as the unintended side-effect of the interactions of agents. Second, morality emerges from a series of repeated interactions between small groups of agents (most models deal with two-person interactions only). To put this in functionalist terms: morality is not to solve one problem, but frequently re-occurring problems. Third, rather than assuming full information and full rationality, evolutionary game theory makes less demanding assumptions of the cognitive and deliberative skills of the agents. This can lead to fundamentally different results.

We can illustrate this as follows. Rousseau describes the state of nature as one that resembles the so-called Stag Hunt (Rousseau 1964, p. 166–167). (See Skyrms 2004 for a contemporary treatment of this game.) Imagine two hunters who can choose to hunt for hare. Their chances of catching a hare are not affected by the actions of others. However, both prefer to have venison for dinner; but if they were to hunt for stag, they will only be successful if the other does so as well.

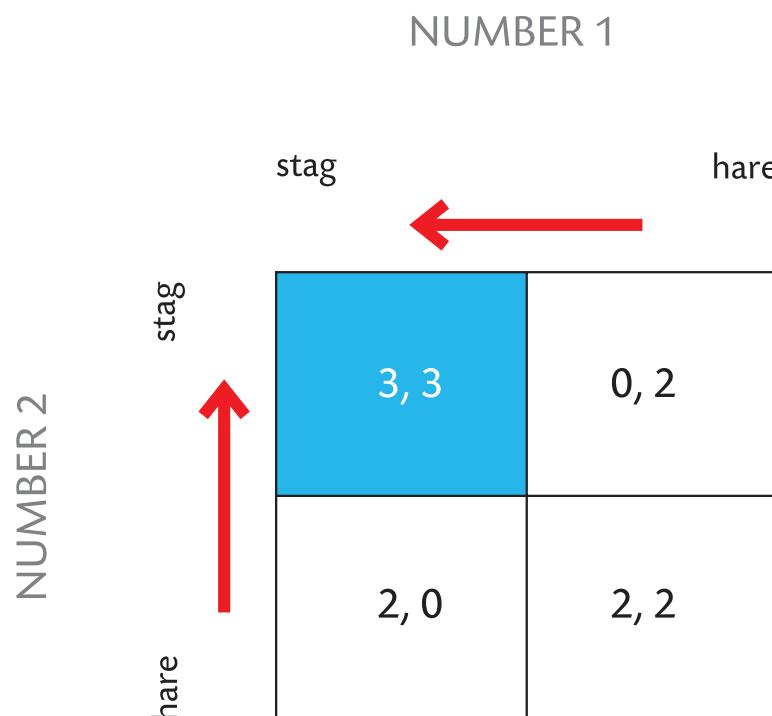


Figure 5: Illustrating the example of the Stag Hunt

Suppose Number 1 and Number 2 coordinate on (hare, hare). This equilibrium is strictly Pareto-inferior to (stag, stag). Whereas contractarian choice would have it that (Stag, Stag) is the correct norm to settle upon, evolutionary game theory teaches us that it is unlikely that the Pareto-efficient equilibrium will be selected in a process of repeated interactions. What is more, the Pareto-efficient equilibrium is unstable: occasional deviations from this equilibrium will lead the population as a whole to coordinate on (hare, hare) rather than (stag, stag).

For such dynamic game theory systems, we introduce a new equilibrium concept, due to Maynard Smith (1982). A set of strategies, in some particular proportion (e.g., 1/3:2/3, 1/2:1/2, 1/9:8/9, 1/3:1/3:1/6:1/6—always summing to 1) is at an ESS (Evolutionary Stable Strategy) equilibrium just in case (1) no individual playing one strategy could improve its reproductive fitness by switching to one of the other strategies in the proportion, and (2) no mutant playing a different strategy altogether could establish itself ('invade') in the population.

The topic that has received most attention from evolutionary game theorists is altruism, defined as any behaviour by an organism that decreases its own expected fitness in a single interaction but increases that of the other interactor. It is common in nature. How can it arise, however, given Darwinian competition? Skyrms studies this question using the dynamic Prisoner's Dilemma as his example. This is simply a series of PD games played in a population, some of whose members are defectors and some of whom are co-operators. Payoffs, as always in dynamic games, are measured in terms of expected numbers of copies of each strategy in future generations. Let  $U(A)$  be the average fitness of strategy A in the population. Let  $U$  be the average fitness of the whole population. Then the proportion of strategy A in the next generation is just the ratio  $U(A)/U$ . So if A has greater fitness than the population average A increases. If A has lower fitness than the population average then A decreases.

In the dynamic PD where interaction is random (i.e., there's no correlation), defectors do better than the population average as long as there are co-operators around. This follows from the fact that, as we saw earlier, defection is always the dominant strategy in a single game.

100% defection is therefore the ESS in the dynamic game without correlation, corresponding to the NE in the one-shot static PD. However, introducing the possibility of correlation radically changes the picture. We now need to compute the average fitness of a strategy given its probability of meeting each other possible strategy. In evolutionary PD cases, co-operators whose probability of meeting other co-operators is high do better than defectors whose probability of meeting other defectors is high. Correlation thus favours cooperation.

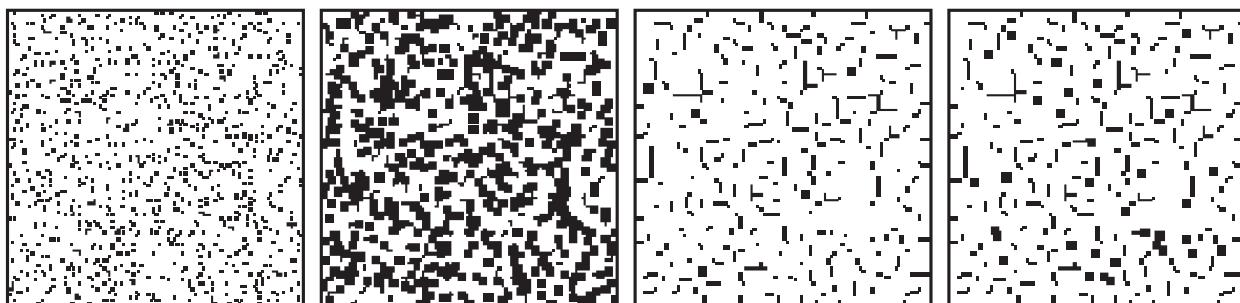
We have seen above that Evolutionary Game Theory (EGT) may be used to explain and to evaluate human behaviour in contexts where the outcome of action depends on what several agents choose to do and where their actions depends on what others choose to do. The main result of the evolutionary approach so far is the 'recovery' of many existing moral intuitions and norms. Thus, evolutionary game theorists writing about ethics (as well as moral philosophers using evolutionary game theory) have shown that among not-so-fully rational agents many of the norms of coordination and cooperation can emerge that are the object of inquiry of the more traditional moral theories (Sugden 1986; Binmore 1994, 1998; Skyrms 1996). Furthermore, Skyrms (1996) and others have demonstrated that otherwise self interested agents will develop reasoning heuristics such as the Golden Rule (do to others as you want to be done by) and a version of Gauthier's 'constraint maximization' under appropriate circumstances. That is, they show that evolution favours not only the emergence of patterns of behaviour that conform to moral standards, but also favour the development of cognitive heuristics that have all the characteristics of moral reasoning.

Most authors who have embraced the evolutionary approach, are quick to point out that this approach avoids much of the criticism raised against the previous two approaches. First, the evolutionary approach provides a genuine explanation of the emergence and persistence of moral norms. Norms are the unintended side-effect of the actions of (boundedly) rational agents and emerge in the process of repeated interactions. On the evolutionary approach, the "function" of a moral norm is to select a stable equilibrium, in a situation in which there is more than one. Thus stable equilibrium, in a situation in which there is more than one. Thus stable norms can be Pareto-inefficient. There is no fundamental link between efficiency and morality on the evolutionary approach. Its focus is on equilibrium and not on efficiency. This is also the reason why an agent in such a population should follow that norm. That is, the fact that the other members of a population follow a norm explains why, and justifies that, an individual in such a population will do so as moral?" Following an existing norm is individually rational. Furthermore, no unorthodox revisions of choice theory need to be accepted to achieve this result, which is a big advantage over Gauthier's claims for 'constrained maximization'.

However, there is also some reason to be wary of the success of the evolutionary approach. For just like the functionalist approach and unlike the contractarian project, its focus is on explanation. Evolutionary Game Theory is primarily used to explain the emergence and stability of existing norms. It does not supply the instruments to be critical of the content of these norms. It provides no justification of a code of conduct as one that is decidedly moral (however, see Binmore 1994, 1998). This tendency is especially worrisome when we see in the literature on the evolution of behaviour explanations for nasty dispositions such as the propensity of men to rape, the human inclination to make status distinctions based on race, and the like. So it is not clear to what extent this approach provides an alternative to existing moral theories. It is probably best understood as a form of social theory, albeit one that is ambivalent as to whether it is an empirically informed theory or a form of *a priori* theorizing (Sugden 2001). Of course, one may come to think that Evolutionary Game Theory is not an alternative to moral theory as much as a vehicle for undermining or debunking moral claims. If the source of our moral dispositions and judgments is essentially the same as the nasty inclinations mentioned above, then perhaps we should conclude that our moral judgments are false or unjustified and our moral dispositions untrustworthy. Evolutionary game theory, on this interpretation, would support a kind of moral scepticism. Some answers to this scepticism may be found, for instance, in Gibbard (1990).

It is not difficult to see some similarities among Von Hayek's evolutionary political conception and some ethical-political consequences of Skyrms' approach. Von Hayek would agree that to deal with human beings requires a wider notion of possibility than the one assumed by Utopian theories. In fact, Von Hayek (1973, p. 13) observes that the evolutionary approach drives us "to consider the limits about what we can try to implement, and it helps us to acknowledge that some of our desires and wishes are illusions". On the other hand the classic rationalistic constructivism "offers the idea that any desire can be realized". These are precisely the main reasons why the liberalistic approach reduces the control on the social order to those general rules that are strictly necessary for a spontaneous development in which not all details can be predicted with sufficient accuracy.

It is important to remark that Skyrms' work on the notion of rationality has many similarities with the notion of bounded rationality formulated by Herbert Simon (1983). Simon's main claim is the classic theory of behavioural rationality – as for example decision theory and game theory – are essentially based on an "Olympic Model" of rationality. These types of theories offer strategies that are optimal, but very abstract and far from the concrete individuals in our societies. On the contrary the behavioural model of bounded



*Prisoner's Dilemma: Cooperate*

rationality aims at finding strategies which are applicable in an effective manner to agents with the characteristics of real human beings Simon (1983, p. 56). Since the main objective of ‘Bounded Theories’ is that of individuating behavioural norms and strategies which are effectively enforceable, then such theories must be applicable to different classes of situations in which agents play. Thus Skyrms’ work offers several elements useful for the construction of the descriptive base of a theory of bounded rationality (Festa, 1999).

Following Skyrms some norms are based on some principle of equity and altruism. These norms spread because of their success in the long term in the evolutionary dynamic. In this manner they anchored themselves in a considerable group of people becoming a constant and stable habit in their behaviour. But in general, if this hypothesis is true, then most of the time we are in presence of players which do not maximize their own utility as postulated by classic game theorists. In this case the strategies proposed by classic game theory could be ineffective and even superfluous if the players play used crystallized good habits. In general it seems that the description of the social world where we live in is not a sequence of poker games in which players try to maximize their own utility, but more that described by Skyrms in which behaviours are controlled by habits (no matter if good or bad). In this case, our theory of bounded rationality should take into account also the probability that other players play using this or that specific habits.

Regardless of the merits of the three approaches we discussed above, there are some remarkable insights that the application of game theory offers to the moral theorist. As we noted above, there are many games with multiple equilibria. This is especially the case with iterated plays of particular games such as the Prisoner’s Dilemma. One of the implications of this fact is that insofar as these games are helpful representations or models of our social interactions, we have reason to expect much indeterminacy in the world. As a consequence, we have reason to be wary of moral theorists that claim universality and generality for their specific normative recommendations (Hardin 1988, 2003).

Secondly, game theory makes clear that in any sufficiently large population we can expect determinate mixes of behavioural dispositions. Some of the criticisms that have been formulated against the application of game theory to ethics are as follows. The most fundamental ones concern the implicit anthropology of the rational agent. The question is whether everything that is relevant for moral theory about the agent can be captured by the rather one-dimensional picture of rational man as proposed by game theory. The agent is supposed to be completely characterized by his preference rankings over outcomes and his beliefs at each stage of the game. However, morally important distinctions—e.g., between differences in character—have no place in this characterization. We can illustrate this concern with the way the concept of reputation is used in models of altruistic cooperation. Recent game theory has made use of the notion of a player’s reputation in efforts to explain cooperation in iterated plays of games such as the Prisoner’s Dilemma (Kreps and Wilson 1982). In many repeated Prisoner Dilemma games it pays to have a reputation to be cooperative. However, it is not clear what exactly it means to have a reputation in these contexts. Ordinarily, a reputation is what is generally believed about a person’s character. In these models, on the other hand, a reputation is simply a history of the player’s moves in similar games. There is a morally relevant difference between the two.

An important question to consider is, what do we believe when we learn that a merchant is honest? Ordinarily we suppose this means that he is the kind of person who will not cheat others, for instance, customers, even in situations where it might pay him to do so. Why might the merchant do this? While another merchant does not cheat because (or when) it does not pay, our merchant is honest and does not cheat because of his honesty, that is, his character. This makes a big difference in how we judge on these two merchants. Both behave cooperatively, but only the later is praiseworthy for his honesty. Game theory and utility theory generally has no room for this distinction (see Morris 1999). (Of relevance here is Brennan and Pettit, 2004).

## CONCLUSION

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It has been our intention to demonstrate that most contemporary authors in ethics who use game theory in their work are either contractarians or evolutionary theorists. The two approaches represent two different combinations of game theory and ethics. The contractarian tradition, with its emphasis on fully rational agents and bargaining, represents a more traditional use of game theory. The evolutionary approach, on the other hand, with its emphasis on bounded rational agents and repeated interactions, is a more recent arrival. To most experts in the field a synthesis of these approaches seems highly desirable. Binmore 1994, 1998 is to date appears to be the only successful attempt. ■

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# **— PART III**

# **HISTORY OF**

# **PROGRAMMING**

# **LANGUAGES**

*The main aim of the project the history of programming languages and of computers is to explore the historical development of programming languages and computing devices as a means of human expression and creation. This project is entirely devoted to programming languages and their features, people who designed them and what influenced them to design programming languages the way they did. During last year students of the School of Computing actively took part in the project and explored such languages as:*

*COBOL, FORTRAN, ALGOL, LISP, APL, SIMULA, PL/I.*

*In the current issue of the bulletin ML (programming language) will be considered.*

# ML: PROGRAMMING LANGUAGE

JANA JAROLÍMOVÁ  
VENERA MUFTAKHOVA

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## HISTORY

The concept of general-purpose programming in fact predates the development of computers. In the field of mathematical logic in the early 20th century, logicians created their own programming languages. Their motivation originally came from the concept of a proof system, a set of rules in which logical truths could be derived, mechanically. Since proof rules can be applied mechanically, all of the logically true facts can be mechanically enumerated by a person sitting there applying all of the rules in every order possible. This means the set of provable truths are recursively enumerable. Logicians, including Frege, Church, and Curry, wanted to create a more general theory of logic and proof; this led Church to define the lambda calculus ( $\lambda$ -calculus) in 1932, an abstract language of functions which also defines a suitable framework for formal logic (Smith, 2010, p. 1).

The  $\lambda$  calculus can be interpreted as the smallest universal programming language. It consists of a single transformation rule (the rule of substitution for variables) and a single function definition scheme. The  $\lambda$  calculus is universal in the sense that any computable function can be expressed and evaluated using its formalism. As a result it has been proved that every function computable using the calculus is also computable by a Turing machines. Despite the equivalence in terms of computability the  $\lambda$  calculus put more emphasis on the use of transformation rules and it does not focus much on the actual representation of the machine implementing them. Generally speaking, we can say in modern language that it is an approach more related to software than to hardware.

The central concept in this  $\lambda$  calculus is the „expression”. A “name”, also called a “variable”, is an identifier which can be any of the lower case latin letters a, b, c, ...

An expression is defined recursively as follows:

```
<expression> := <name> | <function> | <application>
<function> :=  $\lambda$  <name>. <expression>
<application> := <expression><expression>
```

(Raul Rojas, 1998, p.1)

The logic, however, turned out to be inconsistent, but by then logicians had discovered that the idea of a theory of functions and their (abstract) computations was itself of interest. They found that some interesting logical properties (such as the collection of all truths in certain logical systems) were in fact not recursively enumerable, meaning no computer program could ever enumerate them all. So, the notion of general-purpose computation was first explored in the abstract by logicians, and only later by computer designers. The  $\lambda$ -calculus is in fact a general-purpose programming language, and the concept of higher-order functions, introduced in the Lisp programming language in the 1960's, was derived from the higher-order functions found in the  $\lambda$ -calculus (Smith, 2010, p. 2).

The design of ML was strongly influenced by the needs of theorem proving, but it was equally shaped by Robin Milner's approach to language design in general. Two objectives stand out in this approach: first, the language should solve the practical problems that motivated its existence; second, it should do so with an absolute minimum of concepts, all of which should be rigorously defined and analysed. It should also be remarked that ML falls within the wider tradition of functional programming languages. Several such languages were influential in the design of ML: Burstall and Popplestones' POP-2, Evan's PAL, Landin's ISWIM, McCarthy's LISP and Reynold's GEDANKEN.

The detailed story of the evolution of ML is complex. Here we mention some facts of that evolution, with emphasis on Milner's contribution.

Milner was involved with several people working on early implementations of ML such as Malcolm Newey, Lockwood Morris, Michael Gordon, Christopher Wadsworth, Luca Cardelli, Alan Mycroft, Kevin Mitchell and John Scott.

In particular, in 1969, Dana Scott wrote a celebrated article proposing the use of a hierarchy of continuous partial functions and giving a typed  $\lambda$ -calculus and logic for it; this would prove very influential.

Robin took up Scott's ideas as the basis of a system for computer-assisted theorem proving, the Stanford LCF system - LCF stands for “Logic of Computable Functions,” referring to Scott's logic. He also began his work on concurrency, again in the tradition of Scott and Strachey, formulating a domain-based notion of process to model the behaviour of computing agents. Milner's LCF project started at Stanford in 1970 and continued at Edinburg through the 1980s, making substantial progress towards this goal and stimulating a number of related efforts in the process.

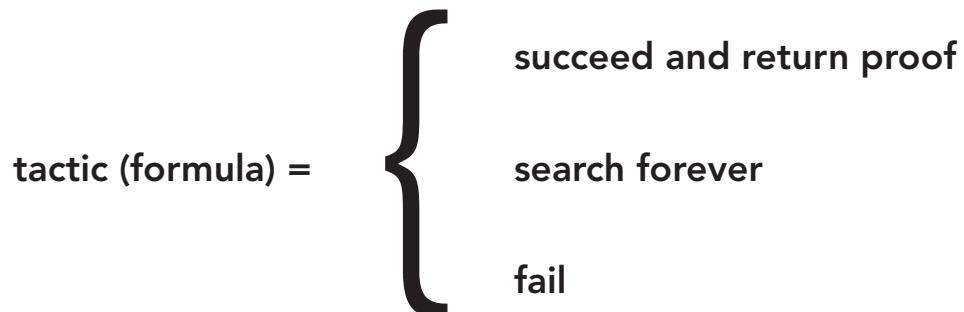
The technical vehicle that guided the design of ML was language semantics. This provided a framework that permitted economy of design. In particular Milner's paper on ML's polymorphic type discipline (1978) was seminal in several ways. Besides presenting the ML type discipline, it provided a strong indication that formal semantics could play a central role in the design of nontrivial programming languages (Plotkin et al., 2000).

## ML AND ITS PURPOSE

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Most successful programming languages were originally designed for a single application or a set of closely related programming tasks. As we mentioned earlier, ML was designed as the metalanguage of the LCF system, whose aim was developing a Logic for Computable Functions. The language of the LCF theorem prover, pplambda, of which ML was the metalanguage, was an amalgamation of the first-order predicate calculus and the simply typed polymorphic lambda-calculus. Its original purpose was for writing programs that would attempt to construct mathematical proofs, a system that would pragmatically prove interesting properties of functional programs in an automated or semi-automated manner. It is a really hard task in many cases, because it is necessary to try a number of methods for finding proofs.

A fundamental concept in the LCF system is the proof tactic. A proof tactic is a function that, given a formula making some assertion, tries to find a proof of the formula. Because a tactic may search indefinitely or reach some situation in which it is clear that no further search is likely to produce a proof, there are three possible results of applying a tactic to a formula (Mitchell 2001, p.102):



Nowadays, ML is merely a family of general purpose programming languages. It is a functional programming language, though it is often ascribed as being impure, as it permits imperative programming by allowing side-effects. Functional programming handles computation as the evaluation of mathematical functions. It draws attention to the evaluation of functional expressions, instead of execution of commands, as imperative programming does. The two main dialects of ML now in use are Standard ML (SML) and Objective Caml (Ocaml). SML is a stable language with a definition and a standard, whereas OCaml is a derivative of ML which can have features supplemented to it without defining them in a standard.

## ML AND ITS PURPOSE

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As a functional language, ML supports first-class functions, meaning it handles functions as first-class objects. This allows for the construction of new functions during program execution, their storage in data structures, their usage as arguments in other functions, as well as having them be returned as values from other functions. ML also boasts automatic memory storage management through garbage collections, freeing the programmer from having to deal with it manually. The language uses static typing, which allows for many type errors to be detected early in the development cycle. It uses the most common evaluation strategy, call-by-value, which is used by a motley of languages. ML also features parametric polymorphism, the Hindley-Milner type inference, pattern matching, algebraic data types, and exception handling.

Bjarne Stroustrup (2000), creator and developer of C++, declared that ML is one of the few languages he likes best outside the C family of languages, by explaining "...what attracts [me] most is flexibility and some very elegant code examples." ("C Family Interview", Java Report, 5(7), July 2000 and C++ Report, 12(7), July/August 2000)

## AREAS OF APPLICATION

ML's assets are mainly employed in language design and manipulation (compilers, analysers, theorem provers), but are also used in bioinformatics, financial systems, and applications including a genealogical database or a peer-to-peer client/server program.

Some of the languages within the ML programming language family include: Standard ML; Caml, which has 2 implementations: Objective Caml (OCaml) and Moscow ML; F#, which is supported by Microsoft for their .NET platform; Lazy ML (LML), which was the language used for the Haskell B Compiler, HBC. Implementations are obtainable on PCs, mainframes, most models of workstation, multi-processors and supercomputers. ML has also influenced other languages, such as: Cyclone, Mirnada, Haskell, and Nemerle.

## STRUCTURE OF ML, DATA TYPES AND EXAMPLES OF CODE

ML is a strongly typed language. It uses type inference, therefore the programmer need not declare the type. There are many syntactical differences between the various ML dialects, the table below lists some of them between SML and Ocaml.

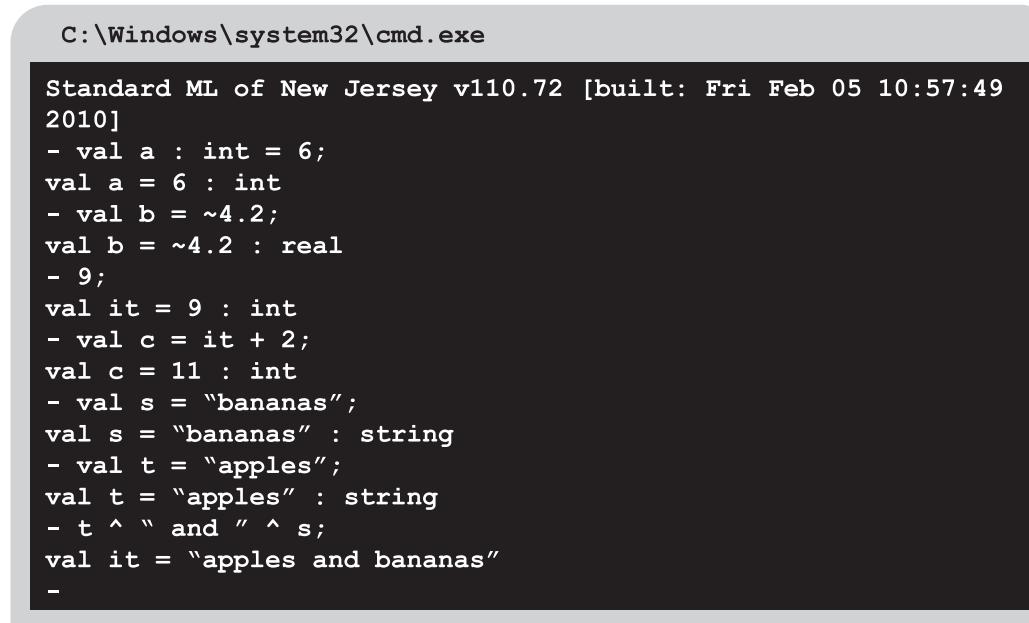
|                    | SML   | OCaml   |
|--------------------|---|---|
| LITERALS           | 5;  | #5;;  |
| EXPRESSIONS        | a orelse b andalso c                          | a    b <del>or</del> c                              |
| CONTROL FLOW       | does not have for loops                       | for i = 1 to 10 do<br>print_endline "Hello"<br>done |
| VALUE DECLARATIONS | val name = expression<br>fun f x = expression | let name = expression<br>let f x = expression       |
| STRING FUNCTIONS   | Int.toString<br>String.size                   | string_of_int<br>String.length                      |

We will now go into more detail with SML, and describe the syntax and semantics of the language. The basic types in SML, which are predefined by the Standard ML Basis Library, are

- int (integer), such as 1 or ~45 (a tilde ~ is used for negative numbers)
- real (floating-point number), such as 2.9 or ~8.3;
- string (string of character), “something written between quotations”;
- char (one character), denoted as #”;
- bool (Boolean value), which is either true or false

SML uses static typing almost exclusively, so many errors are caught at compile-time. Identifiers (variables) in SML are not bound to a specific type. You can reuse identifiers and bind them to values that have different types. Though, be careful, as a new binding to an identifier hides previous ones, but does not destroy them. Code is commented out in SML by enclosing it (\* like so \*).

Using the Standard ML of New Jersey Compiler, here are some examples of type declarations (see Fig. 1):



```
C:\Windows\system32\cmd.exe
Standard ML of New Jersey v110.72 [built: Fri Feb 05 10:57:49
2010]
- val a : int = 6;
val a = 6 : int
- val b = ~4.2;
val b = ~4.2 : real
- 9;
val it = 9 : int
- val c = it + 2;
val c = 11 : int
- val s = "bananas";
val s = "bananas" : string
- val t = "apples";
val t = "apples" : string
- t ^ " and " ^ s;
val it = "apples and bananas"
-
```

Figure 1: Examples of type declarations

This compiler is run from the command line, and awaits input with “-”. Each expression must end with a semicolon, and the following line is the computer's output, defining the user's input. Note that there are no differences between the first and second lines of input, as declaring the type is optional. Identifiers are preceded by “val”, but if no identifier is given, the compiler assigns it as “it”, which can then be used as its identifier on the next line. The ^ symbol denotes “and”.

**SML TYPE CONSTRUCTORS:****LIST**

A list holds elements of an identifier. All elements must be of the same type, and are held within square brackets. Elements can be added to the list with the constructor operator (::), and lists can be joined together with the concatenator operator (@). Heads ('hd', the first element) and tails ('tl', all the elements minus the head) can be retrieved from the list by putting the identifier in curly braces after the head or tail call. The compiler denotes a list with the word 'list' in its output.

For example (see Fig. 2):

```
C:\Windows\system32\cmd.exe
Standard ML of New Jersey v110.72 [built: Fri Feb 05 10:57:49
2010]
- val k = ["my","example","is","lame"];
val k =["my","example","is","lame"] : string list
- tl<k>;
val it = ["example","is","lame"] : string list
-
```

Figure 2: Examples of SML type constructor List

**TUPLE**

A tuple is similar to a list, except it holds elements of any type and it has a fixed length. A tuple is held within curly braces and can hold other tuples and lists. Elements within a tuple are accessed by the '#' accessor. The compiler denotes a tuple with the \* symbol in its output.

For example (see Fig. 3):

```
C:\Windows\system32\cmd.exe
Standard ML of New Jersey v110.72 [built: Fri Feb 05 10:57:49
2010]
- <11, "monkey", 2.97, #"q">;
val it = <11,"monkey",2.97,#"q"> : int * string * real * char
- #2<it>;
val it = "monkey" : string
-
```

Figure 3: Examples of SML type constructor Tuple

## FUNCTION

A function's structure looks like this :*fun fun\_name (parameter) = expression;*

where 'fun' is the keyword for function, and the 'fun\_name' is an identifier of your choosing for the function, whilst the parameter holds the function's argument (if there is only one argument in the parameter the parentheses may be omitted). The expression is then what the function performs with the argument once it is called. The compiler denotes a function with → in its output.

For example (see Fig. 4):

```
C:\Windows\system32\cmd.exe
Standard ML of New Jersey v110.72 [built: Fri Feb 05 10:57:49
2010]
- fun add < x, y > = x + y ;
val add = fn : int * int -> int
- add < 2, 17 >;
val it = 19 : int
-
```

Figure 4: Examples of SML type constructor Function

## CURRYING

Currying is the procedure of transforming a function which takes multiple arguments so it can be called as a chain of functions which each take 1 argument. Curried functions are effective because they allow for the creation of partially instantiated functions, where not all arguments are provided.

Here is an example of a curried function:

```
fun add(x) = fn (y) => fn (z) => x + y + z;
```

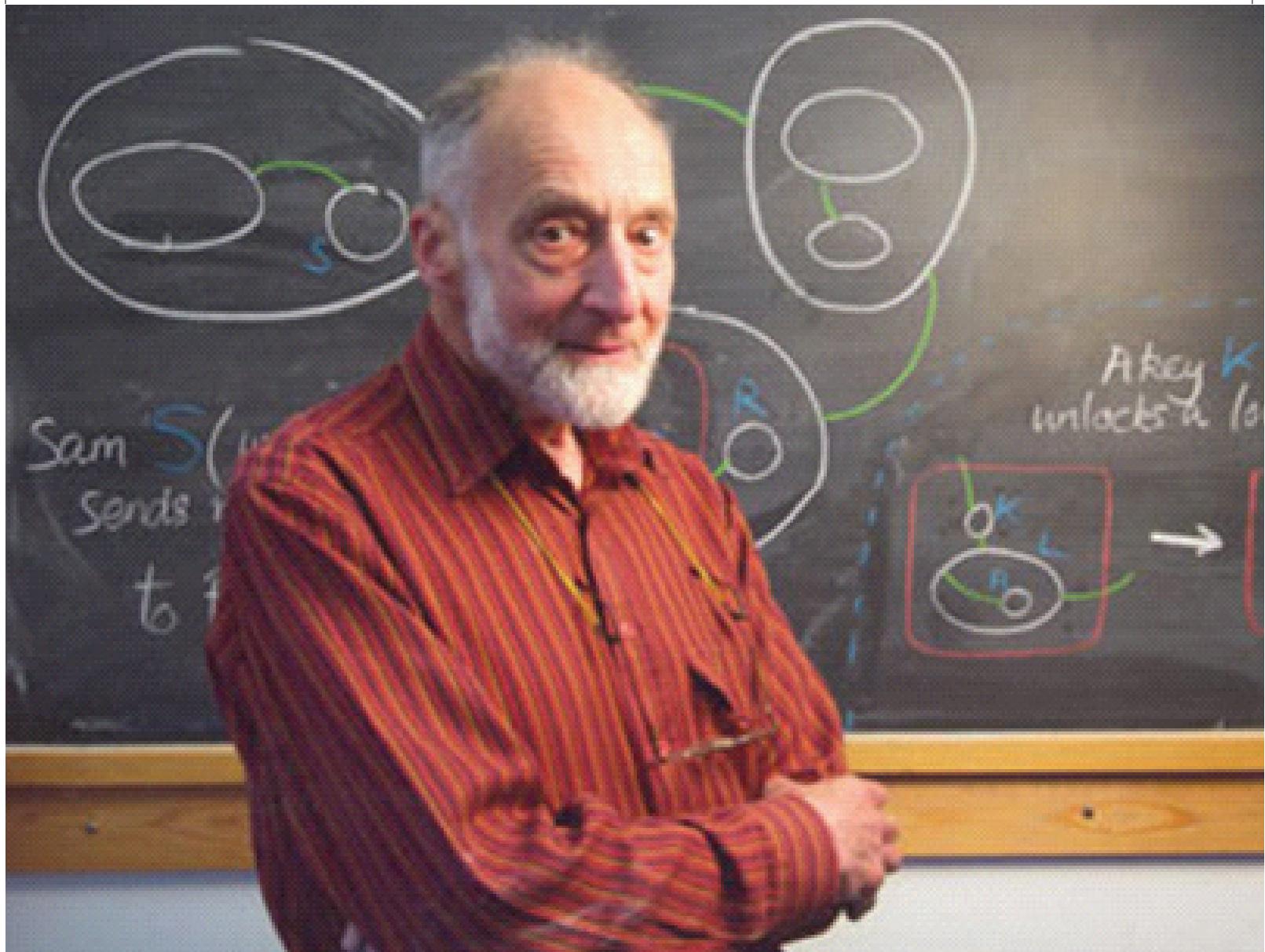
Here is the same function, uncurried:

```
fun add(x,y,z) = x + y + z;
```

To output "Hello World!" in the compiler (see Fig. 5): Source code files can be written in any text editor for the Standard ML of New Jersey Compiler, and loaded by typing: use 'file\_name.sml'. Though, the .sml extension is not necessary, as the compiler will recognize any extension type.

```
C:\Windows\system32\cmd.exe
Standard ML of New Jersey v110.72 [built: Fri Feb 05 10:57:49
2010]
- print "Hello world!\n";
Hello world!
val it = <> : unit
-
```

Figure 5: Examples of SML "Hello World"



## ABOUT ROBIN MILNER

Robin Milner was born in 1934 to John Theodore Milner and Muriel Emily Milner. His father was an infantry officer. In 1942 Robin went to Selwyn House, a boarding Preparatory School. In 1947 he won a scholarship to Eton College and while there he learned how to stay awake all night solving mathematics problems. Scholars who specialised in maths were expected to score 100% on the weekly set of problems, which were tough.

In 1952 he won a major scholarship to King's College, Cambridge. However, before going to Cambridge he did two years' national military service in the Royal Engineers, gaining a commission as a second lieutenant. By the time he went to Cambridge in 1954, Robin had forgotten a lot of mathematics; nevertheless he gained a first-class degree after two years (by omitting Part I of the Tripos). In 1956

he took a short computing course on the EDSAC (Electronic Delay Storage Automatic Calculator); he then deserted numerate study for a while to take Part II of the moral sciences Tripos.

He briefly considered taking up music seriously, as academic life did not appeal to him. He decided upon teaching mathematics at Marylebone Grammar School. After a year, in 1960, Robin took a programming job at Ferranti, in London. He looked after the program library of a small decimal computer called Sirius. Then, in 1963, he moved to a lectureship in mathematics and computer science at The City University.

It was at City that he became interested in artificial intelligence, the semantics of programs and mathematical logic. His interest in the theory of comput-

ing was further inspired by Christopher Strachey, Rod Burstall, Peter Landin, David Park, Michael Paterson and Dana Scott.

Moving towards a life in research, he took a position as senior research assistant in the Computer and Logic group of David Cooper at Swansea University in 1968, working on program correctness. He wrote two papers on program schemata (1969, 1970) and one on program simulation (1971).

The former was inspired by the work of Michael Paterson; the latter used an algebraic approach, under the influence of Peter Landin. The algebraic orientation continued in later research, providing a valua-

terest, with its many novel features, such as implicit typing. A new research effort, with Burstall and others, finally led to the development of Standard ML.

Perhaps, though, his greatest effort at Edinburgh was devoted to concurrency, starting with the invention of CCS - his Calculus for Communicating Systems. Its semantics went through an interesting development, beginning with a domain-theoretic approach, but ultimately emphasizing a novel operational approach to the equality of processes, employing the important notion of bisimulation. This in turn led to the development of other calculi, such as the  $\lambda$ -calculus for mobile computing and, most recently, to action structures and calculi, intended

***In 1987, he and his collaborators won the British Computer Society Technical Award for the development of Standard ML. In one year, 1988, he became a founder member of Academia Europaea, a Distinguished Fellow of the British Computer Society, and a Fellow of the Royal Society.***

able means of modelling structure in computing systems and linking up with later interest in process calculi. While at Swansea he learnt of Dana Scott's work with Christopher Strachey on the foundations of programming languages.

In 1971 Robin moved to Stanford University as a research associate, joining John McCarthy's group at the Artificial Intelligence Project. Robin took up Scott's ideas as the basis of a system for computer-assisted theorem proving, the Stanford LCF system, referring to Scott's logic.

In 1973, he was appointed to a lectureship at Edinburgh University, and obtained a Personal Chair in 1984. Edinburgh LCF was a development of the Stanford work, but now with a specially designed programming language, Edinburgh ML. He also worked on the semantic foundations of LCF. Next, the language ML itself became of independent in-

to provide a framework for comparing processes and other calculi, with a view also towards unifying sequential and concurrent computation.

In 1987, he and his collaborators won the British Computer Society Technical Award for the development of Standard ML. In one year, 1988, he became a founder member of Academia Europaea, a Distinguished Fellow of the British Computer Society, and a Fellow of the Royal Society.

In 1986 he was one of the founding members and the first director of the Laboratory for Foundations of Computer Science. In 1991, the ultimate accolade was bestowed upon him: the Turing Award. In 1995, he left Edinburgh to take up a Chair at Cambridge (in fact the first established chair in Computer Science at Cambridge) becoming Head of Department a year later. Robin Milner passed away in March 2010. (Plotkin et al., 2000) ■

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— **PART IV**  
**EDUCATIONAL**  
**MATTERS**

*The main aim of this section is to allow educators a forum to explore and promote discussion on contemporary issues in education. It is also designed to allow students in higher education access to debates on contemporary education and give them the ability to apply these lessons to their own studies.*

*In this issue the focus will be on students and research, discussing common errors and the psychological reasons behind them. As students at all levels of post-secondary education are expected to conduct research on a variety of topics, there is a need for them to be aware of some of the pitfalls that they can encounter, the reasons for them and to see possible alternatives to avoid them.*

# STUDENT RESEARCH AND SETTING AIMS AND OBJECTIVES

DAVE GANNON

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There are many factors which can influence the success or failure of a piece of research. Besides the effort and involvement of the particular student, what stands out as a key indicator of success is whether the student researcher has managed to set a clear and well thought out series of aims and objectives at the beginning. From my own experience, those that manage to do this are far better placed to produce a quality piece of research and most often do, those with vague or ill-defined objectives struggle throughout the rest of the research process to produce quality work.

Yet this stage is seen as an inessential part of the research by many. Many is the time I have heard the refrain 'I know what I want to do – why should I bother writing it down now? I just want to get on with it'. After the chills have passed, I try to explain to the researcher that without these clearly stated and always in the mind of the researcher, the research will not be focused and the chance of success slight. After scoffing at my unrealistic view of the world they proceed – as I predicted – with research which amounts to very little and it is only in the self-reflection phase that they realize that they made this mistake. The trouble is, by then it is far too late.

The old adage that 'you can take a horse to water but cannot make it drink' comes to mind in situations like this, as an educator I can try to provide the tools but it is the responsibility of the researcher whether they will be used adequately or not. Therefore, this paper has been written to explain some of the points for setting concrete and realistic objectives at the beginning of the research phase in the hope that student researchers will be able to see some of the pitfalls of not doing so and be able to avoid them in their own work and enhance their chances of success.



## INGREDIENTS FOR SUCCESSFUL RESEARCH

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Enthusiasm is sometimes a curse to the researcher, not in the way of wishing to conduct a piece of research, but in the way of choosing a subject which is feasible. Any piece of research has constraints attached to it, whether it be time, access, resources or something else, and the research we do needs to reflect this. Yet enthusiasm often gets the best of the researcher and they choose something which is in direct conflict with the constraints they are under.

An example of this would be someone undertaking research into the 'Effects of the Financial Crisis on World Opinion'. This of course would be a fascinating subject but would give the researcher some obstacles to overcome. Firstly, there is the issue of time. If you intend to look at world opinion, unless you are a multinational person with friends in all corners of the world you will find yourself flying a great deal, spending a lot of money on travel and by the end of the research period, still have not completed a fraction of the research necessary for such a topic.

The second obvious problem with such a topic would be getting access to people. Whilst it may be possible to find people to take surveys in all the countries you wish to sample, is it feasible to also expect access to bankers and government officials who you would probably also have to interview to get a rounded view of such a topic? Probably not.

*- The effect of such enthusiasm is unworkable*

## STUDENT RESEARCH AND SETTING AIMS AND OBJECTIVES

The lesson here is to curb the enthusiasm and to think dispassionately about the following when selecting any topic:

1. Can I do it in the time available?
2. Do I have the resources (money, contacts, friends, etc) to gather the information required?
3. Are my data requirements sensitive? Will an individual or a company permit me access to the information I require?

If the answer to any of the above questions comes out as no, then as a researcher this is an early indicator that what you plan will probably not work and that the parameters of the study should be changed.

Interest or lack of, can be a further inhibitor to a good piece of research. The author of this report is interested in the court protocols of the Byzantine Empire, but it does not necessarily mean it will make an excellent project for a student to do. Interest can only take you so far, it often crumbles when a chosen topic becomes difficult or challenging. To further look at the above topic, not only would I have to take a sabbatical from my present position, I would also have to add to my list of languages both current and no longer used, negotiate access to historical documents – to name just a few of the challenges that could rapidly curb my interest in the subject. Conversely, a lack of interest makes what are minor challenges into mountains to climb. A frequent question which I encounter is why I don't hand out topics to students. A fair question. My answer is because what interests me (as we have already seen) will probably not be what interests them. It is difficult to work on something when your motivation is low, work becomes a chore and often the end-result is a poorly researched and written. What is needed is an interest in a subject, but also a realistic view of what is possible or even appropriate.

Again, we need to think dispassionately about our choices and answer the following questions:

1. Am I really interested in this subject? Am I willing to apply time and effort to deepen my knowledge of it?
2. Does my project fit the parameters of the research I am doing? If I am doing business research, is my topic actually business related?
3. Lastly, have I thought realistically about what this work means for me?

Again, if the answer to any of the questions is 'No', then it is probable that at some point the researcher might encounter some issues with their work.

The third thing a researcher needs to think is whether the work they are doing has the potential to benefit them personally, deepening their knowledge of a specific area or has a practical application for their life. If the answer to this is yes, then it has the potential to give the researcher motivation to carry out the work and apply time and effort to it.

However, what needs to be considered is whether this has the potential to fit the parameters of the research being done. Investigating the market potential of a new product which you have created sounds great, but if your research is to be done on a separate area of business, such as Human Resource Management, then there is a mismatch between what we want to do and what we have to do.

Whilst we may create a great project and it may be of great benefit to us personally, if it does not fit the academic requirements or parameters, then our academic achievement will suffer. Again, we need to answer a series of questions to ensure we do not deviate in our enthusiasm:

1. Does this subject fit the parameters of study?
2. Have I considered the possibilities of doing something else?
3. Have I considered whether my interest will lead to a project which is feasible?

Again, if the answers to these questions is 'No', then the researcher should think carefully about whether what they would like to do is appropriate or not.



## SETTING CONCRETE AIMS AND OBJECTIVES

---

### WHAT IS THE AIM OF MY PROJECT?

For a researcher the most important stage of any project is to have a concrete aim, something which you are striving to fulfil through your research. You must be careful when selecting this as some topics are too wide ranging for effective research or are too narrow to meet its requirements. The best way for selecting such a topic is to think of what you would like to know, learn, understand, gain insight into, or prove by the end of the project. There needs to be a concrete result which you as the researcher are striving to meet through the research process.

Without having a concrete topic in mind the following research will become unfocused and the researcher uncertain as to what it is they are trying to achieve and it is doubtful that their research will achieve anything of substance. The following examples of aims created by students at the institution where I teach will illustrate some of these points.

#### ***Testing a Hypothesis***

This is a common way of creating an aim, setting up a hypothesis and conducting research to prove or disprove it. However, a researcher needs to be aware that there are associated dangers with choosing this. A typical one is of creating a hypothesis and then designing research subjectively rather than objectively so that it is 'proved'. Despite this, it is still a powerful tool in setting aims.

#### ***Example 1 – Businesses – Going Green means greater profitability.***

An interesting subject certainly, but here we have some issues to contend with. The most immediate is what does the researcher mean by businesses? Are they going to investigate businesses in multiple business sectors or just one? Are they talking about small, medium or large businesses? Whilst it provides the reader with some idea of what they intend to investigate, being so general allows too much opportunity for the researcher to stray from their original intention, nor does it assist the researcher keep clear in their mind throughout the project what it is they intend to do. This problem is further compounded by the use of Going Green. What does going green actually mean? It is certain that all of us have different concepts of what being green actually means. Does it mean employing environmentally friendly production processes? Or providing bio ingredients in a product? Again, the aim is not clear on what exactly the researcher intends to look at or focus on.

#### ***Example 2 – Service Sector Businesses gain higher profitability through Environmental Awareness***

This has improved the aim somewhat, as there is now a focus on one specific area, that of the service sector, but again we encounter a similar problem, the service sector is still a very large area to cover. Is the researcher looking at McDonalds and fast food service provision, call centre's of major corporations? There is still not enough focus in the aim which does not allow the reader to understand fully what is being researched, neither does it aid the researcher in knowing the specifics of their project. Environmental Awareness again, slightly better than the first example, is still also too general.

**Example 3 – Public perception of a company's environmental concern affects its profitability – using two telecommunication companies as a case study.**

Unlike the other two titles, this title gives the researcher a specific focus, two companies in one particular segment and looking at the public perception of the environmental concerns of these companies and looking at whether this can affect their profitability. The researcher would then have a focus of research and be able to investigate so to prove or disprove the given hypothesis. The reader from the outset would also understand what the researcher is trying to do and gauge whether they had been successful in achieving it or not.

## EXPLORATORY RESEARCH

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Unlike setting a hypothesis at the beginning of your work and testing it, exploratory work is where the researcher investigates a subject area and then draws conclusions from their investigation. Whilst this may seem to be easier to do in the minds of many researchers, equal caution must be applied to clearly defining what it is we are planning to do otherwise what we can learn or conclude from our research will not have the same impact as if it were tightly focused.

**Example 1 – To understand if being green is beneficial to a company.**

In this particular case the researcher has laid out that they wish to learn something by the end of the project and indicate what kind of study they are doing. The problem becomes when they use the phrases 'being green' and 'beneficial'. Similar to the discussion in the previous section, these words are vague and can mean a wide range of scenarios, often different from person to person. To take one extreme example, the phrase 'being green' can mean feeling envious of somebody or something, is the researcher really investigating whether companies who are jealous of their rivals attain benefits? Admittedly this is a highly unlikely viewpoint, but it does illustrate effectively one thing, use of words in setting our aims can have a marked and negative impact on our readers understanding of our project.

**Example 2 – To understand if using environmentally friendly packaging has an impact on the consumer and brings benefits to a company.**

This could be considered better as the reader now has more specific information about what the researcher is looking at in regards to 'greenness', but there is still the problem with what 'impact' and 'benefit' actually mean. When we consider impact, are we talking about environmental impact? The packaging is damaging to the environment and hence us? Are we talking about the impact on our wallets? It is unclear and therefore as an aim of our research, it again does not help the reader understand exactly what we are investigating.

**Example 3 – To understand if using environmentally friendly packaging by large supermarket chains in the Czech Republic influences customer purchasing choice – using Tesco and Albert as case studies.**

Similar to the third example in the hypothesis section, this title lays out in detail what the researcher is going to look at, which companies the researcher will focus, the fact that the researcher is interested in consumer opinion and that they will draw conclusions from the data that they gather.

## WHAT ARE THE OBJECTIVES OF MY PROJECT?

The objectives of your project provide the focus for what it is exactly you are trying to investigate. Whilst you may have an overall aim such as 'Investigating bullying in the workplace', your objectives provide the focus for that investigation, they explain what it is precisely you intend to do. Without it, your investigation is in danger of being unfocused and becoming too broad to do in the time available. They are basically a list of things which you need the answer to in order to meet the expectations of your overall aim.

For the purpose of illustration, we will select one of our research aims from above:

Public perception of a company's environmental concern affects its profitability – using two telecommunication companies as a case study.

It is quite common to see the following written as the objectives of the project:

### ***Example 1***

- A. What environmental policies do the two companies have?
- B. Do customers base their purchasing decisions on this factor?
- C. Does it make the company more profitable?

There are several problems which we can identify with these objectives. Firstly, they are simply a re-statement of the aim of the project. We already understand what the researcher wants to do, the objectives do not educate the reader in what exactly needs to be learned for the aim of the project to be fulfilled. Secondly, the manner in which they are stated is better suited to the questions to be included in an interview or survey, they do not illustrate anything to the reader.

### ***Example 2***

- A. To understand what policies the two companies have and the reasons behind them.
- B. To determine the impact of these policies on the consumer and their purchasing choices.
- C. To learn if a commitment to environmental corporate policies can influence company profitability.
- D. To develop a set of recommendations for companies regarding the use of environmental policy and its effect on company profit.

These set of questions give a much better indicator of what the researcher is looking at and will go some way towards determining their research design and how they will conduct their research. They will also enable the reader to have a better idea of the focus of the subject. Yet, there are still issues with some of these as specific objectives. If we look at the first question, there is a problem with assessing the reasons behind a corporate policy. Should you be able to access this kind of information, which is open to debate, there is a problem in trying to understand the real reason behind such a policy. How does one gauge if a company is doing it for altruistic reasons or simply as a way of trying to entice consumers to its products? In the second question there is again a problem with wording. What does 'impact' actually refer to? The third question is simply a re-statement, in essence, of what the overall aim of the project is going to be.



### Example 3

- A. To identify the criteria used by consumers for making telecommunications purchasing decisions.
- B. To establish the factors which cause consumers to consider corporate social responsibility in their purchasing decisions.
- C. To determine if there is a causal relationship between perception of environmental concern and consumer choice.
- D. To draw conclusions whether corporate social responsibility in the form of environmental policies has a positive or negative impact on company profitability.

Here we have a set of objectives which are precise, they are outcomes which are measurable and which will lead us to proving or disproving the hypothesis that we set as an aim. They also give the researcher a clear idea of their information needs for the project and allow the reader to also see what the research will be focused on.

### EXEMPLIFICATION OF THE OBJECTIVES

One thing which is often ignored by researchers is providing the discussion which goes with each of the objectives. Without an explanation it is difficult to understand why those objectives were set. What makes it harder for the reader to follow is how exactly those objectives are going to be investigated, what kinds of information is required to answer them. The following example, from a student's Dissertation provides a clear example of this:

1. To identify the concept 'advertising' and advertising tools in the first month of the research study.

This is the initial step that provides a theoretical framework for the whole research. As the topic is around the subject 'advertising', it was important to explore what it stands for and what options of advertising tools are available. Advantages and disadvantages of the tools were crucial for understanding the decisions and choices of companies. Moreover, outcomes of this objective are used to build the survey and observation researches.

- 2.

To list advertising tools used in Prague and its popularity in the third month of the research study.

This objective explores the subject of study on the Prague market. It was crucial to find out whether all types of advertising tools were available in Prague, and which of them is the most popular for people living in Prague.

3. To determine whether the size of companies influence different use of advertising tools in the fourth month of the research study.

By achieving this objective, Aim 1 of this work was met; the author wants to know whether the size of companies influences its use of advertising tools.

4. To evaluate the effectiveness of the companies' choices of advertising tools in the fourth month of the research study.

Once the objectives above had been achieved, the author evaluates the effectiveness of using advertising tools based on companies' choices and preferences of consumers. Eventually, suggestions for improvements for the chosen companies are developed. This contains personal opinion.

Without the discussion of the objectives, the reader would be less clear about what the student is actually trying to do. The use of exemplification assists the reader in also seeing why the focus will be in one area and not others. With the added discussion the reader is able to see the connection between the objectives, how they relate and what their overall purpose is.

### PROVIDING RESEARCH QUESTIONS

What is often lacking, and something which gives clarity to the researcher and the reader, is the issue of stating our research questions. It is quite common for researchers to exclude this element from their work either because they do not consider their importance in again focusing thought and focus or simply through omission, being the researcher they obviously know what they are going to ask or investigate. However, they are worth applying time and effort to not only to benefit the reader but also the researcher as another way of clarifying what is being investigated and where the focus of the research will lie. An objective, whilst showing the way, is not always sufficient in giving the 'how' and 'where', this is where the research questions assume their role.

To continue with the previous example written by a student researcher, they also gave the following as their research questions:

|  |   |
|--|---|
| <p>Objective 1 - To identify the concept 'advertising' and advertising tools in the first month of the research study.</p>                             | <ul style="list-style-type: none"> <li>• What is advertising?</li> <li>• What are the types of advertising tool that could be used?</li> <li>• What are the advantages and disadvantages of the types of advertising?</li> </ul>  |
| <p>Objective 2 – To list advertising tools used in Prague and its popularity in the third month of the research study.</p>                             | <ul style="list-style-type: none"> <li>• What types of advertising tools are used in Prague?</li> <li>• Which tool do people living in Prague prefer?</li> </ul>  |
| <p>Objective 3 – To determine whether the size of companies influence different use of advertising tools in the fourth month of the research study</p> | <ul style="list-style-type: none"> <li>• How do different size companies in the airline business use advertising tools in the Prague Market?</li> <li>• Which tools are the most popular and frequently used by airlines in Prague?</li> <li>• What is the reason for the companies to choose certain advertising tools?</li> </ul> |
| <p>Objective 4 – To evaluate the effectiveness of the companies' choices of advertising tools in the fourth month of the research study.</p>           | <ul style="list-style-type: none"> <li>• Are the chosen companies using advertising tools effectively enough?</li> <li>• What can be done to make the use of advertising tools more effective?</li> </ul>   |

(Adapted from the original by Trang Vu)

Here we can clearly see what needs to be answered for the researcher to effectively achieve each of their objectives and therefore the aim of the project. There is something that should be noted at this point, these are not simply a list of questions which would be asked in the course of an interview or questionnaire, which is a mistake common to see, but research questions which need answering if the objective is to be fulfilled.

Below are some examples of common mistakes made in this situation:

*Example 1*

|   |  |
|---|--|
| Objective 1 - To identify the concept 'advertising' and advertising tools in the first month of the research study. | <ol style="list-style-type: none"><li>1. What types of advertising do people prefer?</li><li>2. Which is the most commonly used?</li><li>3. Which do people react more positively?</li><li>4. Is online preferable to traditional?</li><li>5. What do people think the future of advertising is?</li></ol> |
|---|--|

If we consider them point by point we can see several errors have been made here. Question 1 has jumped straight into the subject but has forgotten that part of the objective is to understand the concept of advertising, what it in fact is. Without this set as one of the research questions, the objective will not be achieved as information will be missing in this area. Question 2 is looking too far forward, it should in fact be related to what tools are available to advertisers, not simply what is in fact used most. Again, we have the problem that the research question will not aid the researcher in achieving the objective, and in fact is related to the second objective and not the first. This is similar to question 3 and 4, again they are related to another objective. The answer to this will not allow the researcher to achieve objective 1. The last question relates to 'nice to know', not 'need to know'. The information may be interesting but it does not help the researcher in achieving their stated objective, nor any of the others.

*Example 2*

|   |   |
|---|---|
| Objective 3 – To determine whether the size of companies influence different use of advertising tools in the fourth month of the research study | <ul style="list-style-type: none"><li>• What are the budgets of the companies for advertising purposes?</li><li>• Does the company management realize the importance of advertising to its success?</li><li>• Are managers in small companies more in touch with the preferences of their customers in regards to advertising?</li><li>• Do men and women respond to advertising in the same way?</li><li>• Does focused advertising prove to be more effective than general advertising?</li></ul> |
|---|---|

Just like in the example on page 80, here we can see some basic errors which will cause the researcher some trouble unless they are remedied before they progress with the project. The first question does not relate to the subject being investigated and is an example of not thinking of the feasibility of a project, companies can be curiously tight lipped about how much they spend on advertising. The second question bears no relation to the objective being set, nor do the others. The questions here, whilst interesting, do not help to fulfil the objective as it is stated. The objective would have to be adapted to reflect these questions, but what is much more usual is that the research questions need to be adapted to the objective.

**For the researcher, what needs to be done here is to provide an indication of what information needs have to be fulfilled for the objective to be met and therefore the aim of the project. The purpose is not only to inform the reader of our research, but equally one for the researcher, to allow them to remain focused throughout the project, to achieve the aim of the project, to enable them to conduct effective and focused research.**

## COMMON PROBLEMS WITH AIMS, OBJECTIVES AND RESEARCH QUESTIONS

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In the above discussion there have been examples of many of the errors which can be committed when setting aims and objectives. This section provides more discussion and gives example of these errors.

### BEING TOO VAGUE

This is perhaps the most common problem - the researcher has not defined clearly in their mind what exactly they wish to investigate. Such an aim could be 'Workplace Bullying'. Whilst this might tell us what the project about it is probably more suitable to the topic of our project than an aim. The reader learns almost nothing about the focus of the project. Are they trying to look at the incidence of workplace bullying, trying to understand the motivation of workplace bullies, look at institutional responses to bullying. Are they trying to do an exploratory study or setting up a hypothesis for testing? Not only does this not aid the reader of the research but it also does not aid the researcher as it gives them no direction, no desirable end-result, whether it be new insight or the proving or disproving of a hypothesis.

This vagueness is often carried on into the objectives which the researcher sets for the project. To continue the theme, a common enough seen objective would be 'To understand bullying in the workplace'. Whilst this may lead us a little closer to the subject under investigation, it is still too vague. Does the researcher mean the incidence of bullying? The effects of bullying? Again, for the reader and for the researcher there is very likely going to be a problem of seeing or maintaining a focus to the investigation.

### BEING UNCLEAR AS TO THE TYPE OF INVESTIGATION BEING CARRIED OUT

Similar in many ways to the above problem, this can take the researcher into trouble as well. If bullying is the theme for research, in this case it is common to see aims such as 'Workplace bullying – the incidence, effects, costs to employers and employees, society and governmental responses to it'. Whilst it does explain what the researcher is interested in and indicates which areas they are looking at, the problem here is that it is too wide ranging unless the researcher has a great deal of time and access to companies, government departments etc.

It also does not quite explain what kind of research is being done, is the researcher setting up a hypothesis and then testing it, or are they trying to investigate the subject and base conclusions on gathered data. What would be a more enlightening aim, is if the researcher sets up the subject for testing – 'Workplace Bullying – the negative effect on workplace productivity'. Here we can clearly see that the researcher will test this hypothesis. Or, they could choose the subject 'Workplace Bullying – does it affect workplace productivity?' Here we can see that the researcher is going to investigate the subject and then draw conclusions.

### QUESTIONS RATHER THAN OBJECTIVES

What is quite common is to see objectives expressed as 'How does bullying make employees feel?', 'Do managers understand bullying?' or 'Do people feel able to report bullying?' These are important questions to ask and the answer of great interest, yet as objectives they fail. These kind of questions are more associated with the questions the researcher asks in order to fulfil their objectives. An objective is more of a statement as to what you wish to learn such 'To learn the extent to which bullying takes place in multinational corporate environments.' Here we understand the fact of what the researcher is looking at a specific group of companies, and the above questions which were mistakenly put as objectives could be asked as part of this investigation.

### FAILING TO THINK SMART

One of the most effective ways to look at our objectives as Maylor and Blackman (2005) explain is to apply the following criteria:

**SPECIFIC** **What is it exactly that you wish to achieve from the research?**

**MEASURABLE** **How will you determine if you reached your objectives?**

**ACHIEVABLE** **Given the parameters of your study, are your objectives possible to achieve?**

**REALISTIC** **Will you have the time and resources to complete them?**

**TIMELY** **Do you have enough time?**

**Failing to think about these will result in objectives that are impossible to measure whether they have been reached or impossible to achieve in the time available.**

### FAILURE TO CONSIDER INFORMATION ACCESS REQUIREMENTS

As already stated above, the researcher has to ensure that their goal is achievable. However, it is quite common for people to convince themselves that what they propose is actually possible whereas the opposite is the most likely outcome. To continue our theme of workplace bullying, the researcher has decided to interview company owners and chief executives as to their institutional responses to bullying. It sounds quite reasonable until they start to think about gaining access to those people. If they are lucky, they will have contacts they can use, but even then, with a subject as sensitive as bullying, even friends may decline to take part. If their choice is large multinationals they may find their chances of talking to Steve Jobs or Bill Gates,

let alone talking to them about workplace bullying in the companies they run, are minuscule at best. Realism, however much desirable, it is not always present when researchers decide their objectives. One researcher recently informed me that they wished to interview the head of a fashion chain. When I challenged them as to whether this was feasible and the manager would talk to them, their response was that the manager HAD to talk to them. There were somewhat dispirited when I pointed out that there was no reason why they had to agree to an interview with a student researcher. Yet, this is not an isolated case of the lack of realism in some research. The point here is to think whether what you need to fulfil your aims and objectives is truly possible or whether it is simply wishful thinking.

### **FAILING TO CONSULT WITH OTHERS**

Although it is understandable, it is a shame when student researchers fail to consult or discuss with others what they wish to research. There is a natural suspicion that if they show their ideas to others, someone may use them as well. However, they often ignore the fact that at all levels of research at higher education institutions the students are given a supervisor. This is most often a member of the faculty with experience and knowledge in the area the student wishes to investigate. As a member of faculty they most likely have completed their Bachelors or Masters and there is very little chance of them lifting a set of aims and objectives for themselves. However, what is more likely is that researchers often fear a cold dose of reality which a supervisor can often give to wilder schemes dreamed up by students. Painful as this is to some, if the researcher is truly serious about doing a quality piece of research then this experience can allow them to formulate specific and attainable aims and objectives and benefit them in the long term. Discussion and brainstorming with a supervisor can allow the researcher to see new areas or directions to go in and to create a set of objectives with which they feel confident can be attained within the parameters of the study.

### **CONCLUSIONS**

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The most important thing for a researcher to take away from this discussion is that without knowing from the outset what we want to do, being able to see whether it is possible or not and without clearly defined and explained objectives, our research is in danger of being both unfocused and unlikely to achieve the desired outcome. It is imperative that before any researcher launches themselves into their research they spend time thinking carefully about what they are doing. Project parameters, feasibility and being clear on what they are doing should be the watchwords of anyone who intends to carry out research. For the researcher, the process they should go through a step-by-step process of defining the aim(s) of their project, set concrete objectives, exemplify those objectives and set the research questions. Experience has shown the author of this paper that by doing this, the researcher will increase their chances significantly of producing a quality piece of research. It is amazing how a little time and effort at the beginning of a project can save the researcher a great deal of time, stress, and disappointment later on in their project.■

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# COACHING: FINDING THE RIGHT BALANCE

RADKA PÁTKOVÁ

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## WHAT DOES COACHING HAVE TO OFFER

Stress is a result of the increasing demands in our lives. Although one might assume that higher demands will make someone more productive, it actually has a negative effect on their ability to stay productive and pursue their goals. It is often the case that individuals do not realise till it is too late and exhaustion takes effect. This can happen across the line in any age or situation, caused by pressure in personal life, education as well as on our career path. As many studies have indicated, stress can lead to many psychological and health problems due to a poor maintenance of the individual's long term stress levels (Cooper et al, 2001), therefore a balance has to be found between a healthy level of stress and the pressure while aiming for a goal. A good solution to this nowadays is the offer of coaching practice. It is very common today that individuals suffering of lack of motivation, creativity, energy and the ability to achieve what they are aiming for end up with coaching professionals who help them restore their faded energy and uncover the unknown resources to help them function more productively again.



As Pena and Cooper states ' Coaching offers an effective intervention that can help individuals both manage work demands in the short term and develop new coping mechanisms that help over the long term' (Pena and Cooper, 2006, pp 172). Coaching covers a multitude of interventions for the clients to achieve a variety of aims and while working with a client, an experienced coach does not look only at one aspect of the clients life, but all possible problems that could be stopping their client from pursuing their actual goal. Yet, this does not mean the coach dictates the dynamics or topic of the coaching session, this is only up to the client, who decides what they need to work on. Due to the fact that coaching is so versatile, it is why it is so popular in today's time of change, as it can be applied for any kind of problem at any time or stage in the individual's life.

This paper is going to look at how stress affects the human psychology and physiology and how to look for the early signs of stress. This is going to lead to when coaching can help to prevent the unwanted symptoms of stress and when it cannot help, when a referral to another professional needs to be made. Moreover, the most common coaching models are going to be explained their applicability and the possible reactions to them.

### HOW DOES STRESS AFFECT INDIVIDUALS

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Stress is a reaction to excessive pressure or demands that helps to keep a human body balanced when demands exceed our resources (Sapolsky, 1994). An individual goes through a number of different signs which, if they are ignored can lead to a number of problems, stress is important to show individuals when it is time to slow down.

Long term stress depletes energy and can often result in complete exhaustion of the individual. At this stage there is a risk of the development of mental health issues, such as feelings of being disconnected, feelings of lack of meaning, disappointment, anxiety and depression (Pearsall, 2002), which can further develop

into physiological problems and the decrease of immune system functions. Once the individual continues developing those symptoms a decrease in their productivity takes effect, a sudden lack of motivation and even hate towards their duties as the exhaustion and post stress symptoms gradually develops (Pena and Cooper, 2006). Those individuals that are highly motivated and have a positive attitude towards pursuing their goals are those most likely to develop these symptoms as they are less likely to pay attention to the early signs of stress. In such situation coaching works well in people working under a lot of pressure as a tool to manage stress symptoms when they occur, on the other hand it also helps them to retrieve their unknown resources to achieve their goals and help them in finding meaning and satisfaction in their lives.

### CASES IN WHICH COACHING CAN HELP AND IN WHICH IT CANNOT

Coaching gives individuals chance to develop strategies and maximize their potential to work at their best. The coaching process helps them to identify their needs, while also identifying their strengths and encourage them to use them on a daily basis so that the individuals can achieve their goals.

If any stressor's are present they have to be identified in the coaching sessions and worked on to prevent a decrease in the individual's ability to achieve their goal. Nowadays coaching is known to be an excellent strategy to manage stress as well as improve performance. In the coaching session clients identify stressor's and also work towards developing strategies to manage them and reduce the effects of stress (Gyllensten and Palmer, 2005). By learning to manage the stress symptoms, the clients are more likely to sustain in their aims and remain working on their goal.

Even though coaching has been proven to work so well, it does not mean it works for anybody. To find the best solutions, individuals need to be in a creative state of mind to allow them to use their imagination in generating ideas and solutions to

their problems that has been stopping them from their goal attainment so far. In this case, questions like 'What would happen if they did the opposite from what they normally do?' or 'what would be different if this was not a problem?' needs to be asked (Buzan, 1994). In coaching, clients need to be prepared to face difficult challenging questions like this which can be distressing, therefore coaching is simply not for everybody.

In other cases a referral to another professional is sometimes also needed, such as discovering a mental health issue or discovering a learning difficulty that is stopping the individual from gaining their education, such as dyslexia or attention deficit and hyperactivity disorder (ADHD). By talking to the client, an experienced coach would most likely uncover such deeper problems that are stopping the individual from their achievement. In the case of a learning difficulty the coach might suggest testing with a qualified professional in that field, or in the case of a mental health issue, refer them to a counsellor for example. If all those issues are considered and there are not any serious problems the coaching session can progress.

### IDENTIFYING THE RIGHT COACHING APPROACH

The choice of a coaching approach is situation and person dependent. In talking to the client, the coach will map possible barriers that stand in the way of the clients' achievements and try to understand the mind-set of the client so that they can apply the right coaching approach. Not every approach works with every client and choosing the right one is very important. In order to engage in the coaching process, the preferences of the client need to be discussed as some individuals prefer a more logical approach whereas others prefer a more self-exploring approach.

## COACHING MODELS

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There are a number of different coaching models working on different basis and more are being developed as coaching is a rapidly growing field to serve all the different personal, educational and professional needs. The most commonly used models are GROW standing for Goal , Reality, Options and Wrap-up, Solution Focused Coaching and CBC (Cognitive Behavioural Coaching).

**GROW coaching model** works the best in organizations as it underpins the responsibilities of a manager or a leader synchronizing the leadership activities with the achievement of objectives. It builds on the manager's current knowledge and offers development of excellence skills for good management in a workplace (Goleman, 2002). Moreover, the GROW model is also a good tool to be applied for any other kind of problem in any other situation and coaching interaction. In short, the GROW model helps to integrate a measurable outcome into what the individual wants to achieve (Goal). It helps to uncover the real issues and helps to describe the situation the client is in at the moment (Reality). Additionally it helps to bring out any possible solutions and choose the preferred ones (Options). Moreover, this type of coaching considers the possible obstacles that are present or identify any possible support (Wrap-Up), (Alexander, 2006).

**Solution Focused Coaching Model (SFC)** works on a different basis from the GROW model, The SFC model works more with feelings and emotions of the individual. This kind of coaching model is best to be applied with people that are more open minded, creative and resourceful thus able to construct new possible solutions. A coach using the SFC model is focusing on the generation of feelings that will best help the client to reach their destination, which results in the client's view changing of the situation and helps the client to change their actions. In other words, it directs the client's attention to creating solutions to their problems that they would possibly never consider using. The clients are encouraged to set their own goals, develop their own action plan, act, monitor and evaluate their successes and failures. In case of any failures, clients change actions that do not work to a more effective technique, which in turn creates a cycle process till the client finally reaches their goal (Grant, 2006).

**Cognitive Behavioural Coaching Model (CBC)** has a goal to help the client become their own coach. This approach is best suited to individuals with self-limiting or defeatist thoughts and low belief in themselves which often blocks the way to the client's success path. CBC has developed from CBT (Cognitive Behavioural Therapy) and focuses on changing defeatist thoughts and behaviours to behaviours that are productive. As cited by Neenan (2006) ' The viewpoint we choose determines our reaction to things'(Neenan, 2006, pp 92). In an individual holding self-limiting thoughts it is vital to help them improve their thinking to more adaptive and balanced ways. Of course there are always going to be difficulties in life and adverse events happening, however it is absolutely up to the individual how they view them and deal with them. Therefore the main goal of CBC is to emphasise realistic thinking and help in development of a positive attitude to life in the individual. Even though CBC and CBT are used as one of the most effective methods in psychology and coaching, this model will most likely not work with people unable to engage in introspection.

Those three models are the most commonly used models in coaching nowadays. There are also ways on how to support the healthy mind set beside coaching and it is physical activity. As mind and body do work together, we need to consider not only the psychological strategies to deal with stress, but also how we can help physically. We can support our well-being by a regular exercise which releases endorphins, the 'happy hormone', and helps to develop the body strength against illnesses. Any kind of exercise is beneficial to the human body and its psychology (Hayes, 1986) from highly physically demanding exercise to just a simple walk. These can reduce the tension and help the body and mind to restore a sense of calm.

## CONCLUSION

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In conclusion, coaching can help on the path to preventing stress that drives us to exhaustion as well help to restore the individuals healthy mind and body. In the case when there is a problem already and the individual needs to learn to relax, coaching can restore their faded energy and the passion to succeed in their goals. Coaching helps individuals in developing strategies to prevent stress and look for the early signs of stress that often develop to be

a barrier in goal pursuit and lowers the individual's productivity. At the same time coaching helps individuals to discover their potential and resources they haven't even thought they had, this leads to a greater performance in education, on a career path, but also the reduction in frustration from goals not being achieved and improvement of their whole life satisfaction.■

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