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PREFACE

The Centre for Research and Interdisciplinary Studies (CRIS) was founded with the idea of developing interdisciplinary research crossing several fields and subject areas underlying the academic curricula at Prague College, and 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 programmes 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 organisations 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 had 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 CRIS, formerly 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 CRIS 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 CRIS 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 CRIS on Ebrary (electronic library), in the college library, in six Prague libraries (Narodni knihovna, Knihovna Narodniho muzea v Praze, Ministerstvo kultury CR, Parlamentni knihovna, Mestske knihovne v Praze, Knihovna a tiskarna pro nevidome K.E. Macana), Moravska zemská knihovna in Brno, Stredoceska vedecka knihovna in Kladno, Jihoceska vedecka knihovna in Ceske Budejovice, Studijni a vedecka knihovna Plzenskeho kraje in Plzen, Severoceska vedecka knihovna in Usti nad Labem, Krajska vedecka knihovna in Liberec, Studijni a vedecka knihovna in Hradec Kralove, Moravskoslezska vedecka knihovna in Ostrava, Vedecka knihovna in Olomouc, Krajska knihovna in Pardubice, Havlickuv Brod, Zlin, and Karlovy Vary.

Deadline for the next issue is 31st December 2014.



THE FIBONACCI SEQUENCE: NATURE'S LITTLE SECRET

NIKOLETTA MINAROVA

Fibonacci: a natural design, easy to recognise - yet difficult to understand. Why do flowers and plants grow in such a way? It comes down to nature's sequential secret... This paper discusses how and when the Fibonacci sequence occurs in flora.

FIBONACCI, SPIRALS AND GROWTH

FIBONACCI IN NATURE

When you sit in a garden and look around, you can easily recognise several natural designs. You see bees buzzing around flowers with neatly arranged petals, trees whose trunks are surrounded by pinecones with their distinctly patterned bracts, and maybe a little snail with a spirally shelled house on its back. But what exactly makes these designs look the way they do?

It may sound weird, but it is actually a mathematical sequence, called the "Fibonacci series" which can explain this phenomenon. Actually, this sequence of numbers, which seems to mysteriously pop up everywhere, is not as weird as you may think. In fact, you will find that it would be weird if it was not found there at all.

The Fibonacci Sequence is a pattern of numbers generated by a particular rule (Dunlap, 1997, p. 37). It starts with 0 and 1. These two numbers are added to get 1, then the new 1 is added to the previous 1 to make 2. This pattern repeats itself as seen below:

$$\begin{aligned}
 0 + 1 &= 1 \\
 1 + 1 &= 2 \\
 1 + 2 &= 3 \\
 2 + 3 &= 5 \\
 3 + 5 &= 8 \\
 5 + 8 &= 13 \\
 \\
 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, \dots
 \end{aligned}$$

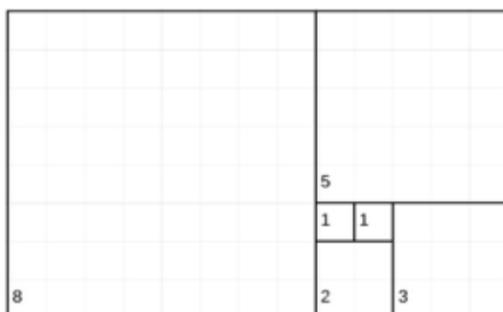
This is known as a recursive sequence defined by the equations:

$$F_1 = 1, F_2 = 1, \text{ and } F_n = F_{n-1} + F_{n-2} \text{ for all } n \geq 3$$

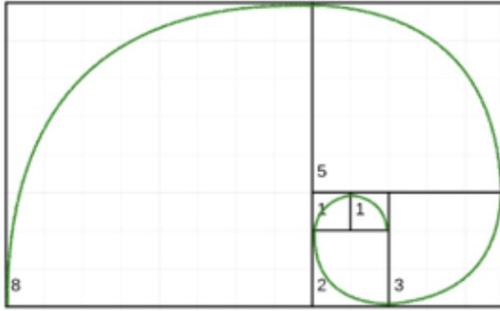
F_n represents the n^{th} Fibonacci number.

CREATING A FIBONACCI SPIRAL

When arranged in a certain way, the Fibonacci sequence creates a special spiral pattern. This pattern can be found in many places in nature.



1. Squares are drawn based on the Fibonacci sequence as is seen in the picture to the right. Graph paper should be used so that the spiral is perfect. The 1x1 squares are drawn first and then more squares are added based on the sequence of numbers.



2. The next step is to draw curves in every square, creating a spiral-like shape. A quarter of a circle is drawn in every square. This spiral can be expanded by adding more squares based on the Fibonacci sequence.

The Fibonacci spiral is a good approximation of a shape which occurs in many places in nature, such as in snail shells or even the spiral of a hurricane (Constance, 2010, p. 1). However, it is not considered a 'true' mathematical spiral, as it is composed of fragmented segments of a circle and does not scale down in size (Knott, 2010). The spiral creates a line from the middle of the spiral and increases by a factor of the golden ratio, 1.618, in every square (Norton, 1999).

CREATING A FIBONACCI SPIRAL



The Fibonacci sequence occurs in the number of many flowering plants. Think about how many plants you know which have 5, 8, or 13 petals...

As was previously mentioned, the Fibonacci sequence occurs very often in nature, not only in number form, but also as a spiral. Very often it appears in flora, such as in the arrangement of seeds on flowering plants, the number of petals in sunflowers, or even "phyllotaxy" which is the arrangement of leaves around the stem (Britton, 2011). Of course, plants and flowers do not have minds and do not actually realise that they grow in this way. According to scientists, certain flora develop in the most efficient way based on the biochemistry of plants as they develop new structures such as leaves or flowers which provides an evolutionary advantage in promoting the plant's survival (Rehmeier, 2007).

Although this is the common belief, researchers are still not entirely sure whether this is the complete answer. Mathematicians Auguste and Louis Bravais were the first to find a mathematical proof which depicted that a certain angle regulated the growth of plants (Smith, 2013, p. 66). They measured the angle between successive primordia as they migrated from the centre of the apex of a flower finding that an "angle of divergence" occurred which was conditioned by Fibonacci numbers (Smith, 2013, p. 66). Their research, however, promoted more questions about why flora develop the sequence in the first place (Rehmeier, 2007).

"Scientists have not entirely solved the mystery, but an idea seems to be emerging..."

(JULIE REHMEYER, 2007)



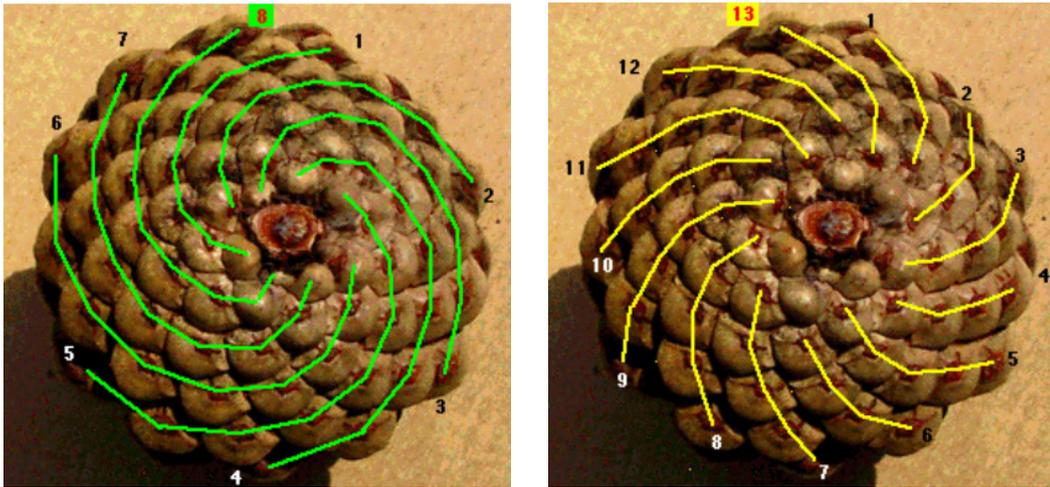
PINECONE PRINCIPLES

Pinecones, along with pineapples, seem to illustrate perfect examples of the Fibonacci sequence.

All pinecones develop in a spiral shape which starts from the base where it was connected to the tree (Carson, 1978, p. 134). There are usually two sets of spirals which circulate in different directions up to the top of the pinecone (Dunlap, 1997, p. 130). In some cases, a pinecone is found not to incorporate the sequence which is usually due to deformities caused by pests (Carson, 1978, p. 135).

The spiralled bracts going in opposing directions are adjacent Fibonacci numbers as is depicted in the images below (Simmons, 2011).

The same pinecone has 8 spirals in one direction yet thirteen in the other (Dunlap, 1997, p.130). The sequence is an approximation to an irrational number meaning that the bracts of pinecones should not line up (Collins, 2011). If they did, the pinecone would be weakened and susceptible to breakage (Collins, 2011).



Peterson (1992) describes how a mathematical model of sunflower floret and seed development was created which illustrated how the florets are produced one by one at the flower's centre, pushing the other florets outward. This is the same thing that happens with pinecones. Every bract settles into a position which happens to have a specific constant angle of rotation pertinent to the position of the last bract, and this is what creates the spiral pattern (Peterson, 1992).

Naylor (2002, p. 163) states that these spirals can be easily simulated: assume that there are k bracts in the arrangement where the most recent is "1" and the previous bracts are 2, 3, 4, etc. so that the most further bract is k . Given that each bract has an area of 1, then the circular face area is k and the radius is $\sqrt{k/\pi}$. This makes the gap between the centre of the pinecone to each bract proportional to the square root of its bract number. As the angle " α " between any two bracts is constant, the angle of bract k is simply $k\alpha$.

SEED HEADS AND SUNFLOWERS

The Fibonacci sequence allows for the maximum number of seeds in an arrangement of seeds in the seed heads of sunflowers (Grob et al., 2007, p. 857). There is no crowding in the centre and no spaces at the edges meaning that the sunflower has the perfect space organisation for its seeds (Grob et al., 2007, p. 857). This is due to a growth characteristic of sunflowers (Segerman, 2002, p. 1). Individual seeds grow at the center of the flower and continue adding seeds pushing those on the edge outwards (Heimbuch, 2002). As it develops in a Fibonacci arrangement, seeds are always grouped uniformly and they stay compact (Heimbuch, 2002).

To optimally fill the sunflower head with the highest amount of seeds, the most irrational number should be used, which is phi, otherwise known as the golden ratio (Winer, 2013). The approximation for phi is as follows:

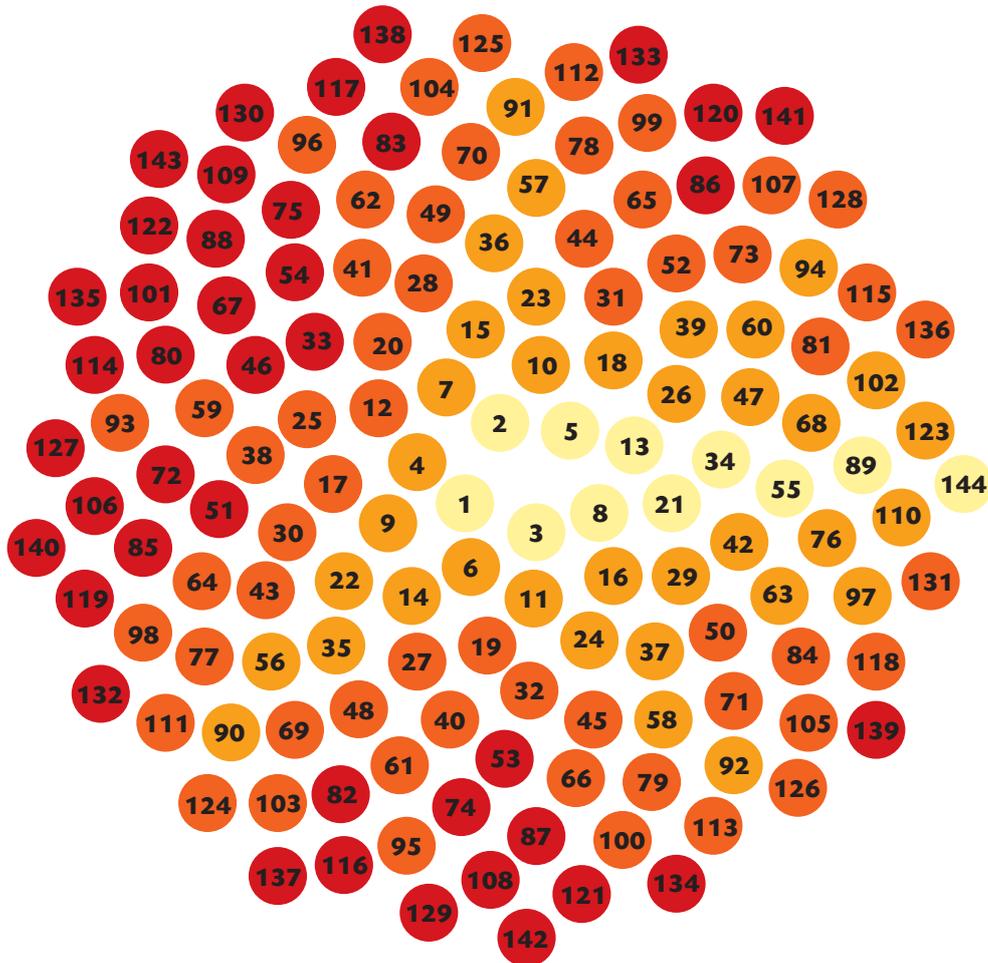
$$x_n = \frac{F_{n+1}}{F_n}$$

Where F_n is the n^{th} Fibonacci number.

Using this irrational number to spread out, the seeds makes it harder to see the number of lines in the spiral of a sunflower; however, this means that the distribution is maximally efficient (Winer, 2013). If the spaces between different spirals were easy to see, it would signify that this space is "wasted" and therefore not being effectively utilised (Winer, 2013).



The Fibonacci metric, $M(n)$, is defined as the number of terms in the Zeckendorf representation of n (Segerman, 2002, p. 1). Zeckendorf's theory declares states that all positive integers can be illustrated as a sum of precise Fibonacci numbers, as long as there is an additional condition that no two adjacent Fibonacci numbers are used (Segerman, 2002, p. 1). Colouring sunflowers according to the Fibonacci metric illustrates subtle connections between the spiral and the sequence as is seen in the image below (Segerman, 2002, p. 3).





LEAF ARRANGEMENT: PHYLLOTAXIS



Phyllotaxis is the arrangement of leaves around a stem. There are two different main types of leaf arrangements in the world: one is where the leaves spring from opposite sides of each other in a decussate pattern, and the other is the spiral pattern which displays the Fibonacci pattern (Mitchison, 1977, p. 270).

According to Mitchison (1977, p. 274) Fibonacci phyllotaxis is a mathematical requirement for the expanding apex of a plant which provides appropriate spacing for the positioning of new leaves. It is noted as a "stable mathematical phenomenon" which seems to appear everywhere, not only in flora, but in nature (Mitchison, 1977, p. 278). As previously discussed, similar to the distribution of seeds on a sunflower head, the arrangement of successive leaves are separated by phi (University of Chicago, 2013, p. 1). This means that they are optimally distributed and have the best access to sunlight which is realised by inanimate physical systems (University of Chicago, 2013, p. 1).

SEED ARRANGEMENTS IN OTHER FLOWERS

Seed arrangements can be found in all different types of flowers as is seen on this page. Like sunflowers, which were discussed in a previous section, the majority of flowers have two sets of spirals which go in opposite directions (Knott, 2010). The number of spirals going in both ways is almost always adjacent Fibonacci numbers (Peterson, 2006). Very often it happens that there are 55 and 34 spirals.





PRETTY PETALS AND PERFECT SPIRALS

Most people have never taken the time to look at flowers and to really notice them. If you have, you would have realised that almost all flowers have a certain number of petals.

Lillies have 3 petals. Buttercups and wild roses have 5. Delphiniums have 8, and cinerarias have 13. Most asters have 21 petals. While ordinary field daisies have 34 petals, other types can have 55 or 89 petals.

Some of these flowers are very specific and always have a Fibonacci number of petals while others are not as precise with the number, but still average a Fibonacci number (Peterson, 2006). In such cases, it is more likely that underdevelopment occurred and the flower has one or two petals less than it is meant to (Peterson, 2006). As with most flora, the reason for these amounts of petals has to do with maximising the efficiency of light during the growth process of plants (Knott, 2010).



FIBONACCI IN ROSES

Rose petals develop in a distinct Fibonacci pattern, where each new set grows between the spaces of the previous set (Peterson, 2006). This means that the more developed petals will not steal light from the newer petals (Peterson, 2006).

It is obvious after some time that the average angle the petals utilise while developing is 137.5 degrees (Johnson, 2013). This is the most effective way of giving as much needed sunlight to each petal as is necessary (Johnson, 2013). If any two adjacent rose petals are taken and divided, their value is always equivalent to phi, the Golden Ratio (Peterson, 2006).



HOW TO CREATE RAINBOW ROSES

The Fibonacci sequence can be implemented when creating "rainbow roses" (Osterrieder, 2012). This technique was developed by Peter van de Werken with his knowledge of plant phyllotaxy (Osterrieder, 2012). The arrangement of rose petals means that the first and sixth petal will be on the same vertical line (Osterrieder, 2012). By cutting the stem into four equal parts and placing each part into different coloured water, the petals change colour depending on which position in the spiral they have (Sarang, 2013).



CONCLUSION

Throughout this report, it can be seen that the mathematical properties of the Fibonacci sequence is found in many places in nature, mainly flora. Flower petals and leaves grow in Fibonacci numbers. Sunflower seeds grow on the seed heads in spirals correlating to the sequence as do the bracts of pinecones.

Although there has been extensive research into the topic, scientists and mathematicians are still not completely sure why this sequence seems to pop up everywhere. It has been presumed that it is just nature's way of getting maximum resources available to it, and taking the easiest path to these goals. ■

REFERENCES

- Britton, J. (2011) *Fibonacci Numbers in Nature*. Available at: <http://britton.disted.camosun.bc.ca/fibslide/jbfibslide.htm> (Accessed: 19 January 2014).
- Brown, C. (2010) *Bloomberg Professional: Fibonacci Analysis*. New York: Bloomberg Press.
- Collins, D. (2011) *Mona Lisa and Fibonacci Pinecones*. Available at: <http://www.warren-wilson.edu/~physics/PhysPhotOfWeek/2011PPOW/20110225FibonacciPinecone/> (Accessed: 19 January 2014).
- Carson, J. (1978) 'Fibonacci Numbers and Pineapple Phylloaxy', *The Two-Year College Mathematics Journal*, 9(3), pp. 132-136, MAOA. [Online]. Available at: <http://www.jstor.org/stable/3026682> (Accessed: 19 January 2014).
- Dunlap, R. A. (1997) *The Golden Ratio and Fibonacci Numbers*. Google eBooks [Online]. Available at: <http://books.google.de/books?id=Pq2AekTsF6oC&pg=PA130&q=fibonacci+pinecone&hl=en&sa=X&ei=M4frUruJMYKvTQaaylHQDA&ved=0CC4Q6AEwAA#v=onepage&q=fibonacci%20pinecone&f=false> (Accessed: 5 January 2014).
- Grob, V., Pfeifer, E. and Rutishauser, R. (2007) 'Sympodial Construction of Fibonacci Type Leaf Rosettes in *Pinguicula Moranensis*', *Annals of Botany*, 100(4), pp. 857-863. Oxford Journals. [Online]. Available at: <http://aob.oxfordjournals.org/content/100/4/857.full> (Accessed: 24 January 2014).
- Heimbuch, J. (2012) *Nature Blows My Mind! The Hypnotic Patterns of Sunflowers*. Available at: <http://www.treehugger.com/slideshows/natural-sciences/nature-blows-my-mind-hypnotic-patterns-sunflowers/> (Accessed: 24 January 2014).
- Johnson, W. (2013) *Are Roses in the Golden Ratio?* Available at: http://www.ehow.com/info_8720076_roses-golden-ratio.html (Accessed: 28 January 2014).
- Knott, R. (2010) *Fibonacci Numbers and Nature*. [Online]. Available at: <http://www.maths.surrey.ac.uk/hosted-sites/R.Knott/Fibonacci/fibnat.html> (Accessed: 5 January 2014).
- Mitchison, G. J. (1977) 'Phyllotaxis and the Fibonacci Series', *Science: New Series*, 196(4287), pp 270-275. AAAS. [Online]. Available at: http://www.johnboccio.com/courses/Physics120_2008/docs/mitchison.pdf (Accessed: 24 January 2014).
- Naylor, M. (2002) *Golden, $\sqrt{2}$, and π Flowers: A Spiral Story*. [Online]. Available at: <http://www.mike-naylor.com/resources/naylor-seeds.pdf> (Accessed: 19 January 2014).
- Norton, A. (1999) 'Fibonacci and the Golden Ratio', *Mathematics Magazine*, 75(3), pp. 163-172, WWU. [Online]. Available at: <http://jwilson.coe.uga.edu/EMT668/EMT668.folders.F97/Norton/Final/Fibonacci.html> (Accessed: 5 January 2014).
- Osterrieder, A. (2012) *Roses are Red - But They Don't Have to Be*. Available at: <http://aobblog.com/2012/02/roses-are-red-but-they-dont-need-to-be-if-you-know-how-to-use-food-dyes-and-fibonacci/> (Accessed: 28 January 2014).
- Peterson, I. (2006) *Fibonacci's Missing Flowers*. Available at: <https://www.sciencenews.org/article/fibonaccis-missing-flowers> (Accessed: 28 January 2014).
- Rehmeyer, J. (2007) *The Mathematical Lives of Plants*. Available at: <http://www.sciencenews.org/article/mathematical-lives-plants> (Accessed: 19 January 2014).
- Sarang, K. (2013) *Rainbow Rose*. Available at: <http://awescience.com/2013/05/26/rainbow-rose/> (Accessed: 28 January 2014).
- Segerman, H. (2010) *The Sunflower Spiral and the Fibonacci Metric*. [Online]. Available at: http://ms.unimelb.edu.au/~segerman/papers/sunflower_spiral_fibonacci_metric.pdf (Accessed: 24 January 2014).
- Simmons, J. R. (2011) *Fibonacci Numbers and Nature*. Available at: <http://jwilson.coe.uga.edu/EMAT6680/Simmons/Essay1/6690ProjectFibonacciF.htm> (Accessed: 19 January 2014).
- Smith, P. (2013) *Climate Change and Cultural Heritage: A Race Against Time: Routledge Explorations in Environmental Studies*, 1st edn. London: Routledge.
- University of Chicago (2013) *Phyllotaxis, the Golden Ratio and the Fibonacci Sequence*. [Online]. Available at: <http://jfi.uchicago.edu/~efrati/compton/handout8.pdf> (Accessed: 28 January 2014).
- Winer, M. C. (2013) *Fibonacci Numbers in Sunflowers*. Available at: <http://www.martincwiner.com/fibonacci-numbers-in-sunflowers/> (Accessed: 24 January 2014).

IMAGE LIST

PAGE 6: Horniak, D. (2013) *Pink Flowers* [Photograph]. Photo taken exclusively for this paper. Photographer's gallery: <http://www.totem.cz/galerie.php?ot1=25&ot2=21798>

PAGE 7: Grizdave (2011) *Math Pine Cone*. Flickr [Online]. Available at: <http://www.flickr.com/photos/grizdave/2736846377/> (Accessed: 27 December 2013).

PAGE 8, LEFT: Knott, R. (2005) *Fibonacci Pine Cone* [Online]. Available at: <http://personal.maths.surrey.ac.uk/ext/R.Knott/Fibonacci/fibnat.html> (Accessed: 27 December 2013).

PAGE 8, RIGHT: Knott, R. (2005) *Fibonacci Pine Cone* [Online]. Available at: <http://personal.maths.surrey.ac.uk/ext/R.Knott/Fibonacci/fibnat.html> (Accessed: 27 December 2013).

PAGE 9, TOP LEFT: Stockbyte (2008) *Sunflower*. Stockbyte [Online]. Available at: http://media.treehugger.com/assets/images/2012/08/71044124-th.jpg.644x0_q100_crop-smart.jpg (Accessed: 27 December 2013).

PAGE 9, TOP RIGHT: Sefaoncul (2011) *Sunflowers*. iStockphoto [Online]. Available at: <http://www.pbs.org/wgbh/nova/assets/img/describing-nature-math/image-05-large.jpg> (Accessed: 27 December 2013).

PAGE 9, BOTTOM: Segerman, H. (2010) *The Sunflower Spiral and the Fibonacci Metric* [Online]. Available at: http://ms.unimelb.edu.au/~segerman/papers/sunflower_spiral_fibonacci_metric.pdf (Accessed: 24 January 2014).

PAGE 10, TOP: Kshitij Education India (2013) *Different Types of Phyllotaxy* [Online]. Available at: <http://www.kshitij-school.com/Study-Material/Class-11/Biology/Morphology-of-flowering-plants/Leaf/3.jpg> (Accessed: 22 January 2014).

PAGE 10, CENTER LEFT: Hamamatsu, F. (2012) *Avage Spiral* [Online]. Available at: <http://fractalfoundation.org/OFCa/agavespiral.jpg> (Accessed: 24 January 2014).

PAGE 10, BOTTOM LEFT: Baab1 (2008) *Fibonacci Flower*. Flickr [Online]. Available at: <http://www.flickr.com/photos/9738004@N08/2593294045> (Accessed: 27 December 2013).

PAGE 10, BOTTOM RIGHT: Jansson, S. (2006) *The Divine Proportion*. Flickr [Online]. Available at: <http://www.flickr.com/photos/41894180985@N01/171302091> (Accessed: 27 December 2013).

PAGE 11, TOP LEFT: Werk, R. (2003) *Purple Coneflower* [Online]. Available at: <http://www.ndsu.edu/pubweb/chiwonlee/plsc211/student%20papers/articles03/rachel.werk/purple-coneflower.jpeg> (Accessed: 20 January 2014).

PAGE 11, TOP RIGHT: Knapp, S. B. (2013) *Fibonacci Flowers* [Online]. Available at: <http://1.bp.blogspot.com/-GTPAFW1W-Nk/UXtE2PYcXVI/AAAAAAAAALeg/yTJcXj8CPU/s1600/500Coneflower.jpg> (Accessed: 20 January 2014).

PAGE 11, CENTER: Peterson, K. (2011) *Fibonacci Flower* [Online]. Available at: <https://www.sciencenews.org/sites/default/files/5907> (Accessed: 23 January 2014).

PAGE 11, BOTTOM RIGHT: Peterson, K. (2011) *Fibonacci Flower* [Online]. Available at: <https://www.sciencenews.org/sites/default/files/5906> (Accessed: 23 January 2014).

PAGE 11, BOTTOM LEFT: Peterson, K. (2011) *Fibonacci Flower* [Online]. Available at: <https://www.sciencenews.org/sites/default/files/5910> (Accessed: 23 January 2014).

PAGE 12, TOP LEFT: Computer Images (2011) *Fibonacci Rose* [Online]. Available at: http://www.computerimages.com/photo_gallery/photos16.html (Accessed: 27 December 2013).

PAGE 12, TOP RIGHT: INTVGene (2008) *Rainbow Rose*. Flickr [Online]. Available at: <http://www.flickr.com/photos/intvgene/2618479990/> (Accessed: 7 January 2014).

PAGE 12, BOTTOM: Wanorizan (2014) *Rainbow Roses* [Online]. Available at: <http://alldaychic.com/rainbow-roses-diy/> (Accessed: 18 March 2014).





CHILDREN'S BOOK ILLUSTRATIONS: VISUAL LANGUAGE OF PICTURE BOOKS

HANA HLADÍKOVÁ

High-quality picture books that merge text and illustration together in order to tell a story are eminent for healthy mental and social growth of children. This paper is to outline the benefits picture books bring to children between the ages three to eight, determine functions of its illustrative language, examine the process of its production, and point out a set of elements that, according to number of professional children's book illustrators, significantly contribute to the success of a picture book.

APPEARANCE OF CHILDREN'S BOOKS AND THEIR BENEFITS TO CHILDREN

Until relatively recently, there were very few books meant primarily for children to read. Children had to make do with literature that was not attuned to their level of understanding, neither in theme nor its language and vocabulary (Kiefer, 2009, p. 6). That changed in the late 19th century. Thanks to new printing technology that made mass production of illustrated books possible and economically accessible, the middle class was also able to enter the world of readership. In addition to that, the attitude towards childhood was altered at that time, from almost solitary to more sentimental and respectful to its different needs, preparing a perfect ground for this new genre of picture books to grow in and flourish (Revolution21, 2013).

Contrarily to its generic categorisation as children's books, picture books entertain a wide spectrum of readers, and in many cases, even non-readers, from an early age through adulthood and beyond. Their power to inspire is wide. Picture books and their illustrations "can hook children into a lifelong love of reading" (Reading Is Fundamental, 2010). That is essential for their further development and their ability to perform well both in school and later in life, for the amount of information that each individual must cover in order to become successful in any line of career is now steadily increasing. For that reason, in many nations nowadays picture books are increasingly perceived as just an aged tool for encouraging children to start reading on their own, abandoning its other benefits in a race to get the children to read earlier and turn to chapter books as quickly as possible, in some cases skipping the stage of picture books entirely (Bosman, 2010; Sloat, 2013). It is due to pressure on both the parents' and industry's sides that are changing the traditional late Victorian view on the place of children's books in children's lives.

However, picture books have much more to offer. Firstly, its pictures introduce and explain the world to children in a comprehensive way even before they are able to read. It allows the children to get accustomed to new words and build up their vocabulary through both verbal and visual references provided by the book. Although a broad public generally believes differently, a vocabulary of picture books is usually very "rich, evocative and engaging" according to Pierce (2010). Many times its quality is much greater than language used in chapter books. The reason is in its average length allowing about five to eight hundred words. Because of that, "an author must craft each and every word, sentence and paragraph with care;" being exposed to such a quality of language aids significantly the growth of the children's language skills (Pierce, 2010).

Picture books also broaden general knowledge and enable children to get a better understanding of themselves and their integration within a society (Reading Is Fundamental, 2010). Its reach is as wide as its variety of themes. Picture books often trigger children's imaginations, which aid children to think of new ideas and bring new possibilities into their lives, both immediate and up-coming. Anita Silvey, for instance, states that many leading figures of the USA she has interviewed declared that their career choice was triggered by a children's book they read in their childhood (Library Of Congress, 2010).

Secondly, picture books require a certain amount of interaction from children; at the very least they have to turn the pages. This trains the child's concentration and can prolong its attention span. Another benefit is the development of the child's memory. Picture books are built in sequences that link pages together. The sequence is usually made of both visual and verbal elements and many times produces a certain pattern within the book. A great example of such a sequence is to be found in the book, *Brown Bear, Brown Bear, What Do You See?*, written by Bill Martin Jr. and illustrated by Eric Carle, where a great rhythm of rhymes introduces animals that are to appear on the next page (Pierce, 2010).

The last, but not the least, reason to read picture books is perhaps the most important. Although the theme and purpose has changed repeatedly during the short life span of this genre, the majority of the most successful children's books are crafted to entertain, to pleasure, and to employ the child's imagination. It provides delight and entertainment that not only shows children that eventually it will be fun to become an active reader but also connects generations and people in general through the sharing of these engaging stories, experiences, and valuable time spent together. Anita Silvey claims that children's books are often attached to more than just their stories, amazing new worlds, or memorable characters; more importantly they are connected to the people the young reader knew and loved in his/her childhood (Library Of Congress, 2010). Sharing picture books with others provides children with feelings of love and security, feelings of utmost importance in their young age.

PURPOSES OF ILLUSTRATION IN PICTURE BOOKS

Illustration, as well as cover design, is one of the marketing tools a children's book publishing company employs to increase its chances in its highly competitive market. A picture book's artwork, both that on a cover and inside, creates a first and second impression on a potential reader and buyer and therefore is crucial for its sell ability. Tori Sloat (2013), however, adds that even though "illustrations may sell the book at the beginning ... to last a lifetime, the book has to begin to rely on the story and how it reads." This bond between the book's visual and written parts is a true key to its lasting success. To harvest this connection, the illustrator must follow the written word of an author, but also add his/her own personality, view, humour, and insight to the story.

The imperative role of illustrations within a picture book is to take the written story to a new level of entertainment. The artwork should stand for as much of the story as the words, expanding the story without duplicating the text itself while acting as a mediator between the text and the reader, allowing the reader "to feel the words" (Murguia, 2013; Downing, 2013; Sloat, 2013). Ann Marie Finn adds that she likes "to use illustrations to create more of an atmosphere ... and add another dimension to the story" (Finn, 2013). She also states that picture books' illustrations that are very often full of action and interesting additions to the story can lead to an extended attention span of children who are easily distracted otherwise. Another, perhaps more technical, purpose of illustrations is to set a seductive rhythm, hierarchy of elements on a page, and easy flow of the story while encouraging the reader through its layout and action depicted on its pages to keep enjoying the narrative until its end (Meidell, 2013).

GETTING THE RIGHT BOOK INTO THE HANDS OF THE RIGHT ILLUSTRATOR

Amongst the first factors in need of consideration in the process of producing artwork for an approved manuscript is the suitability of an illustrator and the narrative in terms of style and technique appropriate for the publication. Both of these influence the overall mood of the story greatly and can therefore contribute to the success or failure of the publication. Martin Ursell (2013, p. 96) states that "the author-illustrator is a rare thing and most children's illustrators illustrate other writer's stories not their own." For that reason, it is imperative to select a fitting illustrator and determine the art director's expectations for the book at the very start so no misunderstanding imperils the smooth progression of the publishing process.

Christine Tripp argues that from a certain point of view, a style and a technique of illustrations for the particular book are in fact chosen by an art director's preference of an illustrator, for the majority illustrators have a recognisable "signature style", or even a variety of styles, from cartoonish to very realistic, using traditional media or working digitally instead (Tripp, 2013). Martin Ursell also mentions that many beginning

illustrators ponder about "not having a style and how to get one", which he thinks to be a pointless worry (2013, p. 51). He says that "one's 'style' is simply the way one draws. Just as we all write in a distinctive way, drawing is no different" (Ursell, 2013, p. 51). In other words, there is no need to learn a distinguishing personal style of drawing, for everyone already has it. In case an illustrator uses a variety of styles, one is either selected by the art director when an offer is made to have a go on a manuscript, or, especially when the illustrator is also the author, the choice is left to the illustrator's judgement. The final decision is often linked to an overall mood and theme of the story. Tom Lichtenheld (2013, author's italics) gives an example of this practice, "if a story is soft and lyrical, I'll use watercolours or pastels, but if it's gritty, like *Goodnight, Goodnight, Construction Site*, I'll use crayon on textured paper."

In many cases, an art director preselects several illustrators whose personal styles are in tune with the manuscript and then asks them to produce sample illustrations. The sample can vary slightly according to different publisher houses, but usually it is a sample spread for a provided passage of the manuscript, which sometimes is extended with a more detailed study of the book's main character(s) (Ursell, 2013, p. 104). Then one of the illustrators is approached with an offer of the job. The final decision is, however, made by the artist by accepting or declining the job. Teri Sloat states that a few times she recommended the art director to hand the job over to another illustrator "because I knew they were right for the job and I wasn't" (2013). Also, Helen Craig points out that it "is not a good idea to illustrate a book you don't like, because there will be no pleasure in it. And if there is no pleasure in your drawing ... it transmits itself into the book" (Creative Choices, 2009). The illustrator spends a rather large amount of time working on a book, which can vary from a few months up to a year, and it would take much more discipline to finish the project, if the illustrator is not enthusiastic about the story itself (Teri Sloat, 2013; AlbanyKALB, 2013).

ILLUSTRATING PROCESS

The very first step the illustrator does after accepting the job is to familiarise oneself thoroughly with the whole manuscript. The story is a paramount source of illustrator's inspiration, and for that reason it is essential to pay due attention to its details that can trigger an interesting insight into the story, providing the illustrator with a good starting point. There are many ways how to bring the illustrations to life. Movement, both in body language, face, and settings together with the expressiveness of all the above, is as important as thorough consistency of the visual language of the whole book. Moreover, the emotional content of the story that is often communicated through the combination of composition, colour, line, or style can bring excitement, engagement, and something the reader can relate to, which makes the illustrations a very powerful part of the reader's experience. Originality of settings, choice of flat or dimensional images, and overall feeling of the narrative can also make a considerable impact on attracting and keeping the reader's attention in the story (Dewdney, 2013; Finn, 2013; Murguia, 2013; Lies, 2013; Tripp, 2013; Waites, 2013; Downing, 2013; Meidell, 2013; Sloat, 2013; Lichtenheld, 2013). It can be argued that many times it is a careful combination of these components that makes the illustrations special and dear to the reader, and each illustrator has a different way how to engage these elements and which elements he/she puts more emphasis on.

To point out an example, Teri Sloat (2013) states that she firstly considers "the weight of the story", which includes analysing the narrative's mood, theme, significance of characters, placement of the story, and its natural pace. Ann Dewdney (2013), however, claims that her "design process is based entirely on both the flow of the book and the emotional content of the pages". It is reasonable to conclude that whichever process the illustrator chooses to follow a consideration of these elements can assist the illustrator greatly in making important decisions such as the establishment of a balance between text and images, development of characters, overall layout, usage of white space, text division, colour scheme, or visual style.

RELATIONSHIP BETWEEN TEXT AND IMAGE

A fine relationship between words and images is vital for picture books. Generally speaking, "what a picture adds to a story and what the words leave out, is key" (Revolution21, 2013). Both the author and the illustrator should have this fact in mind when working on the book. Ideally, the author is considerate to the needs of the illustrator and writes the text in a way that leaves enough room for the illustrator's creativity to enhance the author's creation. In other words, the author should be leading the reader through the action and leave the illustrator enough space to portray the mood of the story and details of the narrative's scenes and characters. This ensures that words and images are not to duplicate the statement of the story, but rather complement each other (Salisbury, 2004, pp. 93-97; Paul, 2009, p. 158; Dils, 2009, pp. 26-27). Therefore, one of the attributes of a successful picture book's illustration is often a complementary or parallel story line enhancing the original manuscript. A wonderful example of such practice is an addition of a cat character to the book *Bears on the Stairs* (Figure 1).

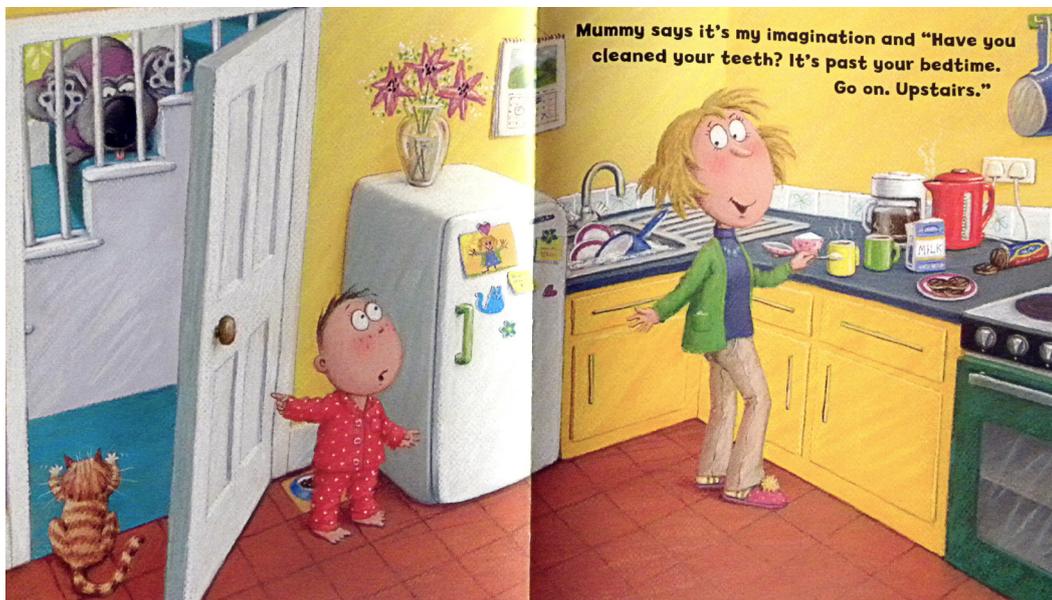


Fig.1. Lynne Chapman, *Bears on the Stairs*, 2010.

Even though it is not in the manuscript, the cat engages the reader in a whole new level by enhancing the story in a very clever way. It brings the opportunity of somewhat humorous interaction between the bears and the cat, reflecting the true feelings of the main character by proxy. It also enables the illustrator to subtly indicate places of higher interest on the page (Open College of the Arts, 2011).

However, the utmost responsibility of the illustrator is to maintain consistency of both verbal and visual communication levels of the book while enriching the story without contradicting the author's manuscript. To do so, many illustrators make a list of features and action that is encoded into the story already. Firstly, there is a certain level of action bond that should appear in the book. If the text portrays a busy character in a heap of action, the illustration should be complimentary in its mood. Nevertheless, there are some exceptions to this rule; for example, clever illustrations of Marla Frazee's picture book called *A Couple of Boys Have the Best Week Ever*, or Marta Altés's picture book *No!*. While Marta Frazee's illustrations use humour to contradict the text itself, which in the end adds a very special feeling to the book as a whole and make it rather enjoyable, Marta Altés's contradicting illustrations are based on presenting two different points of view to the reader, the human's and the dog's (Northrup, 2012, p. 2; Salisbury and Styles, 2012, pp. 108-110).

Figure 2 and Figure 3 illustrate differences in both of these approaches and show rather well how the contradiction is applied to both stories. Marla Frazee challenges the reader's conception of the written truths by visual inversions. For example, when James (the boy in blue shorts) comes to visit Eamon's family, the text implies that he comes with just a couple of his belongings, while the image clearly shows an abundance of boxes and bags bursting with James' stuff. Later, the text indicates the boys' decision to stay home, while the illustration shows them running away so fast they each lost one of their shoes and little clouds of dust formed behind them.

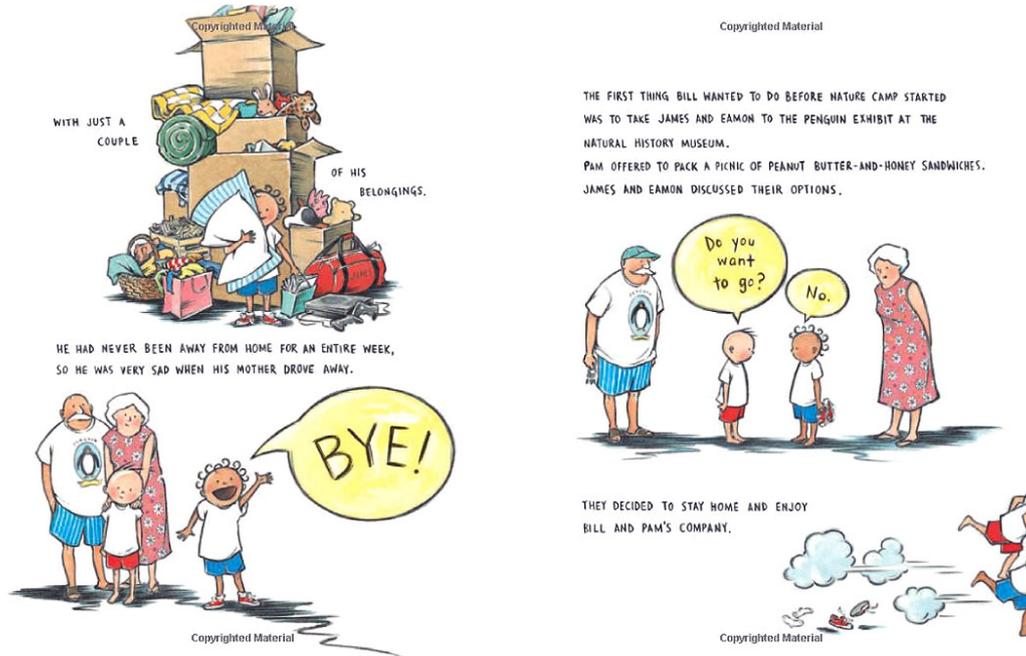


Fig.2. Marla Frazee, *A Couple of Boys Have the Best Week Ever*, 2008.

Marta Altés's approach is different. The textual and visual contradiction is based on the difference of a human's and a dog's conception of desirable and undesirable behaviour of a dog. While the dog assumes his family appreciates his frequent help with a variety of tasks and calls him No, the reader sees images of the same situations from a human point of view, seeing how the dog is being naughty while his family is trying to stop him by shouting 'no' at him.



Fig.3. Marta Altés, *No!*, 2011.

CHARACTER DEVELOPMENT

Crafting a believable character is imperative for the success of any picture book, especially because the majority of contemporary picture books are character-driven. However, creating such a character is a rather personal process for each artist, and therefore it varies somewhat from one illustrator to another.

First of all, the character should be based on the text of the narrative and generically recognisable characteristics. Getting to know the character thoroughly is therefore the best place to start. While some specifications come usually from the narrative itself, the rest is based on research. The research can provide the illustrator with both general identifiable features and delicate details of any animal or human that the artist can then apply to his/her drawings, making the characters accurate and instantly recognisable for the reader as a specific animal species or human being. While Will Terry states that those features of a cat such as pointy ears, eyes, whiskers, triangular nose, and wiggly tail applied on any shape will be deciphered by a reader as a cat, Lynne Chapman adds that it is a fine simplification and exaggeration of those features that in fact shapes the character, so "it looks real, it looks like a cat, but actually no, it's not. It's got this other picture book quality to it" (Will Terry, 2011; Open College of the Arts, 2011). Moreover, by making and adhering to general lists of physical appearance, personalities, abilities, and habits of their characters, illustrators safeguard the continuity of visual appearance of characters through the whole book.

Illustrators also often work with stereotypes. Martin Ursell (2013, p. 49) claims that "stereotypes are useful, essential even, in communicating character" for they present the reader with something instantly known to him/her. The artist, however, should build on stereotypes rather than make universal illustrations, for those would lack any diverse personality; a feature essential to any picture book's character. Furthermore, stereotypes often present only a single viewpoint which leads to failure of the book in the sense of broadening the children's horizons and encouraging their ability to form a more complex understanding of a story, topic, or people (Adichie, 2009). For that reason, stereotypes should be used wisely and only serve as a base to add the distinctive personality of the character that comes always from the particular story.

As for the character's gender preference, it has a tendency to cycle. While a study from 2011 revealed male characters outnumbering female in picture books, some illustrators that were interviewed stated that about 20 years ago, the situation was reversed and there was a significant push for including more male characters into picture books to encourage boys to read more (Flood, 2011; Sloat, 2013; Lies, 2013). While the lion's share of picture books nowadays are written clearly with one or the other gender of the character in mind, there are some gender-neutral manuscripts that leave the decision up to the illustrator. The attitude of illustrators to this topic is threefold. Firstly, there appears to be a double standard, for girls will gladly read books with male characters, but boys do not as eagerly read 'girl' books (Open College of the Arts, 2011; Murguia, 2013; Dewdney, 2013). For that reason, many illustrators would pick a boy to be their leading character, as Lynne Chapman did, for instance, in Julia Jarman's picture book *Bears on the Stairs* (Open College of the Arts, 2011).

Tom Lichtenheld has a completely different approach to this matter. He tries to break the general assumptions and prejudice of a need to have a male in the role of the main character. "For instance, when I'm reading to kids and come across a character of unspecified gender, I'll make it a female. I can actually detect a little hiccup in the children's understanding of the character because they assume it will be a male. I've even had kids protest that it should be a boy. Go figure" (Lichtenheld, 2013).

Secondly, the decision of the illustrator regarding the gender of a character can be influenced by personal reasons. There is an increased inclination to put one or the other gender as a main character based on the illustrator's own family background, especially the gender of the illustrator's own children. Other reasons can be purely artistic. Christine Tripp (2013) for instance, would probably draw a girl, because she loves "detail and quirkiness, and find both hairstyles and clothing can be manipulated by me, to a greater extent, with a girl than with a boy".

Many illustrators indicated that their decision would be based on the story itself, depending on the subject matter, action, setting, plot, and genders of the other characters in the narrative (Finn, 2013; Lies, 2013; Waites, 2013; Downing, 2013; Meidell, 2013). While Brian Lies (2013) adds that he likes to "listen for clues in the text – did the author IMPLY a boy or a girl?", Ann Marie Finn (2013) contributes with a great example of this advice in use, "I used a girl as the main character as it was about someone who despaired of their hair, so it made sense to have a girl for that".

LAYOUT

There are a few elements related to the layout that can enhance or diminish the reader's experience. Therefore, it is essential to keep them in mind and find a good solution for each publication to give it its best chance to succeed. To start with, many picture books work with full spread illustrations and therefore, a bleed¹ and a gutter² must be taken into account at all times. No important parts of the illustration should be placed near the gutter or too close to the bleed to prevent unwanted cropping or disruption in the image. According to Christine Tripp (2013), it is quite a common mistake even for the most experienced illustrators to do, because both pages of each full spread illustration are done as one continuing artwork and it is easy to get consumed by one's enthusiasm. If the illustrator happens to forget about the bleed and gutter, the illustration must be redone.

Secondly, a distance from the gutter and the bleed line must be always kept when dealing with the text to ensure the reader can go through the book without any disturbance, and while it is rarely the illustrator's duty to deal with the text itself, it is usually his/her responsibility to leave enough space for the text in the layout of the artwork.

In that sense, the illustrator must respect the gutter and the bleed limitations as well as the responsible graphic designer. To make sure that the block of text "will not overlap an important element of the illustration ... and the illustration will not interfere with the viewing and readability of the text", the illustrator needs to create an unoccupied zone within the artwork big enough to place the text into (Tripp, 2013). The right size of such an area can be calculated by using a dummy spread with text in correct size and font provided by the publisher. Lynne Chapman, for instance, likes to get such dummy spreads for each book she is working on, for it allows her to judge the space easily, even though the text's placement is not yet accurate (ShooRaynerLife, 2011).

¹ A bleed – an overlapping area that is cropped off in the process of binding

² A gutter – line where two pages are bound together

THE FLOW OF THE STORY

Establishing a natural, engaging flow of the narrative's story is imperative for the success of a picture book and its ability to be beneficial to children. The flow can be affected by many factors, such as the verbal pace of the narrative, division of the text, layout, composition of each page, and interaction of text and images. While the verbal pace is established by the author, the text division is done either by the editor or illustrator and is connected closely to a choice of a particular section of the text that is to be interpreted visually by the artist.

While there is no instant recipe for the right text division, there are some issues both the editor and the illustrator should have in mind. As it was already mentioned, it is the author's responsibility to lead the reader through the action. Illustrations, on the other hand, should engage the reader's imagination and stimulate emotional responses while leaving enough space for the reader's own interpretation of the text. A shadowy figure, a set of eyes glowing in the darkness, empty rooms, or busy scenes can be much more powerful than a simple visual depiction of the action already communicated through the author's writing. For that reason, it is often beneficial to leave the illustrator free hand in picking the text to illustrate and it is also preferable by the majority of illustrators who welcome this challenge (Salisbury, 2004, pp. 96-97; Creative Choices, 2009).

The paramount purpose of the pacing is to engage the reader and encourage him/her to turn to the next page and the next page until the entire book has been read. "The urge to turn the page can be weakened if images or spreads feel repetitive in terms of shape, colour, or scale. Each spread must be designed with its relationship to the preceding and following pages in mind, and indeed its relationship to the flow of the book as a whole" (Salisbury, 2004, p. 83). The layout of elements on the individual pages naturally adds greatly to this effort; nevertheless, it is the interaction of the text and the image in relation with each other or a composition of the parts of the illustration itself. Orientation of action or actions occurring in the illustration is also often taken into account. This can be related both to the movement of the leading character or other parts of the illustration. For instance, a character positioned in the lower left-hand corner of the spread running toward the edge would motivate the reader to find out what the character is running towards and subsequently initiate a page turn (Nikolajeva and Scott, 2006, p. 152).

Likewise, a variety of angles, viewpoints, orientation of action, and composition can complement the pacing of the book and influence a feeling and drama that comes from the narrative. The pace is usually established on a storyboard that is made of small thumbnails of all 32 pages³ of the picture book. However, only about 24 pages are usually dedicated to the story itself. The remaining pages are used for endpapers, a title page, a copyright page, a dedication, and in some cases, a right-hand first page and left-hand last page of the story. An example of a storyboard (Figure 4) for *A Tale of Two Penguins* picture book shows both the story division on spreads and pacing that is, as usual, developed through thumbnail sketches, for it is friendly to making any changes in a small amount of time. A variety of cropping, viewpoints, and layouts were used to communicate emotions, add drama, and bring a change of pace. A graphic element of borders around smaller images was used to add a partition firstly and eventually interaction between pages and the image itself later on. A lonely figure of a penguin framed inside the border of left page of the second spread is in strong contrast with the opposite page full of penguins having fun and communicates a different approach of the two main characters to the life and celebrations. The movement is mostly oriented from left to right, encouraging the reader to move forward, and is only reversed on two spreads where such a break of the established pattern was in tune with the action within the story. Endpapers were used to add to the narrative; for example, the back endpaper picturing the arrival of a package with a gift to a human home, while the story ends by the penguins sending the packages out on the last spread of the book.

³ A majority of picture books are 32 pages long. The reason for that can be traced to the printing process. If the publication is longer or shorter, it is always by 8 more/less pages.



Fig.4. Hana Hladíková, A Tale of Two Penguins Storyboard, 2014.



Top: Fig.5. Jerry Pickney, The Lion and the Mouse, 2009.

COLOUR CHOICES AND STYLE

Although the colour palette greatly affects the overall feeling of a picture book conveyed to the reader, its selection, even though based on what the story needs, seems to be an intuitive process for a majority of illustrators. Many times, there are a limited number of colours repeatedly occurring through the whole book, with the rest complementing them (Finn, 2013). This approach provides a continuity and feeling of wholeness within the book. Nevertheless, the utmost purpose of the colour is the creation of a mood. The mood can be triggered by many sources. Colours often convey the emotional load of the picture, "such as paintings done in tones of grey to express dreariness/unhappiness" (Lies, 2013).

A set of colours can be also picked to complement the setting of the story, or its theme, as Teri Sloat (2013) has done in her picture book, *I'm a Duck*, where she worked with "springtime colours" of pastels, or the use of yellows and browns in Jerry Pickney's book, *The Lion and the Mouse* (Figure 5) (Meidell, 2013). In some cases, colours are used to communicate the time of day, different seasons, or for establishing an area of focus within the illustration. Other times, colours are picked to create enough contrast within the picture. For instance, if the character is dressed in blue jeans and the story calls for a sofa the character is to sit on, the colour of the sofa should not be blue also.

IMPORTANCE OF COOPERATION WITH AN ART DIRECTOR, EDITOR...

Producing a picture book is a long process involving many people on different positions working as a team. Because of its very competitive market, only the best work can be accepted and "a skillful art director can bring out the best in an illustrator" (Tripp, 2013) by providing another educated opinion on the artwork. Art directors are also equipped with "different set of experience when it comes to viewing art so they can add from there great depth of expertise" (Meidell, 2013).

All illustrators stated that their cooperation with the art director is a critical part of their process. As it was already mentioned, the job of the art director starts even before the illustrator is chosen, and continues through the whole time of the book creation after the cooperation with the selected illustrator is confirmed. Art directors approve the route the illustrator is taking in different stages of the illustrating process, from sketches of characters, through storyboards, and rough sketches, to the final artwork, which gives the illustrator a sense of security that his/her final artwork will be accepted. In addition, the art director encourages the illustrator to produce the best artwork possible by providing helpful suggestions for changes, corrections and additions in the artwork, honest comments throughout the whole process, and any other support the illustrator needs.

CONCLUSION

Producing quality literature for young children is an enormous responsibility. Illustrators have a great impact on the ability of picture books to function correctly and succeed on the competitive market. An ultimate intention of this thesis was to determine the complexity of a picture book illustrator's job, point out elements that help the illustrator to produce an engaging, successful art and illustrate the importance of picture books for children on their journey to grow up as complex human beings. Thanks to excellent guidance and comments of illustrators interviewed there is a lot to learn and take inspiration from. ■

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REFERENCES

- Adichie, Ch. (2009) 'Chimamanda Adichie: Danger of Single Story', *TED*. Available at: http://www.ted.com/talks/chimamanda_adichie_the_danger_of_a_single_story.html (Accessed: 22 January 2014).
- AlbanKALB (2013) *Brown Bag Lunch Speaker's Forum: The Making of a Picture Book*. Available at: <http://www.youtube.com/watch?v=C8qclTXYnCO> (Accessed: 22 October 2013).
- Bosman, J. (2010) 'Picture Books No Longer a Staple for Children', *New York Times*, 7 October [Online]. Available at: http://www.nytimes.com/2010/10/08/us/08picture.html?_r=4&pagewanted=1 (Accessed: 7 October 2013).
- Creative Choices (2009) *Helen Craig: Book Illustrator*. Available at: <http://www.youtube.com/watch?v=cFeBM4h49LE> (Accessed: 29 October 2013).
- Dils, T. E. (2009) *You Can Write Children's Books*. 2nd edn. Cincinnati: Writer's Digest Books.
- Flood, A. (2011) 'Study finds huge gender imbalance in children's literature', *theguardian*, 6 May [Online]. Available at: <http://www.theguardian.com/books/2011/may/06/gender-imbalance-children-s-literature> (Accessed: 12 October 2013).
- Hladíková, H. (2013) *Questionnaire – answers by Ann Dewdney*, 22 October 2013.
- Hladíková, H. (2013) *Questionnaire – answers by Ann Marie Finn*, 4 November 2013.
- Hladíková, H. (2013) *Questionnaire – answers by Bethanie Murguia*, 5 November 2013.
- Hladíková, H. (2013) *Questionnaire – answers by Brian Lies*, 19 November 2013.
- Hladíková, H. (2013) *Questionnaire – answers by Christine Tripp*, 21 October 2013.
- Hladíková, H. (2013) *Questionnaire – answers by Joan Waites*, 12 November 2013.
- Hladíková, H. (2013) *Questionnaire – answers by Julie Downing*, 9 November 2013.
- Hladíková, H. (2013) *Questionnaire – answers by Sherry Meidell*, 28 October 2013.
- Hladíková, H. (2013) *Questionnaire – answers by Teri Sloat*, 24 October 2013.
- Hladíková, H. (2013) *Questionnaire – answers by Tom Lichtenheld*, 18 November 2013.
- IllustrationCourse (2011) *Children's book illustrator Patrice Barton on her art for „Mine!“ by Shutta Crum*. Available at: http://www.youtube.com/watch?v=Gq8ip_7nrds (Accessed: 18 October 2013).
- Kiefer, B. Z. (2009) *Charlotte Huck's Children's Literature*. 10th edn. Boston: MCGRAW-HILL Higher Education.
- LibraryOfCongress (2010) *Anita Silvey: 2010 National Book Festival*. Available at: <http://www.youtube.com/watch?v=1Fe0gQrVyFI> (Accessed: 20 October 2013).
- Nikolejeva, M. and Scott, C. (2006) *How Picturebooks Work*. London: Taylor & Francis Ltd.
- Northrup, M. (2012) *Picture books for children: Fiction, folktales and poetry*. ebrary Prague College [Online]. Available at: <http://site.ebrary.com/lib/pcollege/docDetail.action?docID=10635885&p00=draw+illustration> (Accessed: 25.10.2013)
- Open College of the Arts (2011) *How to Illustrate a book – part 1*. Available at: <http://www.youtube.com/watch?v=LKIME1rGoy4> (Accessed: 27 October 2013).
- Paul, A. W. (2009) *Writing Picture Books*. Cincinnati: Writer's Digest Books.
- Pierce, T. (2010) 'Five Reasons Why Children NEED Picture Books', *Terry Pierce: Children's Author*, 12 October. Available at: <http://terrypierce.blogspot.cz/2010/10/five-reasons-why-children-need-picture.html> (Accessed: 11 October 2013).

Reading Is Fundamental (2010) *CHOOSING GOOD BOOKS: Getting the Most Out of Picture Books*. Available at: <http://www.rif.org/us/literacy-resources/articles/getting-the-most-out-of-picture-books.htm> (Accessed: 17 October).

Revolution21 (2013) *BBC - The Beauty of Books. Part 3: Illustrated Wonderlands*. Available at: <http://www.youtube.com/watch?v=pVso9sEt31M> (Accessed: 12 November 2013).

Salisbury, M. (2004) *Illustrating Children's Books*. New York: Barron's Educational Series, Inc.

ShooRaynerLife (2011) *Illustrating books with Lynne Chapman*. Available at: <http://www.youtube.com/watch?v=rqUiaRCE3ao> (Accessed: 18 October 2013).

Ursell, M. (2013) *Illustrating Children's Books*. Ramsbury, Marlborough: The Crowood Press Ltd.

Will Terry (2011) *Drawing Characters - „How To Illustrate Children's Books" - 7videos-*. Available at: <http://www.youtube.com/watch?v=dWxdLNLKJvk> (Accessed: 10 October 2013).

IMAGE LIST

FIGURE 1: Chapman, L. (2010) *Bears on the Stairs*. London: Andersen Press Ltd., pp. 14-15, illus.

FIGURE 2: Frazee, M. (2008) *A Couple of Boys Have the Best Week Ever*. [book illustration].[Online]. Available at: http://www.amazon.com/Couple-Boys-Have-Best-Week/dp/0152060200/ref=sr_1_12?s=books&ie=UTF8&qid=1392110131&sr=1-12&keywords=frazee+marla (Accessed: 26 November 2013).

FIGURE 3: Altes, M. (2011) *No!* [book illustration].[Online]. Available at: <http://www.martaltes.com/No> (Accessed: 20 October 2013).

FIGURE 4: Hladíková, H. (2013) *A Tale of Two Penguins* [storyboard].

FIGURE 5: Pinkney, J. (2009) *The Lion and the Mouse* [book illustration]. [Online]. Available at: <http://www.lexpublib.org/page/2009-best-picture-books> (Accessed: 3 December 2013).

McDonald's



POST OFFICE



REPORT ON THE FINANCIAL EVALUATION: McDONALD'S CORPORATION AND YUM! BRANDS

TAMARA AYRAPETOVA

The aim of this paper is to perform financial analysis by using financial ratios and to comment, evaluate, and understand the origins of the results by using the comparison of two companies chosen as a case study.

The McDonald's Corporation is the largest fast food restaurant in the world. McDonald's Corporation statistics base it in over 119 countries and it serves more than 68 million customers daily. The company's revenues are coming not only from its primary products like hamburgers, cheeseburgers, etc., but also from rent, royalties, and fees paid by the franchisees. This report will look at the financial statements of the McDonald's Corporation over the past 3 years starting from 2010 through 2012. The author of the paper will apply financial ratios to analyze company's position and to identify patterns and trends. She will then compare the results of the analysis with one of the biggest competitors of McDonald's - Yum! Brands Inc. and the industrial averages. Yum! Brands Inc. is a US based corporation. It includes famous brands like KFC and Pizza Hut in their chain. Currently Yum! Brands are the largest competitors McDonald's has in the fast-food industry. To compare the two companies financial statements will be taken from Yahoo Finance (2013).

1.GRAPHICAL COMPARISON OF GENERAL PERFORMANCE MCDONALDS & YUM! BRANDS

To start this paper, the author will first give graphical comparisons of several financial factors, which determine the company's performance. The author will focus on total revenue, gross and net incomes of the companies to understand if there is a tendency in the industry. The analysis consists of data from over 5 years.

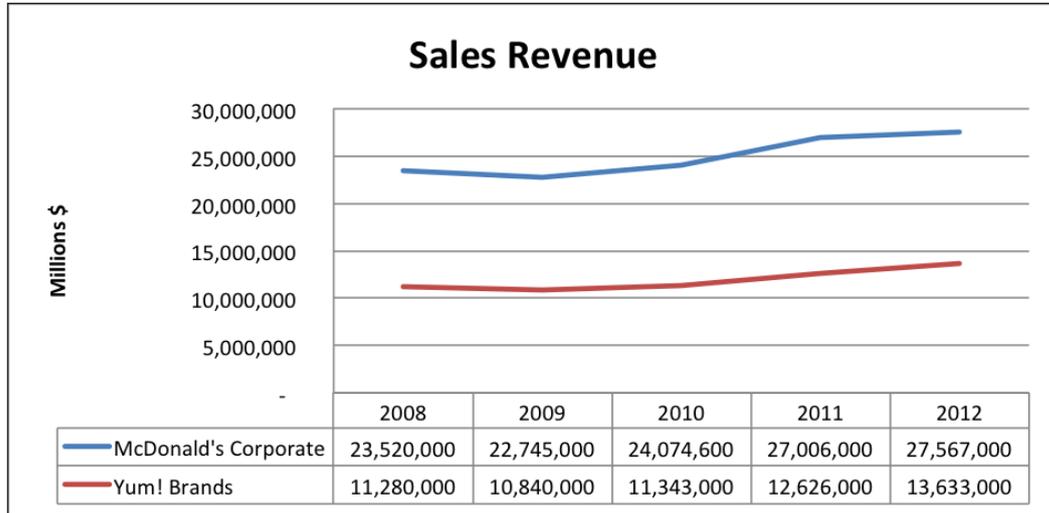


Figure 1: Sales Revenue Comparison McDonald's vs. Yum! Brands.

As one can see from the above graph, even though Yum! Brands are the second biggest chain, the total revenues are still considerably lower in comparison to the McDonald's revenues over the same period of time. We can see that there are trends in the movement as both of the companies experienced decline in revenues during the years 2009-2010. One of the main reasons this could be is the crisis the US was experiencing during that time. Looking at the gross profit and net profit we can also see the same tendency the lines do show a decrease in profits over 2009-2010 and an increase over 2011-2012. One can also see that McDonald's has experienced much more sufficient increase in income both gross and net in 2011 than Yum! Brands.

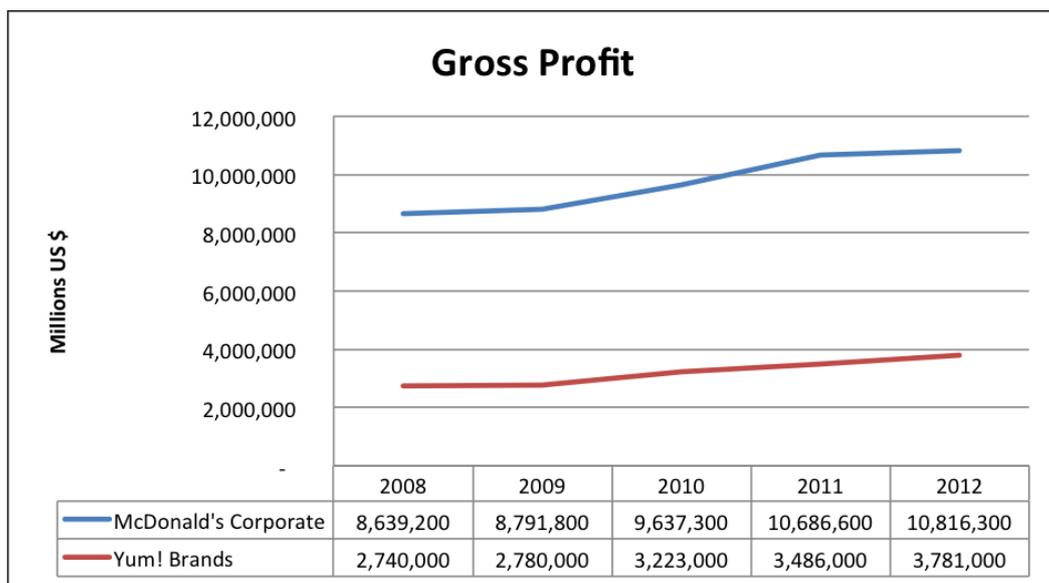


Figure 2: Gross Income Comparison McDonald's vs. Yum! Brands.

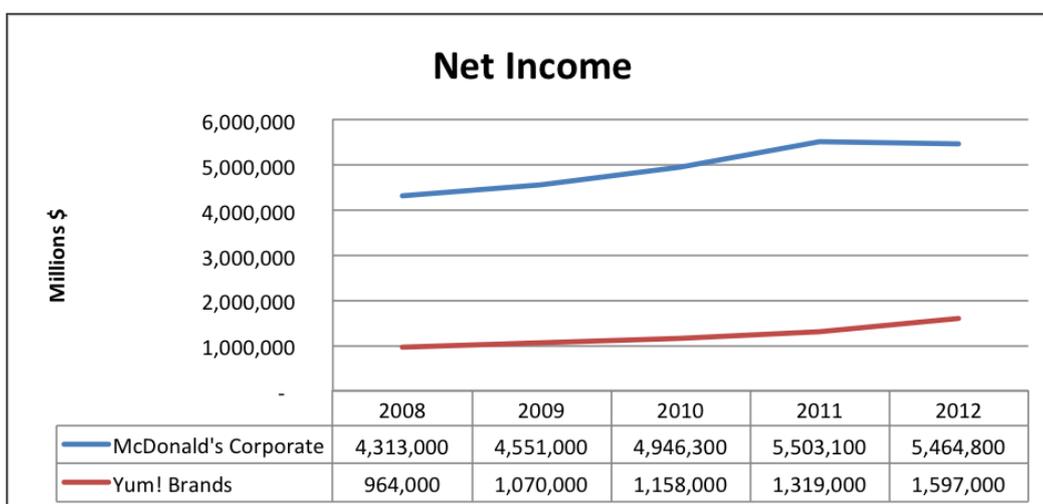


Figure 3: Net Income Comparison McDonald's vs. Yum! Brands.

2. FINANCIAL ANALYSIS

In this part of the paper we will look at the financial ratios and apply them to both of the companies. The author will firstly define the formulas used to calculate the ratios and then will comment on the results.

3.1 LIQUIDITY ANALYSIS

Liquidity ratios allow us to measure the ability of the company to meet its short-term obligations. Mainly they highlight if the company can pay off its liabilities on the due date. In this paper we will use Current Assets and Acid Test to see if McDonald's and Yum! Brands have THE necessary liquidity. Generally, the higher are the result of the ratios, the better the financial health of the company is. The desired minimum in this case would be value of 1.

$$\text{Current Assets} = \frac{\text{Current Assets}}{\text{Current Liabilities}}$$

$$\text{Acid test} = \frac{\text{Current Asset} - \text{Stock(Inventory)}}{\text{Current Liabilities}}$$

The results of those ratios one can find below:

TABLE 1 - MCDONALD'S CORPORATION

	2010	2011	2012
Current Assets	4 368 500	4 403 000	4 922 100
Current Liabilities	2 924 700	3 509 200	3 403 100
Current Asset Ratio	1,49	1,25	1,446357733

TABLE 2 - YUM! BRANDS

	2010	2011	2012
Current Assets	2 313 000	2 321 000	1 909 000
Current Liabilities	2 448 000	2 450 000	2 188 000
Current Asset Ratio	0,94	0,95	0,872486289

Current asset ratios shows the extent to which company is able to meet its short-term obligations, and as we can see, McDonald's has higher results than Yum! Brands. For all 3 years, Yum! Brands shows results lower than 1, which shows that they might have issues to pay their obligations. The reason why the results are so low is because Yum! Brands' current liabilities are higher than the assets the company holds (see Figure 4).

Looking at the Acid Test we can see similar trend:

TABLE 3 - MCDONALD'S CORPORATION

	2010	2011	2012
Current Assets	4 368 500	4 403 000	4 922 100
Intentory	109 000	116 800	121 700
Current Liabilities	2 924 700	3 509 200	3 403 100
Acid Ratio	1,46	1,22	1,41

TABLE 4 - YUM! BRANDS

	2010	2011	2012
Current Assets	2 313 000	2 321 000	1 909 000
Intentory	189 000	273 000	313 000
Current Liabilities	2 448 000	2 450 000	2 188 000
Current Asset Ratio	0,87	0,84	0,73

McDonald's has values over 1, which shows that the company is in a stable position whereas Yum! Brands are still showing results lower than 1, which shows that the company can have liquidity issues as large part of its current assets is actually inventory/stock which cannot be used to meet the obligations.

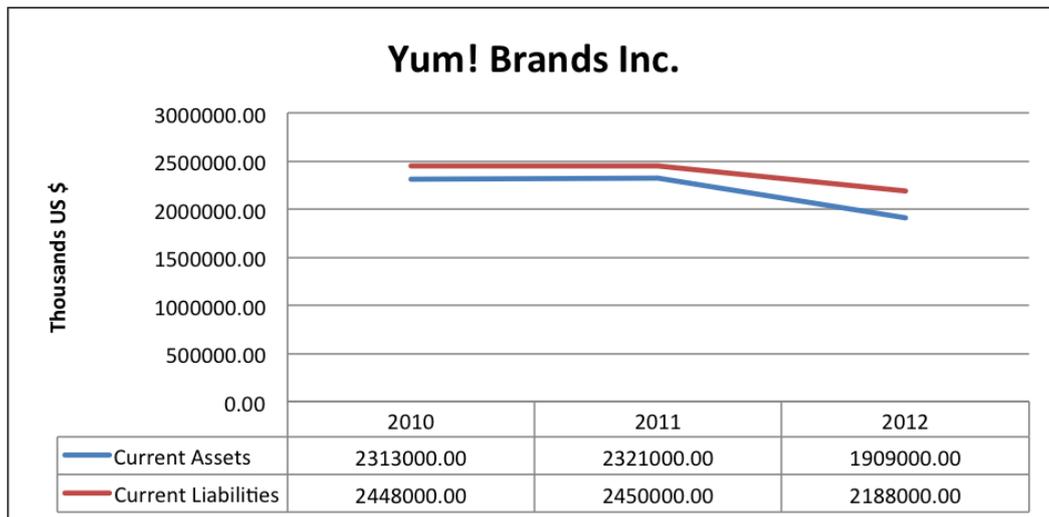


Figure 4: Current Assets to Current Liabilities Yum! Brands.

This leads us to another factor to consider when looking at liquidity, which is working capital (WC). Working capital shows us operational liquidity. The higher is WC, the lower is the chance of cash flow problems, and the more liabilities are covered by the currently owned assets. The formula for WC is:

$$\text{Working Capital} = \text{Current Assets} - \text{Current Liabilities}$$

One can find the results for both McDonald's and Yum! Brands below:

TABLE 5 - MCDONALD'S CORPORATION

	2010	2011	2012
Current Assets	4 368 500	4 403 000	4 922 100
Current Liabilities	2 924 700	3 509 200	3 403 100
Working Capital	1 443 800	893 800	1 519 000

TABLE 6 - YUM! BRANDS

	2010	2011	2012
Current Assets	2 313 000	2 321 000	1 909 000
Current Liabilities	2 448 000	2 450 000	2 188 000
Working Capital	-135 000	-129 000	-279 000

If we look at the results for WC, one can see that Yum! Brands experience WC problems. These results go together with acid and current asset ratios. The liabilities Yum! Brands has dramatically exceeded their assets, which can cause issues for them to pay their short-term liabilities. McDonald's is doing pretty good, even though the results are not ideal in terms of coverage (not 2:1) and are showing fluctuations, for example, in the year 2011.

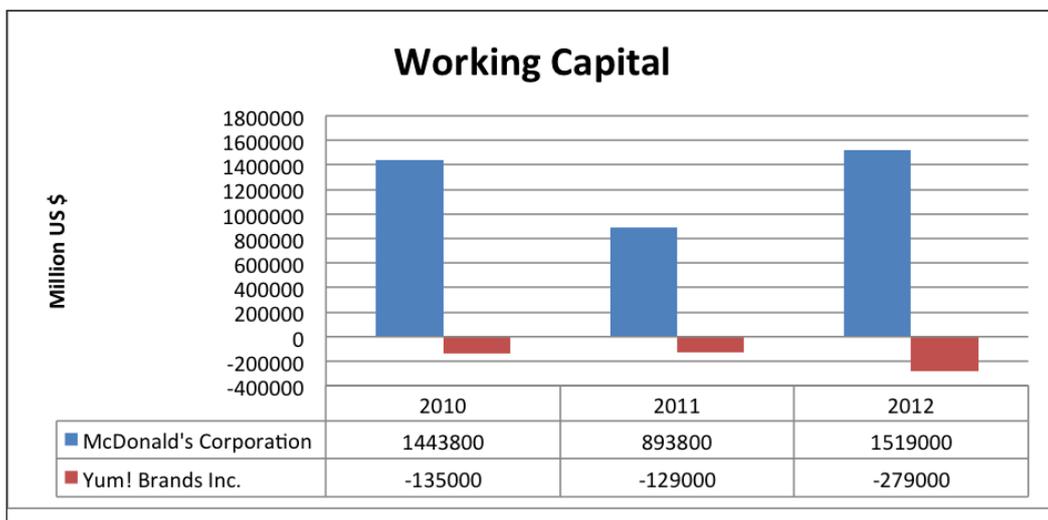


Figure 5: Working Capital McDonald's vs. Yum! Brands.

3.2 PROFITABILITY ANALYSIS

Profitability ratios help to measure a company's ability to generate earnings, profits, and cash flows by comparing the budget invested and the cash results of sales. In this paper we will use the Return on Capital Employed (ROCE) ratio to compare the cash earned with the cash invested. Gross Profit Margin is used to see the percentage by which profits exceed production costs and Net Profit Margin to see the amount of profit made after expenses and tax per sales dollar.

$$\text{ROCE} = \frac{\text{Earnings Before Interest and Tax}}{\text{Capital Employed}} * 100 \quad \text{or} \quad \text{ROCE} = \frac{\text{Profit Margin}}{\text{Asset Turnover}}$$

$$\text{Capital Employed} = \text{Total Assets} - \text{Current Liabilities}$$

$$\text{Gross Profit Margin} = \frac{\text{Gross Profit}}{\text{Total Revenue}} * 100$$

$$\text{Net Profit Margin} = \frac{\text{Net Profit}}{\text{Total Revenue}} * 100$$

The results for both of the companies are represented below:

TABLE 7 - PROFITABILITY RATIOS - MCDONALD'S CORPORATION

	2010	2011	2012
Earnings Before Interest and Taxes	8 595 600	8 505 000	8 595 600
Capital Employed	29 050 500	29 480 700	31 983 400
ROCE	30%	29%	27%

	2010	2011	2012
Capital Employed			
Total Assets	31 975 200	32 989 900	35 386 500
Current Liabilities	2 924 700	3 509 200	3 403 100
CE	29 050 500	29 480 700	31 983 400

	2010	2011	2012
Asset Turnover			
Sales Revenue/Total Revenue	24 074 600	27 006 000	27 567 000
Total Stockholder Equity	14 634 200	11 737 000	12 489 600
AT	1,65	2,30	2,21

	2010	2011	2012
ROCE			
Profit Margin	0,3570402	0,314930016	0,311807596
Asset Turnover	0,83	0,92	0,86
PM(%) * AT	30%	29%	27%

	2010	2011	2012
Gross Profit	9 637 300	10 686 600	10 816 300
Net Income	4 946 300	5 503 100	5 464 800
Sales Revenue/Total Revenue	24 074 600	27 006 000	27 567 000
Gross Profit Margin	40%	40%	39%
Net Profit Margin	21%	20%	20%

TABLE 8 - PROFITABILITY RATIOS - YUM! BRANDS

	2010	2011	2012
Earnings Before Interest and Taxes	1 594 000	1 659 000	2 145 000
Capital Employed	5 868 000	6 384 000	6 823 000
ROCE	27%	26%	31%

Capital Employed	2010	2011	2012
Total Assets	8 316 000	8 834 000	9 011 000
Current Liabilities	2 448 000	2 450 000	2 188 000
CE	5 868 000	6 384 000	6 823 000

Asset Turnover	2010	2011	2012
Sales Revenue/Total Revenue	11 343 000	12 626 000	13 633 000
Total Stockholder Equity	1 576 000	1 823 000	2 154 000
AT	7,20	6,93	6,33

ROCE	2010	2011	2012
Profit Margin	0,140527197	0,131395533	0,15733881
Asset Turnover	1,93	1,98	2,00
PM(%) * AT	27%	26%	31%

	2010	2011	2012
Gross Profit	3 223 000	3 486 000	3 781 000
Net Income	1 158 000	1 319 000	1 597 000
Sales Revenue/Total Revenue	11 343 000	12 626 000	13 633 000
Gross Profit Margin	28%	28%	28%
Net Profit Margin	10%	10%	12%

From above tables one can see that McDonald's generally has high ROCE, Gross and Net Profit Margins over the 3 years. However, in the year 2012 Yum! Brands have higher ROCE than McDonald's (see Figure 6) as their earnings before tax and interest increased, whereas McDonald's capital employed increased dramatically and the actual return stayed nearly the same as in 2011 which caused decline.

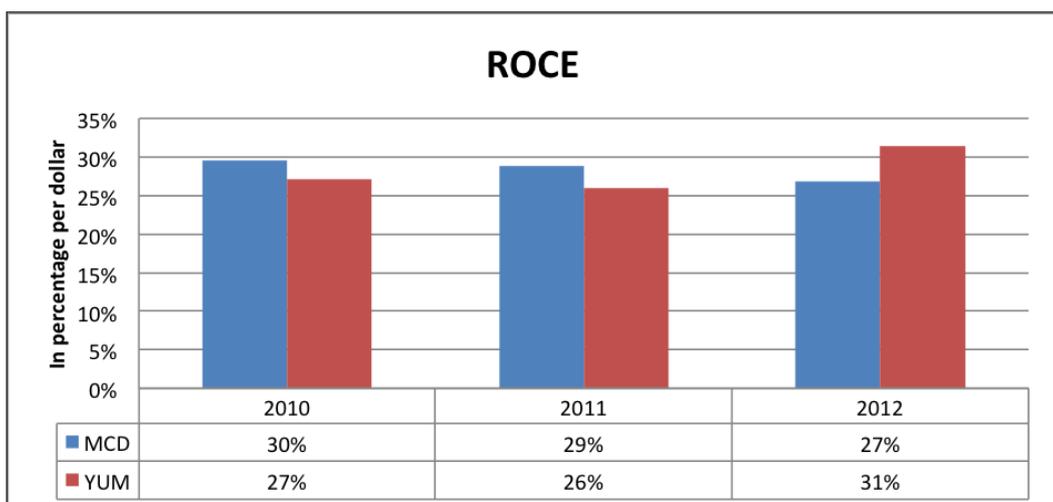


Figure 6: ROCE McDonald's vs. Yum! Brands.

When we look at the Gross and Net Profit Margins, McDonald's has much higher percentages than Yum! Brands (see Figures 7 and 8). This can be due to the better cost management systems the company has. Gross Profit Margin shows how well the company utilises and allocates its resources. In this case, McDonald's is also doing better. Looking at the Net Profit Margins, we can see that both of the companies surely do well, however Yum! Brands score substantially less than McDonald's. The main reason for such results can be that Yum! Brands have much more liabilities to pay than McDonald's. As we could see from Figure 4, they exceed the assets the company owns; due to this, the Net Profit can be very low after the company pays all of the expenses and its obligations. One can also see that over 3 years both of the companies did not experience dramatic increase or decrease in their Gross and Net Profit Margins; the numbers are nearly the same, which shows stability in their operations.

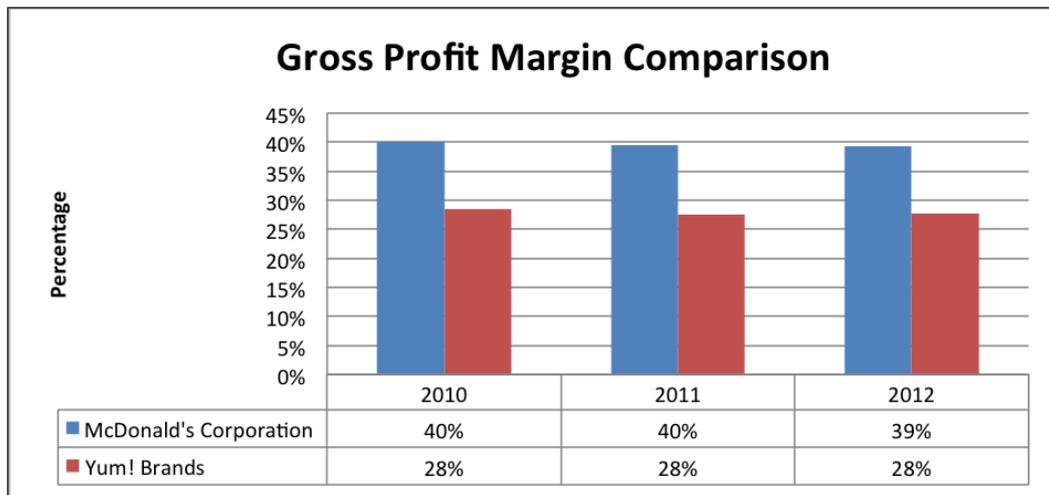


Figure 7: Gross Profit Margin McDonald's vs. Yum! Brands.

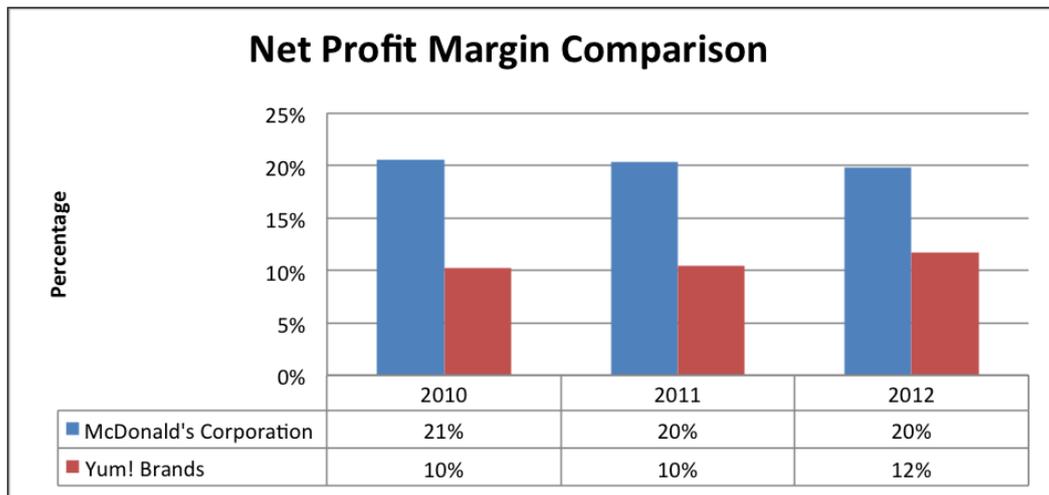


Figure 8: Net Profit Margin McDonald's vs. Yum! Brands.

3.3 EFFICIENCY ANALYSIS

Efficiency ratios show how well the company is using its assets and liabilities. The analysis mainly focuses on the measurement of efficiency by calculating turnover of receivables, fixed assets turnover, and the trade debtor collection period along with creditor payment period. Those ratios are particularly useful when the results are compared between competitors in the same industry. It is also true that change in these ratios directly impact profitability of the organisation.

$$\text{Stock Turnover} = \frac{\text{Cost of goods sold (Cost of Revenue)}}{\text{Closing stock (Inventory)}}$$

$$\text{Fixed assets turnover} = \frac{\text{Sales (Total Revenue)}}{\text{Fixed assets at net book value (Total Assets)}}$$

$$\text{Trade debtor collection period} = \frac{\text{Closing trade debtors (Net Receivables)}}{\text{Credit sales (Total Revenue)}} * 365$$

$$\text{Trade creditor payment period} = \frac{\text{Closing trade creditors (Accounts Payable)}}{\text{Total credit purchases (Cost of Revenue)}} * 365$$

The results of the above ratios can be found below:

TABLE 9 - EFFICIENCY RATIOS - MCDONALD'S CORPORATION

	2010	2011	2012
Cost of Revenue	14 437 300	16 319 400	16 750 700
Inventory	109 000	116 800	121 700
Stock Turnover	132,45	139,72	137,64
Total Revenue	24 074 600	27 006 000	27 567 000
Total Assets	31 975 200	32 989 900	35 386 500
Fixed Asset Turnover	0,75	0,82	0,78
Net Receivables	1 179 100	1 334 700	1 375 300
Trade debtor collection period (days)	17,88	18,04	18,21
Accounts Payable	943 900	961 300	1 141 900
Trade creditor collection period (days)	14,31	12,99	15,12

TABLE 10 - EFFICIENCY RATIOS - YUM! BRANDS

	2010	2011	2012
Cost of Revenue	8 120 000	9 140 000	9 852 000
Inventory	189 000	273 000	313 000
Stock Turnover	42,96	33,48	31,48
Total Revenue	11 343 000	12 626 000	13 633 000
Total Assets	8 316 000	8 834 000	9 011 000
Fixed Asset Turnover	1,36	1,43	1,51
Net Receivables	317 000	398 000	412 000
Trade debtor collection period (days)	10,20	11,51	11,03
Accounts Payable	1 775 000	2 130 000	2 178 000
Trade creditor collection period (days)	57,12	61,58	58,31

Looking at the first measure which is Stock Turnover, one can see that McDonald's numbers are higher than those of Yum! Brands (see Figure 9).

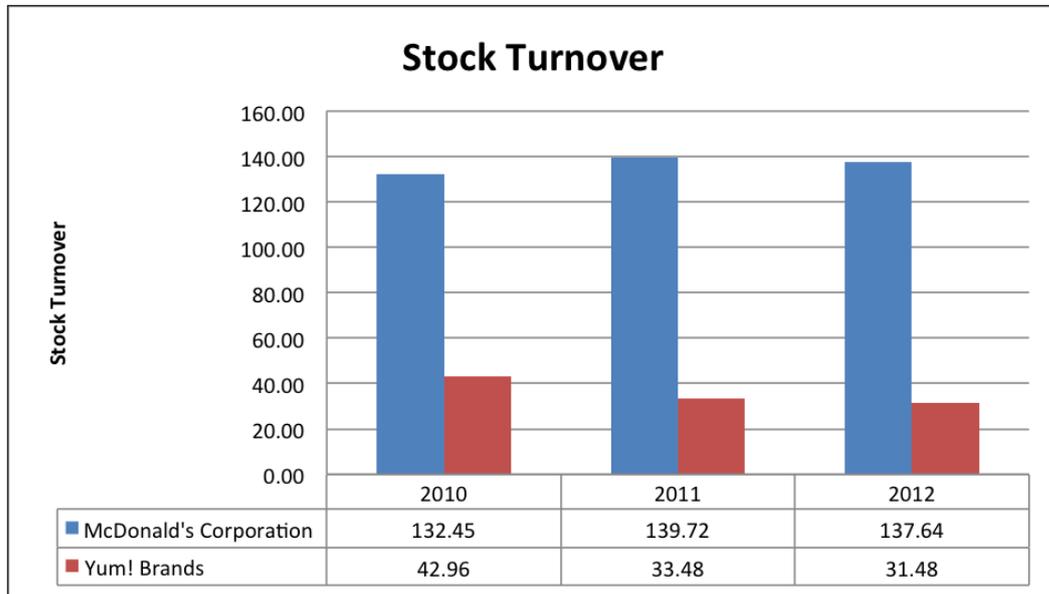


Figure 9: Stock Turnover McDonald's vs. Yum! Brands.

One can see that McDonald's has a positive trend whereas Yum! Brands has experienced a decrease in stock turnover over the 3 year period. The higher the stock turnover, the more efficient the company is in purchasing and selling goods. In this case, if we look at the numbers one can see that the inventory (stock) of McDonald's is actually nearly the same as of Yum! Brands but the Cost of Revenue is extremely higher, and this is the main reason why the results are so different.

The second measure of efficiency is fixed assets turnover (see Figure 10). Fixed assets are used to generate more sales, which means that a higher level of fixed assets tends to generate more sales. In this case the larger the result of the ratio is, the more amount of investment into fixed assets is recovered by the sales. The results can be expressed in percentages. Looking at the results of McDonald's and Yum! Brands (see Figure 10), one can see that Yum! Brands have much higher recovery on the investment into fixed assets.

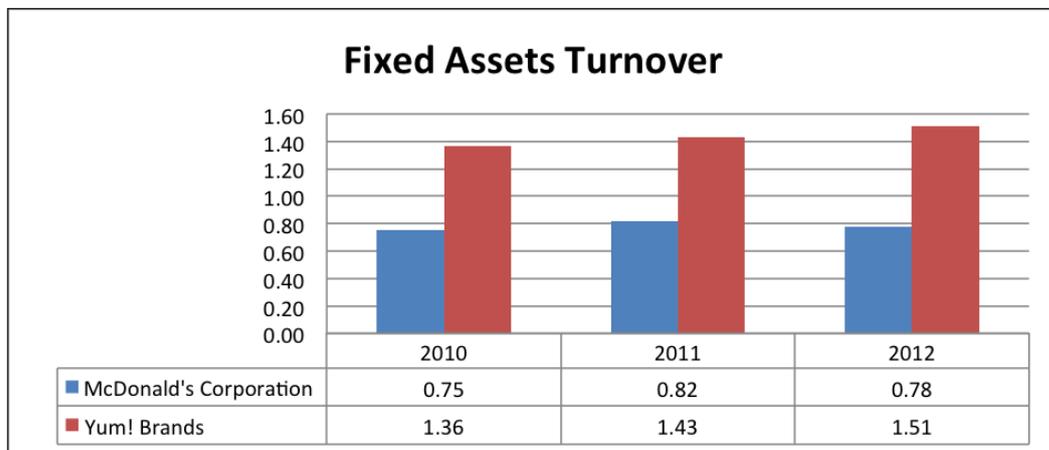


Figure 10: Fixed Assets Turnover McDonald's vs. Yum! Brands.

Such difference in the results can be caused by the amount of total assets the companies own. In the case of McDonald's, the number of total assets is much higher than the actual revenues. This tells us that with the number of assets McDonald's has, it could produce much more than it does. Whereas with Yum! Brands, the revenues are higher than the assets owned and there is a positive trend in sales.

Looking at the third important area, which is the trade debtor collection period used to determine the period of time a customer is required to pay back for the goods. The higher the result of this ratio is, the bigger the chance that the company will run into cash flow problems and will not be able to cover its sales costs.

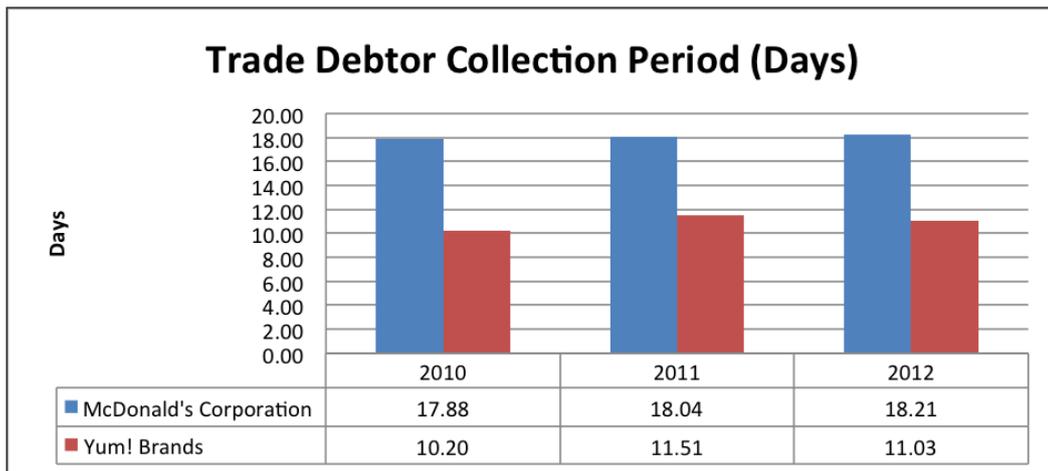


Figure 11: Trade Debtor Collection Period McDonald's vs. Yum! Brands.

As one can see from Figure 11, both of the companies have debtor collection periods lower than 1 month, which is mainly due to the origins of their business. Most of the customers will pay for their products straight away, only the payments from franchisees can come with a delay. From Figure 11 one can also see that,

McDonald's has a higher debtor collection period in comparison to Yum! Brands; one of the main reasons why this could happen is that McDonald's has more headquarters and franchisees than Yum! Brands. This makes the number of Net Receivables higher for McDonald's than for Yum! Brands as the majority of their customers are end consumers of the products.

Another criterion in efficiency analysis is trade creditor payment, which tells the settlement period for paying the suppliers. Higher results in this ratio would mean that company is experiencing issues to find a cash to pay its creditors/suppliers. Looking at the results of McDonald's and Yum! Brands in figure 12, one can see that McDonald's has a much lower creditor payment period than Yum! Brands do.

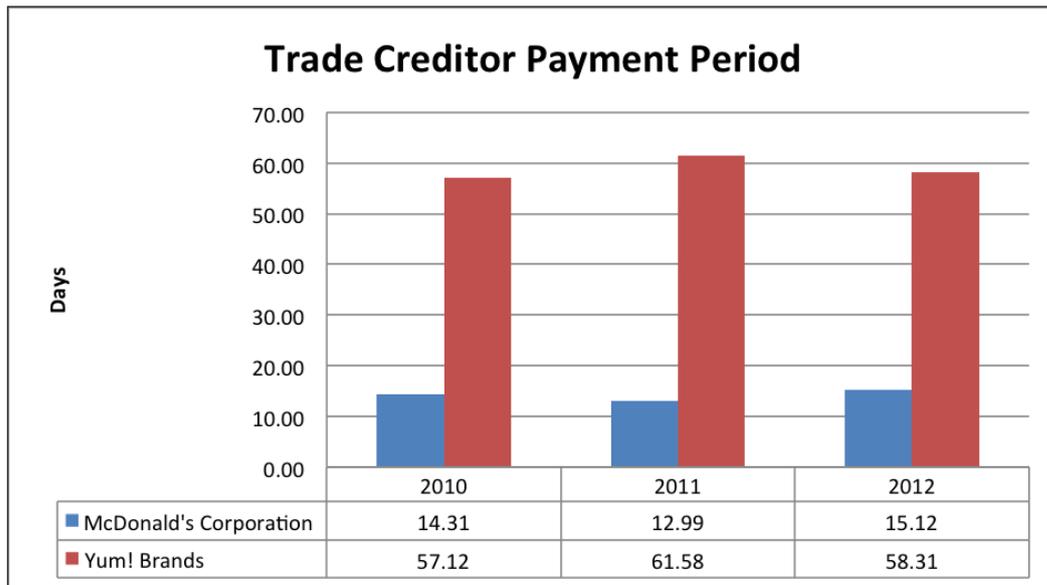


Figure 12: Trade Creditor Payment Period McDonald's vs. Yum! Brands.

One of the reasons why Yum! Brands might have such a high creditor payment period is the amount of liabilities they have to pay (Accounts Payable). Generally it is viewed that a standard credit period is 1 month, and in the case of Yum! Brands it is more than a month, and the result suggests that the company either needs to reduce the amount of liabilities or it has to generate more cash by increasing sales. The results for Yum! Brands correspond to what we have seen previously in Figure 4 and liquidity ratios.

The last metric one can consider in effectiveness analysis is Working Capital Cycle (WCC). In this paper we will calculate working capital cycle using the following formula:

$$WCC = \frac{\text{Average Working Capital} * 365}{\text{Total Sales Revenue}}$$

The results for both of the companies' one can find below:

TABLE 11 - WORKING CAPITAL CYCLE - MCDONALD'S CORPORATION

	2010	2011	2012
Working Capital	1 443 800	893 800	1 519 000
Total Revenue	24 074 600	27 006 000	27 567 000
Working Capital Cycle	21,89	12,08	20,11

TABLE 12 - WORKING CAPITAL CYCLE - YUM! BRANDS

	2010	2011	2012
Working Capital	-135 000	-129 000	279 000
Total Revenue	11 343 000	12 626 000	13 633 000
Working Capital Cycle	-4,34	-3,73	-7,47

As one can see from Figure 13 and the results, McDonald's has much more WCC than Yum! Brands. The negative results Yum! Brands received were caused by the negative working capital. This as the result means that efficiency of their resources is low and that they might not be able to meet their obligations.

3.4 INVESTMENT RATIOS

Investment ratios are used by investors to estimate the attractiveness of the specific investment. In this section we will look at most widely used ratios:

$$\text{Dividend Yield} = \frac{\text{Annual Dividend Declared per Share}}{\text{Market Price of Share}} * 100$$

$$\text{Earnings Per Share} = \frac{\text{Earnings after tax and dividends(Net Income from Continuing Operations)}}{\text{Common Shares (Outstanding Shares)}}$$

$$\text{Price Earnings Ratio} = \frac{\text{Market Price of the Share}}{\text{EPS}}$$

(Market price of the share was taken from closing historical prices for each year ending December 1 at Yahoo Finance)

$$\text{Capital gearing} = \frac{\text{Long – Term Debt}}{\text{Capital Employed (Total Stockholder Equity)}} \times 100$$

Where:

$$\text{Capital Employed} = \text{Total Assets} - \text{Current Liabilities}$$

The results for the ratios one can find below:

TABLE 13 - INVESTMENT RATIOS - MCDONALD'S CORPORATION

	2010	2011	2012
Annual Dividend Per Share	2,26	2,53	2,87
Market Price of the Share	76,76	100,33	88,21
Dividend Yield %	2,94	2,52	3,25
Earnings After Tax and Dividends	4 946 300	5 503 100	5 464 800
Outstanding Shares	1 054 000	1 021 100	1 003 000
EPS	4,69	5,39	5,45
Market Price of the Share	76,76	100,33	88,21
Price to Earnings Ratio	16,36	18,61	16,19
Long-term Debt	11 497 000	12 133 800	13 632 500
Capital Employed	29 050 500	29 480 700	31 983 400
Capital Gearing	40%	41%	43%

Capital Employed

Total Assets	31 975 200	32 989 900	35 386 500
Current Liabilities	2 924 700	3 509 200	3 403 100
CE	29 050 500	29 480 700	31 983 400

TABLE 14 - INVESTMENT RATIOS - YUM! BRANDS

	2010	2011	2012
Annual Dividend Per Share	0,92	1,07	1,24
Market Price of the Share	49,05	59,01	66,25
Dividend Yield %	1,88	1,81	1,87
Earnings After Tax and Dividends	1 597 000	1 319 000	1 158 000
Outstanding Shares	469 000	460 000	451 000
EPS	3,41	2,87	2,57
Market Price of the Share	49,05	59,01	66,25
Price to Earnings Ratio	14,40	20,58	25,80
Long-term Debt	2 915 000	2 997 000	2 932 000
Capital Employed	5 868 000	6 384 000	6 823 000
Capital Gearing	50%	47%	43%

Capital Employed

Total Assets	8 316 000	8 834 000	9 011 000
Current Liabilities	2 448 000	2 450 000	2 188 000
CE	5 868 000	6 384 000	6 823 000

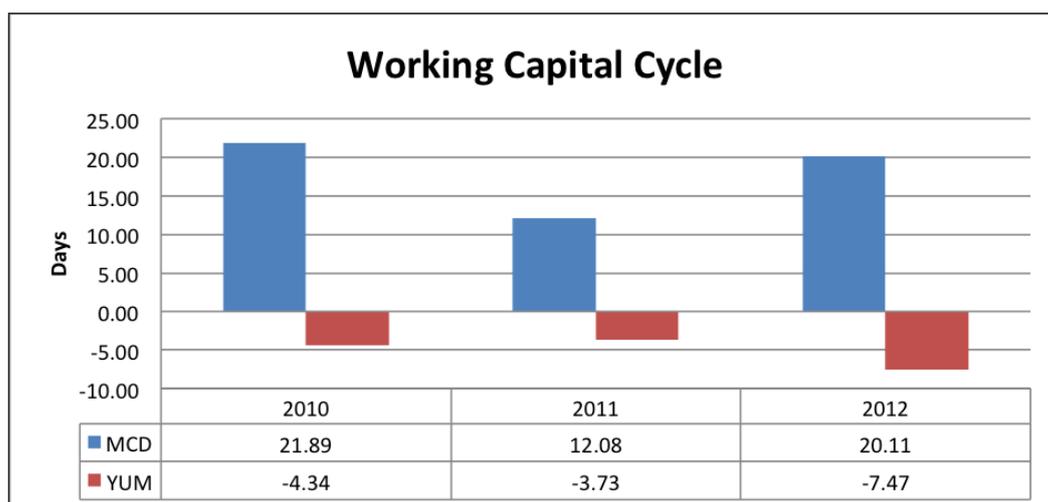


Figure 13: WCC McDonalds vs. Yum! Brands.

To start our comparison, we will firstly look at dividend yield. It shows the productivity of the investment, being more specific, it represents how much cash flow the investor is getting per dollar invested. In the case of McDonald's and Yum! Brands, we can see that Yum! Brands has a lower cash flow per dollar than McDonald's (see Figure 14).

One of the main reasons why McDonald's has higher results is because it has a higher net income from which it can pay higher dividends. This can be a result of efficient cost reduction strategies and utilisation of the equipment, which we have seen from the efficiency ratios.

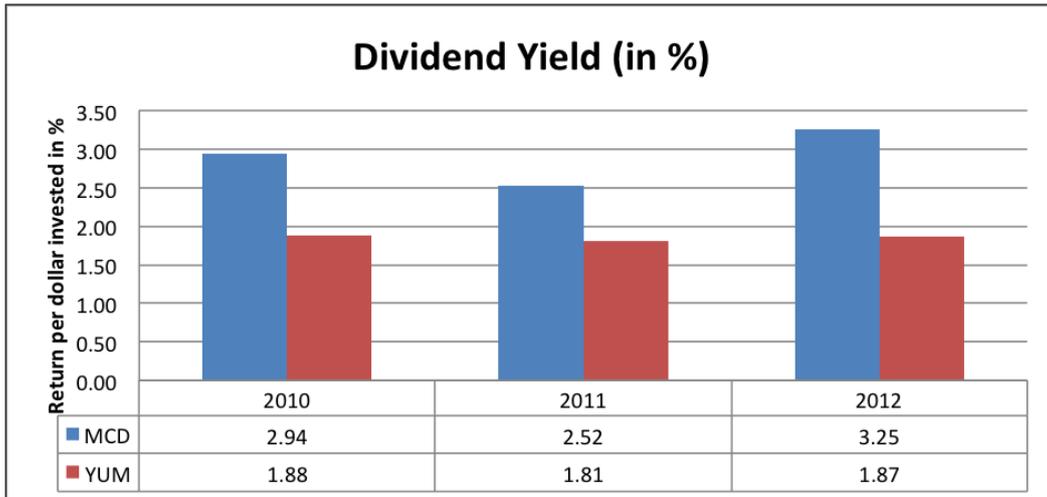


Figure 14: Dividend Yield McDonald's vs. Yum! Brands.

Looking at the EPS of the companies we can see that Yum! Brands EPS is lower than McDonald's. This ratio is very popular between investors as it tells how much the market is willing to pay for a company's earnings. The higher is the ratio, the more the market wants to pay, and the more positive is the prediction for the future growth of the share price. The reason why Yum! Brands have lower EPS can be explained by the relationship between equity and liabilities. As the company has much more liabilities than the equity, it therefore has more expenses and this decreases the net income from which EPS is calculated. There is also a negative tendency over the years. This can be explained by an increase in the number of shares as the company grows and less increase in earnings. McDonald's in this case is more stable than Yum! Brands.

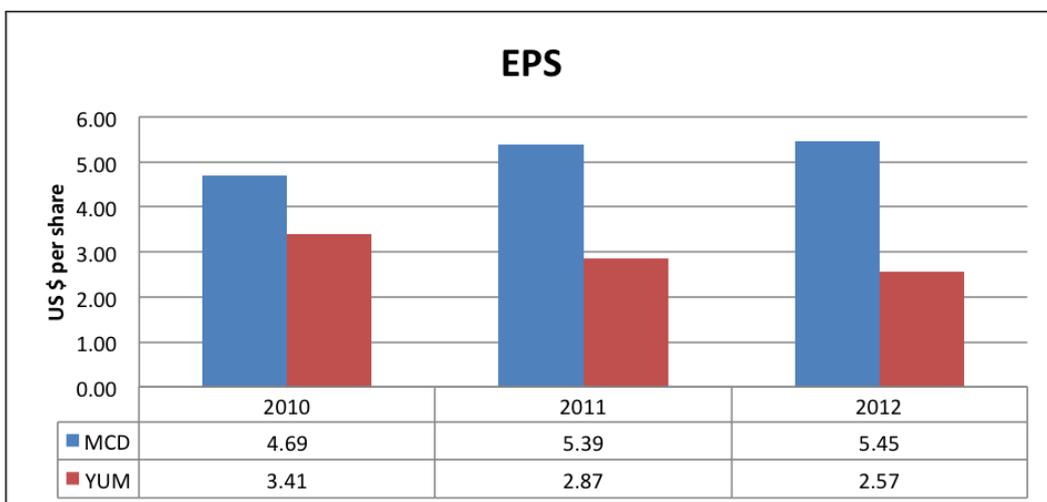


Figure 15: EPS McDonald's vs. Yum! Brands.

The next indicator is Price to Earnings Ratio (P/E). This indicator is a tricky one as most of the investors tend to forget that the lower is the result of this ratio, the more profitable is the investment. Generally, a value of 12-15 counts to be good. In this case one can see that Yum! Brands are doing much better than McDonald's (see Figure 16) in 2010; however they did much worse in 2011-2012. As this ratios links stock share price with EPS, one of the reasons why Yum! Brands had a change the results might be an increase in the pricing of their shares as they grow, but a less sufficient increase in their EPS.

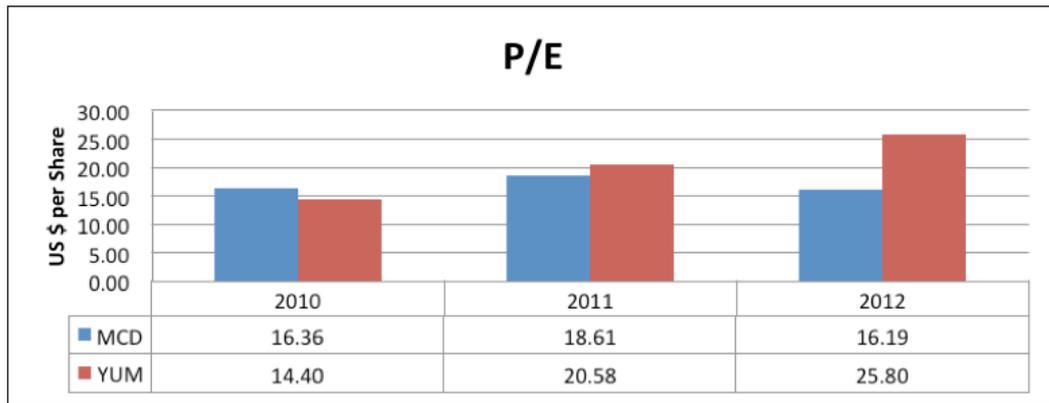


Figure 16: Price to Earnings Ratio McDonald's vs. Yum! Brands.

The next indicator we will look at in this section is the Capital Gearing Ratio. This ratio shows the capital structure of a company and its financial strength. The higher the ratio is, the more risky the investment is since the more activities of the company are supported by borrowed funds, the more interest the company has to pay for its debt. As one can see from Figure 17, Yum! Brands have much higher results than McDonald's, and this corresponds to what we have seen previously as the company has a lot of liabilities and debt. Even though McDonald's has lower results, one should notice that it still has a lot of long-term debt, which can be covered by its capital, but not in full.

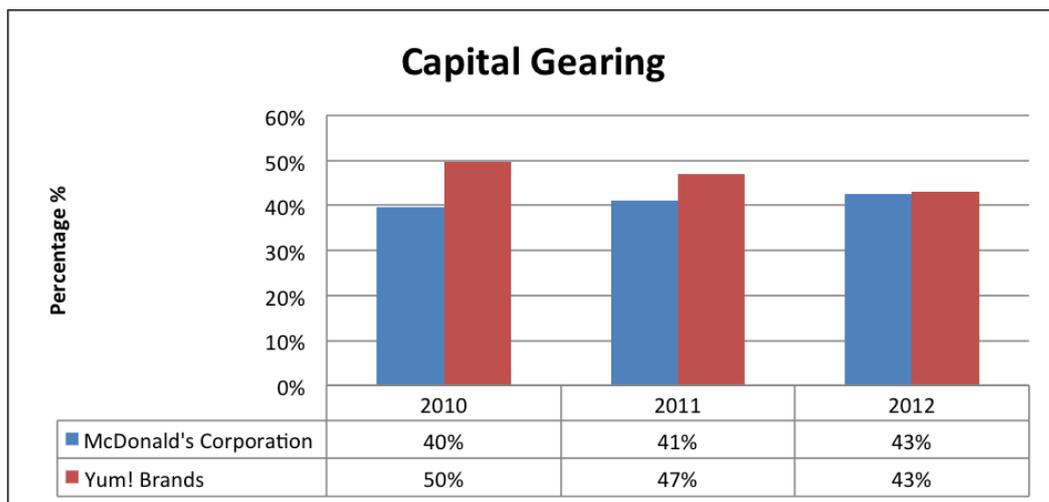


Figure 17: Capital Gearing McDonald's vs. Yum! Brands.

Normally, the ratios for a low-gearing company would be under 25%, and everything in between 25%-50% middle-gearing, and everything over 50% highly-gearing. As we can see, both McDonald's and Yum! Brands are middle-gearing companies. In this case, McDonald's still performs better than Yum! Brands. One of the main reasons is the long-term debt the company holds and its relationship with the capital employed. As we have seen previously, Yum! Brands have a lot of short-term and long-term liabilities, whereas their assets are not increasing as dramatically as needed; due to this, McDonald's is a safer investment.

It is important to remember that not always financing business through long-term debt gives negative outcomes, as it is most of the times cheap. It would really depend on the ability of the company to raise profits to cover this debt. In this case, both of the companies have great potential, but McDonald's has better performance in meeting its liabilities.

4. MCDONALD'S AND YUM! BRANDS VS. INDUSTRIAL AVERAGES

4.1 MCDONALD'S VS. YUM! BRANDS STOCK PERFORMANCE EVALUATION

In this section of the paper we will look at the performance of MCD and YUM stocks over a 3-year period. The author will use SharpCharts from which one could see the volume of the traded stock, the opening and closing price, the change in the price in percentage for the date of 6 Dec 2013. One can also find the MACD (Moving Average Convergence-Divergence), Slope charts, MA (50), MA (200), and RSI.



Chart 1: MCD Stock Performance (3 years). Stock Charts (2013)

At the top of Chart 1 one can find the RSI indicator. This indicator stands for Relative Strength Index and is a momentum oscillator. This indicator can vary from zero to 100. RSI can be of different parameters, and in this case the author is using the default 14-day parameter; however, if one needs to increase sensitivity, he/she should reduce it to 10 days. Since RSI is an oscillator, it determines when the market is overbought or oversold. Generally, it is considered that if RSI is above 70, then it is overbought; if it is less than 30, then it is oversold. If the stock is overbought, then it might experience a decline in price, whereas if it is oversold, it has potential to grow in the future. Investors use RSI to identify the best time to sell or buy financial assets. When the asset is approaching 70, it is beneficial to sell it, whereas if the stock is approaching 30, it is time to buy. As one can see both YUM and MCD are stable stocks.

As one can see from Charts 1 and 2, the results for MCD and YUM are not falling into any of the categories. In the Chart 1, one can see the blue and the red lines which stand for moving averages (MA). This indicator helps to better analyse the price movement by eliminating 'noise' from random price fluctuations. This indicator is based on previous prices due to sometimes it can lack accuracy. Generally, there are two types of MAs, SMA (Simple Moving Average) and EMA (Exponential Moving Average). The main difference between the two is that EMA gives bigger weight to more recent prices. In this report, we will consider SMA for the period of time of 50 days and 200 days, represented respectively by blue and red lines.

As one can see, the SMA for the 50 days period is much higher than SMA for 200 days. MA (50) has the price of \$95.43 and SMA (200) only \$82.35. MA for a shorter period of time will have smaller lag than MA for a longer period such as 200 days. Therefore, short-term investors would prefer to refer to short-term MAs whereas long-term investors generally prefer to look at a long-term MA.



Chart 2: YUM! Stock Performance (3 years). Stock Charts (2013)

Even though the prices for MA (200) is lower, it is still on the uptrend, which indicates that the security has growth. One can also see that in the MCD case, the long-term MA and the short-term MA did not crossover, which indicates that overall the performance is on a steady growth path. Comparing MCD, MA (50) and (200) with the results for YUM represented in Chart 2, one can see that the averages are smaller for YUM- MA (50) – 69.11 and MA (200) - 56.68. One can also see the same tendency that MA (50) is larger than MA (200), and the author assumes that one of the reasons for this is the lag. Both of the companies though have a positive uptrend over the 3 years.

MA is not only a single indicator but also a contributor to the next measure which is Moving Average Convergence-Divergence (MACD). This indicator, which one can see represented in both Charts 1 and 2 below the main body, is counted to be the easiest momentum indicator. What it does is it subtracts longer moving average from the shorter moving average. The shorter the period under study, the more sensitive are the results. In this report we will use the standard setting (12, 26,9). The investors tend to look for the signal lines crossovers, centerline crossovers, and divergences to generate signals. Since MACD is based on concepts of convergence and divergence, it is important to mention that convergence occurs when the MAs move towards each other and divergence occurs when they move away from each other. As one can see from Charts 1 and 2, both of the companies have convergence in the movement of the MAs. One can also see that the averages are higher for YUM than for MCD as it experienced a negative performance during the second half of the year 2012 until 2013.

The last indicator in this section, the slope, is a result of linear regression which generates the line of best fit for a price series. This indicator is a good tool to measure the direction and strength of a trend. Investors can also use it in combination with other tools to identify the potential point of entry to the already on-going trend. The trend can fluctuate above and below zero. In this paper the author took the 52-week slope. As one can see, MCD has a positive trend until the first quarter of 2012 first when it experienced a decline which one could also see in the results of the ratios for the previous sections. From the third quarter of year 2013 until the first quarter of 2013 MCD was in negative territory; however, then it experienced growth. As for the YUM! Brands one can see that the trend is much more positive and the period where they performed under the positive region is shorter (only the first quarter of 2013). If we look at the average YUM has 0.18 and MCD 0.12, which means that YUM has a more positive price trend than MCD.

4.2 INDUSTRY COMPARISON

In this section of the paper, the author will compare stock performance of YUM and MCD to each other as well as to the industry indices like S&P 500 and Dow Jones. In Chart 3 one can see the comparison of MCD and YUM, and S&P 500, and DJ Indices stock performance. S&P 500 stands for Standard & Poor's 500 Index. This index consists of 500 stocks which are chosen by market size, liquidity, etc. This index is meant to be the leading indicator of the U.S. stock market. Previously, it was the Dow Jones Index which is also represented in Chart 3 in red; however, since DJ includes only 30 companies, S&P 500 is considered to be the best representation. Both of the indices are appropriate for this specific comparison since we are evaluating companies which are listed in the NYSE.



Chart 3: MCD, YUM, S&P 500, and DJ Comparison. Yahoo Finance (2013).

When we look at Chart 3 one can see that both MCD and YUM outperform S&P 500 and DJ indices, which shows that generally both of the companies have higher growth than the competitors and are attractive to investors. If one compares the performance of MCD to YUM, we can see that through the years 2007-2012 MCD has the highest prices and the best stock performance. However, starting in 2012 we can see that YUM is actually performing at the same level with periodic crossover. It is essential to highlight here that both of the companies are the benchmarks of the industry and of course even when they experience a decrease in their prices, they can outperform the competitors, as one can see from Chart 4.



Chart 4: Comparison to Direct Competitors. Yahoo Finance (2013).

In Chart 4 one can see the comparison of several stocks, which are directly competing with MCD and YUM. Those are stock of companies – Wendy & Corporation, Burger King, and Starbucks. The chart also shows S&P 500 represented by a light-green line. As one can see, starting end of 2007 beginning of 2008, when the U.S. market experienced a crisis, the performance of S&P 500 and YUM and MCD are dramatically different.

As S&P 500 shows most of the companies experienced a decline in their stock performance; however, for MCD and YUM we can see a positive trend. When we look at Wendy's Corporation, we can see that starting in the year 2007, it experienced a decline and after this, it did not experience any major growth and is beyond the S&P 500 index.

Whereas Starbucks after experiencing a decline in the years during the crisis, experienced growth and still has a positive trend, even though it is still has lower stock prices than YUM and MCD. When we look at Burger King, the data is available only starting in the year 2012, and we can see that the stock performance is nearly the same as of S&P 500. Comparing all of the stocks one can see that MCD and YUM outperform all of their competitors and also the S&P 500 Index.

4.3 FINANCIAL RATIOS MCDONALD'S AND YUM! BRANDS INDUSTRY COMPARISON

In this section the author will compare the two companies with industrial averages for a set of ratios which are usually used by investors to evaluate the performance of the stock. The author of the report referred to Morning Stars' (2013) estimates, which one can find below:

FIGURE 18 - - MCD AND YUM! VALUATION

	MCD	YUM	Industry Avg.
Price/Earnings	17.4	32.5	29.5
Price/Book	6.3	15.8	7.7
Price/Sales	3.5	2.8	2.5
Price/Cash Flow	13.7	17.7	11.6
Dividend Yield %	3.2	1.8	1.9

When we look at the **P/E** ratio, one can see that industry average for this metric is 29.5, high P/E ratio is less attractive for investors as it means that they are paying more for the earnings. In this case, Yum! Brands is more attractive for the value investors, who are looking for undervalued stocks, with the potential growth, whereas McDonald's would be desirable for growth investors who are looking for the stock with high growth rates. Yum! Brands shows higher results than the industry average and this means that the company might face issues with solvency.

Price/Book ratio provides an understanding if the stock is overvalued or undervalued. As one can see Yum! Brands score much higher than McDonald's and the industry average, which might mean that the stock is overpriced or investors have high expectations. McDonald's in this case scores lower than the industry average, which means that the stock is underpriced, due to lower growth expectation associated with it, whereas Yum! Brands exceeds the industry average which might mean that it is overvalued.

Price/S compares the value of the stock to either its own performance in the past or to other companies. It determines how much investors pay for the dollar of company's sales. Therefore, the lower the ratio is, the more attractive the stock is. This measure can be very useful only when comparing to the industry average, and in this case, the industry average is 2.5, as we can see both Yum! Brands and McDonald's score higher than this, but Yum! Brands is performing better than McDonald's.

P/C metric compares stock market price to cash flow generated per-share. This ratio is similar to P/E, however a lot of investors consider it much more solid. The main reason behind this is that cash flow is generally harder to manipulate, whereas earnings are affected by such factors like depreciation. The same way as the P/E ratio, the lower the results, the better. The industry average for this ratio is 9.6 which both of the companies outperform. However, McDonald's has lower scores than Yum! Brands. These results correspond to the working capital issues Yum! Brands currently has.

When we look at the last metrics, **Dividend Yield**, which represents the return (in percentage) the company pays out in dividends. The average for this metrics is 1.9%, which is higher than what Yum! Brands pays out. McDonald's, though, exceeds this amount and it pays 3.2%. It is important to notice here that generally older companies tend to pay higher dividends, and their dividends history tends to be more stable.

To summarise the above, the author wants to highlight that generally McDonald's is performing better than Yum! Brands. It is more stable and has better return on the investment. As in most of the ratios, it scored less than Yum! Brands. Even though Yum! Brands show concerns in areas of cash flow, working capital and debt, their growth rates are high and are increasing from 2012. This might help the companies to increase revenues to cover liabilities.

5. CONCLUSIONS

In this paper the author has performed financial analyses for McDonald's and Yum! Brands. She has compared the results of the liquidity, profitability, efficiency, and investment ratios as well as looked at the industrial averages to better evaluate the companies' performance.

From the above analyses, the author can conclude that McDonald's performed much better than Yum! Brands in all of the areas investigated. Yum! Brands are experiencing issues with working capital and might face problems with covering their short-term and long-term liabilities. They are also less efficient in managing their costs of production, even though they utilise their assets better than McDonald's. Yum! Brands performed better in ROCE in 2012 due to an increase in their Gross Profit; however, they have a lower Net Profit Margin than McDonald's. This can be explained by the expenses the company encounters and their costs management and pricing systems. Another reason why McDonald's performed better nearly in all profitability ratios was because of the number of liabilities Yum! Brands need to pay. As we have seen from the liquidity ratios, those exceed their assets.

If we look at the efficiency ratios, McDonald's has higher debtor collection period and lower fixed asset turnover than YUM, but the company still does not have problems with the Working Capital Cycle. It also performs better in the creditor collection period, which shows that the company has enough cash to pay to its creditors in the short-term.

When one considers investment ratios, he/she can see that McDonald's also scored better. It has a lower P/E ratio meaning that investors pay less for the earnings they receive than Yum! Brands. Its EPS is higher and therefore the Dividend Yield is also higher than that of Yum! Brands, and exceeds the industry average. Its Capital Gearing Ratio shows that it is a low-gearing company and is less risky as an investment. If we look at the stock performance one can see that McDonald's has a positive trend of growth and outperforms the S&P 500 and DJ Indices. It also outperforms all of the competitors in its sector, including Burger King and Wendy's Corporation. However, when we look at Yum! Brands we can see that they entered into competition with McDonald's in 2012, and in the future it can be a very attractive stock to invest in for the growth investors. McDonald's, on the other hand, would be an option for value investors who are seeking for long-term investments. ■

REFERENCES

Yahoo Finance (2013) *Financials McDonald's Corporation*. Available at: <http://finance.yahoo.com/q/is?s=MCD+Income+Statement&annual> (Accessed: 1 November 2013).

Yahoo Finance (2013) *Financials Yum! Brands*. Available at: <http://finance.yahoo.com/q/is?s=YUM+Income+Statement&annual> (Accessed: 1 November 2013).

Morning Star (2013) *McDonald's Corporation MCD*. Available at: <http://financials.morningstar.com/valuation/price-ratio.html?t=MCD®ion=USA&culture=en-US> (Accessed: 11 November 2013).

Morning Star (2013) *Yum Brands Inc*. Available at: <http://financials.morningstar.com/valuation/price-ratio.html?t=YUM®ion=USA&culture=en-US> (Accessed: 11 November 2013).

Yahoo Finance (2013) *Historical Prices: MCD*. Available at: <http://finance.yahoo.com/q/hp?s=MCD+Historical+Prices> (Accessed: 11 November 2013).

Yahoo Finance (2013) *Historical Prices: Yum! Brands*. Available at: <http://finance.yahoo.com/q/hp?s=YUM+Historical+Prices> (Accessed: 11 November 2013).

Stock Charts (2013) *SharpCharts*. Available at: <http://stockcharts.com/h-sc/ui?s=mcd> (Accessed: 7 December 2013).

McDonald's Corporation (2013) *Annual Report 2012*. Available at: <http://www.aboutmcdonalds.com/content/dam/AboutMcDonalds/Investors/Investor%202013/2012%20Annual%20Report%20Final.pdf> (Accessed: 29 November 2013).

Yum! Brands (2013) *Annual Report 2012*. Available at: <http://yum.com/annualreport/pdf/2012yumAnnReport.pdf> (Accessed: 29 November 2013).

APPENDIX 1 - MCDONALD'S CORPORATION

Income Statement		Get Income Statement for: <input type="text"/> <input type="button" value="GO"/>		
View: Annual Data Quarterly Data		All numbers in thousands		
Period Ending	Dec 31, 2012	Dec 31, 2011	Dec 31, 2010	
Total Revenue	27,567,000	27,006,000	24,074,600	
Cost of Revenue	16,750,700	16,319,400	14,437,300	
Gross Profit	10,816,300	10,686,600	9,637,300	
Operating Expenses				
Research Development	-	-	-	
Selling General and Administrative	2,203,700	2,160,800	2,135,100	
Non Recurring	8,000	(3,900)	29,100	
Others	-	-	-	
Total Operating Expenses	-	-	-	
Operating Income or Loss	8,604,600	8,529,700	7,473,100	
Income from Continuing Operations				
Total Other Income/Expenses Net	(9,000)	(24,700)	(21,900)	
Earnings Before Interest And Taxes	8,595,600	8,505,000	7,451,200	
Interest Expense	516,600	492,800	450,900	
Income Before Tax	8,079,000	8,012,200	7,000,300	
Income Tax Expense	2,614,200	2,509,100	2,054,000	
Minority Interest	-	-	-	
Net Income From Continuing Ops	5,464,800	5,503,100	4,946,300	
Non-recurring Events				
Discontinued Operations	-	-	-	
Extraordinary Items	-	-	-	
Effect Of Accounting Changes	-	-	-	
Other Items	-	-	-	
Net Income	5,464,800	5,503,100	4,946,300	
Preferred Stock And Other Adjustments	-	-	-	
Net Income Applicable To Common Shares	5,464,800	5,503,100	4,946,300	

Income Statement	Cash Flow	Balance Sheet	Credit Rating		
Income Statement	2012	2011	2010	2009	2008
Revenue	\$27,567	\$27,006	\$24,074.6	\$22,744.7	\$23,522.4
Gross Profit	\$10,816.3	\$10,686.6	\$9,637.3	\$8,791.8	\$8,639.2
Operating Income	\$8,604.6	\$8,529.7	\$7,473.1	\$6,841	\$6,442.9
Net Income	\$5,464.8	\$5,503.1	\$4,946.3	\$4,551	\$4,313.2
Diluted EPS	\$5.36	\$5.27	\$4.58	\$4.11	\$3.76

Balance SheetGet Balance Sheet for:

View: Annual Data | Quarterly Data

All numbers in thousands

Period Ending	Dec 31, 2012	Dec 31, 2011	Dec 31, 2010
Assets			
Current Assets			
Cash And Cash Equivalents	2,336,100	2,335,700	2,387,000
Short Term Investments	-	-	-
Net Receivables	1,375,300	1,334,700	1,179,100
Inventory	121,700	116,800	109,900
Other Current Assets	1,089,000	615,800	692,500
Total Current Assets	4,922,100	4,403,000	4,368,500
Long Term Investments	1,380,500	1,427,000	1,335,300
Property Plant and Equipment	24,677,200	22,834,500	22,060,600
Goodwill	2,804,000	2,653,200	2,586,100
Intangible Assets	-	-	-
Accumulated Amortization	-	-	-
Other Assets	1,602,700	1,672,200	1,624,700
Deferred Long Term Asset Charges	-	-	-
Total Assets	35,386,500	32,989,900	31,975,200
Liabilities			
Current Liabilities			
Accounts Payable	3,403,100	3,142,600	2,916,400
Short/Current Long Term Debt	-	366,600	8,300
Other Current Liabilities	-	-	-
Total Current Liabilities	3,403,100	3,509,200	2,924,700
Long Term Debt	13,632,500	12,133,800	11,497,000
Other Liabilities	1,526,200	1,612,600	1,586,900
Deferred Long Term Liability Charges	1,531,100	1,344,100	1,332,400
Minority Interest	-	-	-
Negative Goodwill	-	-	-
Total Liabilities	20,092,900	18,599,700	17,341,000
Stockholders' Equity			
Misc Stocks Options Warrants	-	-	-
Redeemable Preferred Stock	-	-	-
Preferred Stock	-	-	-
Common Stock	16,600	16,600	16,600
Retained Earnings	39,278,000	36,707,500	33,811,700
Treasury Stock	(30,576,300)	(28,270,900)	(25,143,400)
Capital Surplus	5,778,900	5,487,300	5,196,400
Other Stockholder Equity	796,400	449,700	752,900
Total Stockholder Equity	15,293,600	14,390,200	14,634,200
Net Tangible Assets	12,489,600	11,737,000	12,048,100

Cash FlowGet Cash Flow for:

View: Annual Data | Quarterly Data

All numbers in thousands

Period Ending	Dec 31, 2012	Dec 31, 2011	Dec 31, 2010
Net Income	5,464,800	5,503,100	4,946,300
Operating Activities, Cash Flows Provided By or Used In			
Depreciation	1,488,500	1,415,000	1,276,200
Adjustments To Net Income	135,900	192,000	248,100
Changes In Accounts Receivables	(29,400)	(160,800)	(50,100)
Changes In Liabilities	(66,500)	253,000	(28,100)
Changes In Inventories	(27,200)	(52,200)	(50,800)
Changes In Other Operating Activities	-	-	-
Total Cash Flow From Operating Activities	6,966,100	7,150,100	6,341,600
Investing Activities, Cash Flows Provided By or Used In			
Capital Expenditures	(3,049,200)	(2,729,800)	(2,135,500)
Investments	-	-	-
Other Cash flows from Investing Activities	(118,100)	158,900	79,500
Total Cash Flows From Investing Activities	(3,167,300)	(2,570,900)	(2,056,000)
Financing Activities, Cash Flows Provided By or Used In			
Dividends Paid	(2,896,600)	(2,609,700)	(2,408,100)
Sale Purchase of Stock	(2,286,500)	(3,029,100)	(2,235,400)
Net Borrowings	1,204,600	1,003,900	787,400
Other Cash Flows from Financing Activities	(13,600)	(10,600)	(1,300)
Total Cash Flows From Financing Activities	(3,849,800)	(4,533,000)	(3,728,700)
Effect Of Exchange Rate Changes	51,400	(97,500)	34,100
Change In Cash and Cash Equivalents	400	(51,300)	591,000

6-Year Summary

<i>Dollars in millions, except per share data</i>	2012	2011	2010	2009	2008	2007
Company-operated sales	\$18,603	18,293	16,233	15,459	16,561	16,611
Franchised revenues	\$ 8,964	8,713	7,842	7,286	6,961	6,176
Total revenues	\$27,567	27,006	24,075	22,745	23,522	22,787
Operating income	\$ 8,605	8,530	7,473	6,841 ⁽¹⁾	6,443	3,879 ⁽⁴⁾
Income from continuing operations	\$ 5,465	5,503	4,946	4,551 ^(1,2)	4,313 ⁽³⁾	2,335 ^(4,5)
Net income	\$ 5,465	5,503	4,946	4,551 ^(1,2)	4,313 ⁽³⁾	2,395 ^(4,5,6)
Cash provided by operations	\$ 6,966	7,150	6,342	5,751	5,917	4,876
Cash used for investing activities	\$ 3,167	2,571	2,056	1,655	1,625	1,150
Capital expenditures	\$ 3,049	2,730	2,135	1,952	2,136	1,947
Cash used for financing activities	\$ 3,850	4,533	3,729	4,421	4,115	3,996
Treasury stock purchases ⁽⁷⁾	\$ 2,605	3,373	2,648	2,854	3,981	3,949
Common stock cash dividends	\$ 2,897	2,610	2,408	2,235	1,823	1,766
Financial position at year end:						
Total assets	\$35,386	32,990	31,975	30,225	28,462	29,392
Total debt	\$13,633	12,500	11,505	10,578	10,218	9,301
Total shareholders' equity	\$15,294	14,390	14,634	14,034	13,383	15,280
Shares outstanding in millions	1,003	1,021	1,054	1,077	1,115	1,165
Per common share:						
Income from continuing operations-diluted	\$ 5.36	5.27	4.58	4.11 ^(1,2)	3.76 ⁽³⁾	1.93 ^(4,5)
Earnings-diluted	\$ 5.36	5.27	4.58	4.11 ^(1,2)	3.76 ⁽³⁾	1.98 ^(4,5,6)
Dividends declared	\$ 2.87	2.53	2.26	2.05	1.63	1.50
Market price at year end	\$ 88.21	100.33	76.76	62.44	62.19	58.91
Company-operated restaurants	6,598	6,435	6,399	6,262	6,502	6,906
Franchised restaurants	27,882	27,075	26,338	26,216	25,465	24,471
Total Systemwide restaurants	34,480	33,510	32,737	32,478	31,967	31,377
Franchised sales⁽⁸⁾	\$69,687	67,648	61,147	56,928	54,132	46,943

(1) Includes pretax income due to impairment and other charges (credits), net of \$61.1 million (\$31.4 million after tax or \$0.08 per share) primarily related to the resolution of certain liabilities retained in connection with the 2007 Latin America developmental license transaction.

(2) Includes income of \$58.8 million (\$0.05 per share) for gain on sale of investment related to the sale of the Company's minority ownership interest in Redbox Automated Retail, LLC.

(3) Includes income of \$109.0 million (\$0.09 per share) for gain on sale of investment from the sale of the Company's minority ownership interest in U.K.-based Pret A Manger.

(4) Includes pretax operating charges of \$1.7 billion (\$1.32 per share) due to impairment and other charges (credits), net primarily as a result of the Company's sale of its businesses in 18 Latin American and Caribbean markets to a developmental licensee.

(5) Includes a tax benefit of \$316.4 million (\$0.26 per share) resulting from the completion of an Internal Revenue Service examination of the Company's 2003-2004 U.S. federal tax returns.

(6) Includes income of \$60.1 million (\$0.05 per share) related to discontinued operations primarily from the sale of the Company's investment in Boston Market.

(7) Represents treasury stock purchases as reflected in Shareholders' equity.

(8) While franchised sales are not recorded as revenues by the Company, management believes they are important in understanding the Company's financial performance because these sales are the basis on which the Company calculates and records franchised revenues and are indicative of the financial health of the franchisee base. Franchised restaurants represent more than 80% of McDonald's restaurants worldwide.

APPENDIX 2 - YUM BRANDS INC.

Income Statement

Get Income Statement for:

View: Annual Data | Quarterly Data

All numbers in thousands

Period Ending	Dec 29, 2012	Dec 31, 2011	Dec 25, 2010
Total Revenue	13,633,000	12,626,000	11,343,000
Cost of Revenue	9,852,000	9,140,000	8,120,000
Gross Profit	3,781,000	3,486,000	3,223,000
Operating Expenses			
Research Development	-	-	-
Selling General and Administrative	1,450,000	1,536,000	1,407,000
Non Recurring	37,000	135,000	47,000
Others	-	-	-
Total Operating Expenses	-	-	-
Operating Income or Loss	2,294,000	1,815,000	1,769,000
Income from Continuing Operations			
Total Other Income/Expenses Net	-	-	-
Earnings Before Interest And Taxes	2,145,000	1,659,000	1,594,000
Interest Expense	-	-	-
Income Before Tax	2,145,000	1,659,000	1,594,000
Income Tax Expense	537,000	324,000	416,000
Minority Interest	(11,000)	(16,000)	(20,000)
Net Income From Continuing Ops	1,597,000	1,319,000	1,158,000
Non-recurring Events			
Discontinued Operations	-	-	-
Extraordinary Items	-	-	-
Effect Of Accounting Changes	-	-	-
Other Items	-	-	-
Net Income	1,597,000	1,319,000	1,158,000
Preferred Stock And Other Adjustments	-	-	-
Net Income Applicable To Common Shares	1,597,000	1,319,000	1,158,000

Balance Sheet

Get Balance Sheet for:

View: Annual Data | Quarterly Data

All numbers in thousands

Period Ending	Dec 29, 2012	Dec 31, 2011	Dec 25, 2010
Assets			
Current Assets			
Cash And Cash Equivalents	912,000	1,312,000	1,538,000
Short Term Investments	-	-	-
Net Receivables	412,000	398,000	317,000
Inventory	313,000	273,000	189,000
Other Current Assets	272,000	338,000	289,000
Total Current Assets	1,909,000	2,321,000	2,313,000
Long Term Investments	72,000	167,000	154,000
Property Plant and Equipment	4,250,000	4,042,000	3,830,000
Goodwill	1,034,000	681,000	659,000
Intangible Assets	690,000	299,000	475,000
Accumulated Amortization	-	-	-
Other Assets	575,000	775,000	519,000
Deferred Long Term Asset Charges	481,000	549,000	366,000
Total Assets	9,011,000	8,834,000	8,316,000
Liabilities			
Current Liabilities			
Accounts Payable	2,178,000	2,130,000	1,775,000
Short/Current Long Term Debt	10,000	320,000	673,000
Other Current Liabilities	-	-	-
Total Current Liabilities	2,188,000	2,450,000	2,448,000
Long Term Debt	2,932,000	2,997,000	2,915,000
Other Liabilities	1,579,000	1,471,000	1,284,000
Deferred Long Term Liability Charges	-	-	-
Minority Interest	99,000	93,000	93,000
Negative Goodwill	-	-	-
Total Liabilities	6,798,000	7,011,000	6,740,000
Stockholders' Equity			
Misc Stocks Options Warrants	59,000	-	-
Redeemable Preferred Stock	-	-	-
Preferred Stock	-	-	-
Common Stock	-	18,000	86,000
Retained Earnings	2,286,000	2,052,000	1,717,000
Treasury Stock	-	-	-
Capital Surplus	-	-	-
Other Stockholder Equity	(132,000)	(247,000)	(227,000)
Total Stockholder Equity	2,154,000	1,823,000	1,576,000
Net Tangible Assets	430,000	843,000	442,000

Cash Flow

 Get Cash Flow for:

 View: **Annual Data** | Quarterly Data

All numbers in thousands

Period Ending	Dec 29, 2012	Dec 31, 2011	Dec 25, 2010
Net Income	1,597,000	1,319,000	1,158,000
Operating Activities, Cash Flows Provided By or Used In			
Depreciation	645,000	628,000	589,000
Adjustments To Net Income	(176,000)	(8,000)	(82,000)
Changes In Accounts Receivables	(18,000)	(39,000)	(12,000)
Changes In Liabilities	135,000	253,000	165,000
Changes In Inventories	9,000	(75,000)	(68,000)
Changes In Other Operating Activities	91,000	76,000	198,000
Total Cash Flow From Operating Activities	2,294,000	2,170,000	1,968,000
Investing Activities, Cash Flows Provided By or Used In			
Capital Expenditures	(1,099,000)	(940,000)	(796,000)
Investments	-	-	-
Other Cash flows from Investing Activities	94,000	(66,000)	217,000
Total Cash Flows From Investing Activities	(1,005,000)	(1,006,000)	(579,000)
Financing Activities, Cash Flows Provided By or Used In			
Dividends Paid	(544,000)	(481,000)	(412,000)
Sale Purchase of Stock	(903,000)	(693,000)	(269,000)
Net Borrowings	(282,000)	(262,000)	313,000
Other Cash Flows from Financing Activities	(85,000)	(43,000)	(38,000)
Total Cash Flows From Financing Activities	(1,716,000)	(1,413,000)	(337,000)
Effect Of Exchange Rate Changes	5,000	21,000	21,000
Change In Cash and Cash Equivalents	(422,000)	(228,000)	1,073,000

YUM! Brands, Inc. and Subsidiaries
 (in millions, except per share and unit amounts)

	Fiscal Year				
	2011	2010	2009	2008	2007
Summary of Operations					
Revenues					
Company sales	\$ 10,893	\$ 9,783	\$ 9,413	\$ 9,843	\$ 9,100
Franchise and license fees and income	1,733	1,560	1,423	1,461	1,335
Total	12,626	11,343	10,836	11,304	10,435
Closures and impairment income (expenses) ^(a)	(135)	(47)	(103)	(43)	(35)
Refranchising gain (loss) ^(a)	(72)	(63)	26	5	11
Operating Profit ^(b)	1,815	1,769	1,590	1,517	1,357
Interest expense, net	156	175	194	226	166
Income before income taxes	1,659	1,594	1,396	1,291	1,191
Net Income – including noncontrolling interest	1,335	1,178	1,083	972	909
Net Income – YUM! Brands, Inc.	1,319	1,158	1,071	964	909
Basic earnings per common share	2.81	2.44	2.28	2.03	1.74
Diluted earnings per common share	2.74	2.38	2.22	1.96	1.68
Diluted earnings per common share before Special Items ^(c)	2.87	2.53	2.17	1.91	1.68
Cash Flow Data					
Provided by operating activities	\$ 2,170	\$ 1,968	\$ 1,404	\$ 1,521	\$ 1,551
Capital spending, excluding acquisitions and investments	940	796	797	935	726
Proceeds from refranchising of restaurants	246	265	194	266	117
Repurchase shares of Common Stock	752	371	—	1,628	1,410
Dividends paid on Common Stock	481	412	362	322	273
Balance Sheet					
Total assets	\$ 8,834	\$ 8,316	\$ 7,148	\$ 6,527	\$ 7,188
Long-term debt	2,997	2,915	3,207	3,564	2,924
Total debt	3,317	3,588	3,266	3,589	3,212
Other Data					
Number of stores at year end					
Company	7,437	7,271	7,666	7,568	7,625
Unconsolidated Affiliates	587	525	469	645	1,314
Franchisees ^(d)	26,928	27,852	26,745	25,911	24,297
Licensees	2,169	2,187	2,200	2,168	2,109
System ^(d)	37,121	37,835	37,080	36,292	35,345
China Division system sales growth ^(e)					
Reported	35 %	18%	11 %	33%	34%
Local currency ^(f)	29 %	17%	10 %	22%	28%
YRI system sales growth ^(e)					
Reported	13 %	10%	(4)%	10%	15%
Local currency ^(f)	8 %	4%	5 %	8%	10%
U.S. same store sales growth ^(g)	(1)%	1%	(5)%	2%	—%
Shares outstanding at year end	460	469	469	459	499
Cash dividends declared per Common Stock	\$ 1.07	\$ 0.92	\$ 0.80	\$ 0.72	\$ 0.45
Market price per share at year end	\$ 59.01	\$ 49.66	\$ 35.38	\$ 30.28	\$ 38.54

ETHICAL LEADERSHIP AND LEADER MEMBER EXCHANGE (LMX) THEORY

BASED ON A CASE STUDY IBM "LEADING THE TURNAROUND"

ŠEJLA BABIČ

The aim of this paper is to evaluate the contribution that developments in the area of ethical leadership and trust have made to our understanding of effective people management within organisations. This paper is based on a case study from Harvard Business Review (2007) called "IBM - Leading the Turnaround". The author will use Leader Member Exchange (LMX) theory by Graen and Uhl-Bien (1995) and integrate the ideas of ethical leadership to critically evaluate the leadership style of the CEO of IBM Louis V. Gerstner that led to the turnaround of IBM. In particular, the author will focus on the following question: What role did trust play in the leadership style of Gerstner in the transformation of IBM?

When Gerstner became the CEO of IBM in 1993, an \$8.1 billion loss on the stock market was announced by IBM; this was one of the largest in U.S. history. Gerstner was facing a difficult job as stock market commentators were rapidly writing off IBM as a 'slow elephant' and, as a result, IBM's workforce was not in any state to accept change. Gerstner's first task was to analyse what was going wrong within IBM, despite having dedicated people, high technological infrastructure, and a sound strategy, he found that IBM was suffering from its own success during the many years of operation. Its own success was its downfall, for it had become slow moving and inward looking.

Organisationally, it had become a decentralised 'kingdom' in which none of the business units communicated with each other. Gerstner realised that, if IBM was to be saved, he had to lead this massive organisation through cultural change. He realised that changing the attitude and behaviour of thousands of people was hard to accomplish, but was the main key to success. Management could not change organisational culture through words and policies alone; leaders such as Gerstner had to create the conditions for transformation and invite employees to respond willingly.

IBM had a tradition of appointing executives from within. Indeed, Gerstner was the first CEO to be hired from outside; this in itself was revolutionary and created widespread internal concern. Before Gerstner arrived, it was accepted that the break-up of IBM was inevitable. The question was only what form this would take. Morale was at rock-bottom, and Gerstner's appointment did nothing to raise spirits. It was assumed he had been brought in to 'wield the hatchet'.

Therefore, it was a real surprise when Gerstner made himself open to input from anyone in the company. It was even more surprising when he announced that IBM's strength lay in its integration and that there would be no break-up. Immediately spirits started to soar. Everyone knew there would be a pain, but now it seemed it would be on a much lower level, and employees were prepared to listen for a change. While it took time to build trust, Gerstner's no-nonsense style created confidence that someone was in charge. His actions were not popular, but they were decisive. It was this that steadily led to a sense of trust; he did what he said he would do, and he proved himself trustworthy.

In the next section, the author will provide a background to leader-member exchange (LMX) theory and relate it to ethical leadership so that we can explore the leadership style of Gerstner during the change at IBM.

LEADER MEMBER EXCHANGE (LMX) THEORY AND ETHICAL LEADERSHIP

Leader-member exchange (LMX) theory by Graen and Uhl-Bien (1995) focuses on the relationship between the leader and member. The key principle of LMX theory is that leaders develop different types of exchange relationships with their followers and the quality of the relationship that is developed alters the impact on outcomes of this leader and member exchange. Therefore, according to LMX theory, leadership occurs when leaders and followers are able to develop effective relationships that result in mutual influence (Uhl-Bien, 2006).

Leadership can be described as a process that involves several factors; one of these could be the ability to influence others and motivate them to reach a common oriented goal, like the change required at IBM (Northouse, 2007, pp. 2-9). This would require leadership changes that foster relationships and accompany ethical burdens and responsibilities, as making a change in people may influence not only their working lives, but also the lives of people around them. Trust, therefore, plays a central role in developing relationships with employees during the process of change management.

LMX theory explores how leaders and managers develop relationships with team members, and it explains how those relationships can either contribute to the growth and assist change or hold people back in the leadership context. In LMX theory trust is described as a leader's authentic behaviour, a leader's trustworthy behaviour and how it is implemented in daily actions are key components of LMX exchanges.

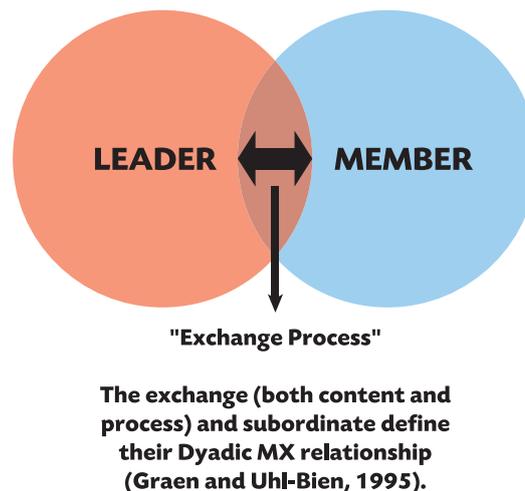


Figure 1: LMX model illustrating the exchange process

The LMX process is based on the assumption that leaders pay attention to the traits, skills and competencies of their followers during the exchange process (Figure 1) and assess whether they are competent and effective to take care of a certain position or work in the organisation. From the perspective of the follower, the main question is how trustworthy the leader is.

According to Graen and Uhl-Bien (1995) researchers have found that high-quality leader-member exchanges produce less employee de-motivation and greater organisation commitment. Graen and Uhl-Bien have also suggested that leadership making develops progressively over time in three phases: (1) the stranger phase, (2) the acquaintance phase, and (3) the mature partnership phase. During the final phase (3), the mature partnership relationship is marked by high-quality leader-member exchanges that involve a high degree of mutual trust, respect, and obligation towards each other. Such high quality relationships will produce high LMX during the transformational leadership phase such as the one faced at IBM.

The quality of the exchange process will, therefore, depend upon the qualitative characteristics of the exchange between leader and member. Such qualitative characteristics could be 'ethical values' and trust will play a major role in this process. Such 'ethical values' can be considered as qualitative characteristics that create high LMX in transformational leadership. We could say that 'ethical value' congruence between the leader and the member could be defined as the degree of agreement between the leader's value system and the member's value system, a high degree of agreement would point towards a high LMX.

Weiss (1978, pp. 711-718) has found that people aligned their values with the values of their leader if they perceived their leader as trustful. Leaders, therefore, have an ethical responsibility and one of the characteristics that exercise such responsibilities are accommodating the value systems of the members in the leadership process. According to Beauchamp and Bowie (1988), this requires the essential ability of leaders to be sensitive to the interests and concerns of others.

With such an attentive attitude, an ethical leader may foster change in others and lead people towards change in an organisation similar to the one required at IBM. Heifetz (1994) states that in order for such effective changes to occur successfully, leaders have to exercise their authority with a notion of responsibility, a responsibility that requires respect for the prospective change in others. Heifetz (1994) calls this a "holding environment" where trust, nurturance, and empathy are exercised with the aim of change. Such a change would generally be resisted; however, Heifetz (1994) says that in such a "supportive context" followers would generally feel secure to face the hurdles of change more effectively and to manage issues that may arise. During the change at IBM, Gerstner was instrumental in changing the mental orientation of his employees from a self-centric to a customer-centric point of view. Initially, this was resisted, and he had to develop an environment of "supportive context" where employees would trust the leader (Heifetz, 1994).

Therefore, he used his authority and got employees to pay attention to the issues facing IBM. He recognised the values in others and identified the changes required so that conflicting values would be reduced during the high congruence process that led to a high LMX. As Heifetz (1994) says, Gerstner recognised the benefits of the existing environment at IBM and utilised the importance of trust in a "supportive context" where employees would feel safe to confront any hurdles the process of change.

So, for a transformational leader to lead change effectively, the needs, values, and moral of employees have to be at the forefront. Burns (1978) in his theory of transformational leadership emphasises that a transformational leadership requires a focus by leaders to assist employees to higher standards of moral responsibility. He states that leadership has a moral dimension, and he characterises this as ethical leadership. He stresses that leaders need to engage themselves with employees and assist them in their personal struggles concerning conflicting values so that these are aligned with organisational values in the process of effective change. It is, therefore, the responsibility of the leader to assist employees in the assessment of their own values and through trust align these values with organisation values in the process of change, this "connection", Burn (1978) says, that raises the level of morality in both the leader and the employee and develops trust, an essential element of ethical leadership.

As a transformational ethical leader, according to Bass (1985), Gerstner led to initiate change at several business processes within IBM, and these processes of change were not easy to implement for a company that has been described as moving like a "slow elephant". Gerstner had to initiate specific conditions for this transformation and for employees to respond to these necessary changes. Some of these changes were to gain the support of major customers by establishing credibility, comparing expense to revenue of IBM with those of leading competitors in the market to monitor expense reduction, re-engineer business processes at IBM to reduce overheads, and sell off unproductive assets.



Figure 2. Trust and the principles of leadership.

In order to carry out these changes, Burns (1978) stresses that ethical leadership requires engagement with employees, and this process of engagement requires the identification of personal values and realigning them with changing corporate values, a process that would create a high degree of congruence in aligned ethical values and therefore a high LMX. Such a process involves several stages where the leader has to recognise the importance of personal values, develop a level of trust in the managers' abilities to change and communicate the importance of realigned corporate values. Burns emphasises that when such a process works effectively, the leader attends to the personal motivations of the managers and re-directs them to a better set of moral values that are congruent with corporate values.

In many ways, one can note a common theme running through the different perspectives of ethical leadership and its relationship with LMX theory presented in the last section, the main ones being that a high quality leader-member engagement is essential to ethical leadership. It is also essential for ethical leaders to pay close attention to the needs of their employees; these leadership theories are similar to those presented in the "Ethics of Caring" by Gilligan (1982). Gilligan emphasises five key principles relating to ethical leadership with the origins of these can being traced back to the works of Aristotle. These principles provide the foundation for the development of ethical leadership traits; these principles are respect, service, justice, honesty, and community.

These are shown in Figure 1 which has been adapted from Northouse (2007). Briefly discussing each of these traits, we see that leaders who respect others, approach people with trust, and acknowledge others' values and ideas. Leaders who exercise this trait in their leadership are seen as providing service towards others; they are considered as altruistic and are placing their followers' welfare as a priority in their plans to implement change. This service trait has been emphasised by several authors on ethical leadership maintaining that attending to the service of others, and developing trust is the primary building blocks of ethical leadership.

The importance of these traits can also be seen in the works of Senge (1990). In his work on learning organisations, Senge emphasises that one of the most important tasks for a leader in learning organisations is the stewardship role; the steward (servant), or the visionary of change, directs implementation during the change process. This viewpoint has the characteristics of not being self-centered; it involves a deliberate step taken by the leader with a motive of integrating one's vision with that of others in the organisation. Senge, therefore, stresses that ethical leadership concerns itself with fairness and justice, with fairness playing a role in integrating personal values with organisational values and justice demanding that the leader place issues of fairness as a motive of their decision making.

Here we may look to the works of Beauchamp and Bowie (1998), who have outlined principles that may guide an ethical leader in distributing the benefits and burdens relating to transformational change fairly.

The fourth principle of ethical leadership relates to the manifestation of honesty in an ethical leader. For Gerstner, the communication of change at IBM was not an easy task; he had to represent the reality of the situation at IBM and the challenge for him was to strike a balance between being truthful and to monitor what information to disclose in particular stages of the transformation at IBM.

Dalla Costa (1998) makes this point clearly in his book "The Ethical Imperative" where he states that "being honest" is more than just "not deceiving"; for an ethical leader, Della Costa points out that being honest is governed by the characteristics such as to not promise what you cannot deliver, not misrepresent information, not suppress obligations, not to reject accountability, and not openly accept that the competitive pressures of business are an open reason to release our responsibility towards the respect and dignity of others. Burns (1978) placed this characteristic of honesty at the centre of his theory of transformational leadership. With the exercise of these four principles, the ethical leader, therefore, fosters a community, a community created with belonging that has the characteristics of trust placed in the ethical leader, a community that is bonded together and believes in the vision of the transformational leader such as Gerstner. One of the eight principles that Gerstner developed at IBM to transform employees' beliefs was that outstanding dedicated people make it all happen, particularly when the work together as a team.

THE ROLE OF TRUST IN HIGH LMX EXCHANGES

Central to these five principles of leadership is the role that trust has to play in each one of them. The five principles of leadership presented in Figure 1 represent actions that an ethical leader follows as part of his/her character. These actions can cause successful change when the leader has developed trust. For example, respect of others can be exercised successfully only if the other person respects and trusts the leader in the first place. Similar arguments can be applied for the other four principles of ethical leadership.

Gerstner at IBM exercised these five principles of ethical leadership to bring about transformational change, and he was trusted as a leader and his team had confidence in what he was planning. We can use the model of ethical leadership from Northouse (2007) and adapt it with the idea of trust as developed by the author and see how this change was achieved at IBM. This can be seen in Figure 3, which shows how Gerstner as a leader led IBM through the necessary transformational changes.

The main component that functions actively through the five ethical leadership traits is the notion of trust. When you trust someone, or someone trusts you, things can move more quickly and effectively. Less obvious, but not less important, are the benefits of trusting others which are the abilities to trust customers for greater efficiency and creativity in serving them.

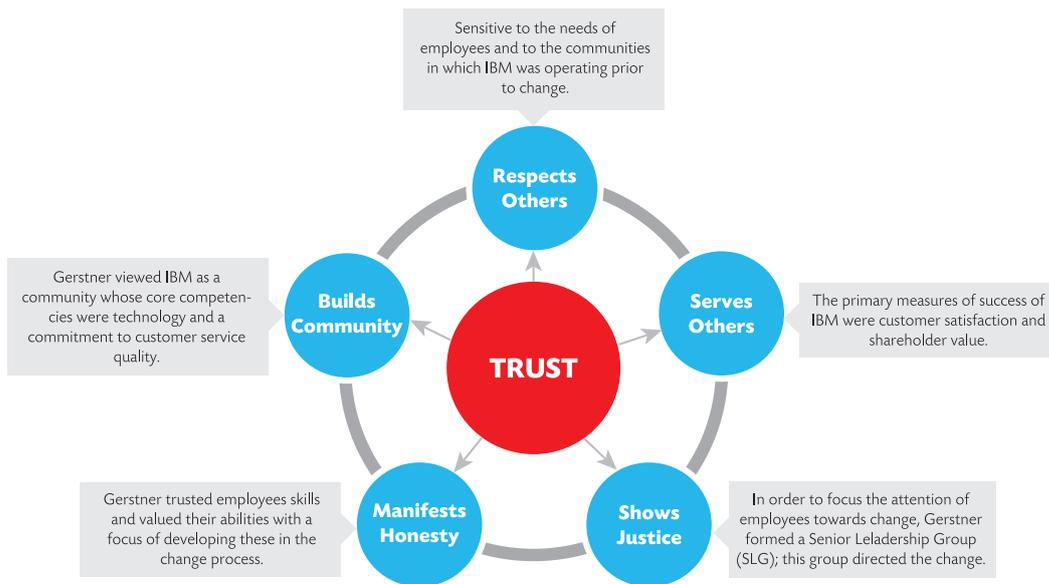


Figure 3. Relationship of the Ethical Leadership and Trust Model to change at IBM led by Gerstner.

We note that Gerstner would not have been able to lead with trust unless he was personally trustworthy and capable of trusting. A trust relationship, therefore, has three aspects: (1) two asymmetrical roles - one who trusts, another who is trusted, (2) the element of risk, and (3) reciprocating the roles of trustor and trustee.

Trust can be seen as a dance with two players: one who trusts, and one who is trusted. Most leaders and managers focus more on being trusted than on trusting. Learning to juggle these is a critical skill for ethical leadership. The best way to be trusted is to be worthy of trust, to be trustworthy. By far the most efficient and effective strategy for being trusted is to actually be trustworthy. But what does that mean? One thing it means is actively exercising certain personal traits. Whether from habit or personality, personal traits are what allow others to consider us trustworthy or not. We will use the term 'virtues' to describe these traits. It implies a consistency of character that provides a guidepost for the individual, and that can be relied upon by others. It may not be absolute, but we expect it to withstand some level of incentives, group pressure, or business process. A virtue is something that we see as getting to the heart of a person.

According to Maister, Green and Galford (2000), there are four such traits: credibility, reliability, intimacy, and (low) self orientation; they can be expressed, on a scale of 1 to 10, in the form of an equation, the Trustworthiness Equation, and they cover most of the usages of "trustworthiness" in common and business language, as well as across cultures. The Trust Equation arrays the four virtues in the form of an equation. This format allows for discussion about interplay and impact though should not be taken too literally as a description of something that exists outside the model.

The trustworthiness equation is:

$$\text{Trustworthiness} = \frac{\text{Credibility} + \text{Reliability} + \text{Intimacy}}{\text{Self Orientation}}$$

Credibility is largely about words. We might say; I can trust what she says about this issue, meaning we recognise her degree or her credentials, her statements are logical, she uses recognised means of communication, there are no spelling errors in her resume, and so forth.

Reliability applies more to actions. We might say; I can trust him to do (whatever he said he would do), meaning he is dependable, predictable, a person of integrity; someone who honours his word, and if he cannot honour it, takes immediate responsibility for it. Reliability is only trust equation component that literally requires time, because it requires repeated experiences which happen over time.

Intimacy refers to a sense of security. We might say, I trust her with this information, meaning she is sensitive to our needs, knows when and to whom to pass information along, and knows just how to treat it.

Self-Orientation is in the denominator of a trust equation, high levels of self-orientation mean low level of trustworthiness. High self-orientation comes in two forms: selfishness and self obsession; the latter is less obvious, therefore, more pernicious in business.

Any interaction with another human being is a potential source of fear, thus of fight or flight, but also an opportunity to behave differently, in ways that create trust. Overcoming self-orientation is not a business process, an analytic, or even a skill such as practicing tennis or a golf shot. It is a self-willed psychological state in which we are ego-comfortable enough with our own selves to relate to others without fear or desire to control.

The role that trust has to play in ethical leadership is, therefore, a crucial element in the overall character of the ethical leader bringing about transformational change in any organisation. Credibility, reliability, intimacy and self-orientation are, therefore, important variables that define trustworthiness in its relationship together with the key factors of ethical leadership defined in Figure 4.

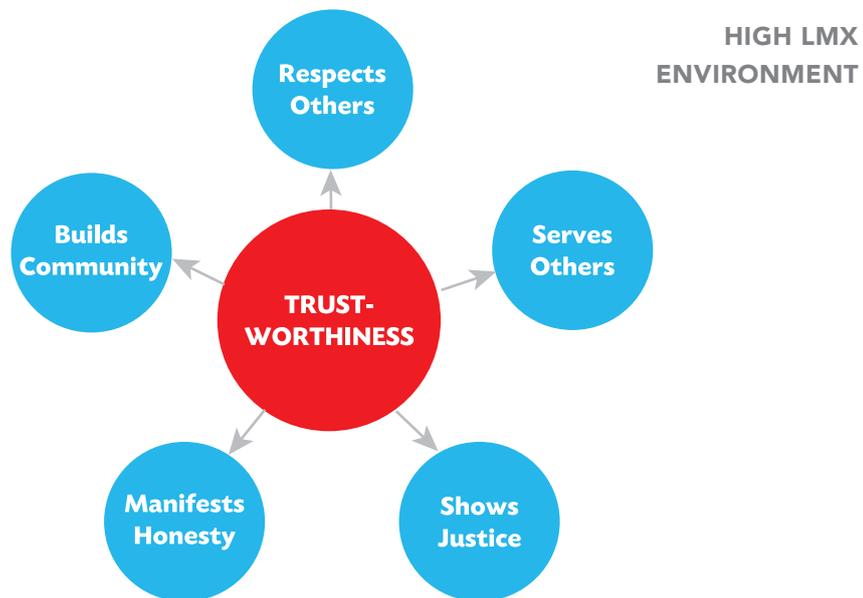


Figure 4: Illustrating Ethical Leadership, Trustworthiness and LMX Relationships

LMX and ethical leadership theories make several positive contributions to our understanding of the leadership process carried out by Gerstner at IBM. LXM theory uses the dyadic exchange relationship as the main leadership process and emphasise that effective leadership is contingent on effective leader-member exchanges. The author has attempted to add content to this effective leader-member exchange by using the model of ethical leadership and trust. LMX theory is also related to positive organisational outcomes, and in a review of their research Graen and Uhl-Bien (1995) point out that it is related to performance, organisational commitment, and many other important organisational variables. One of the criticisms of LMX theory is that the basic ideas of the theory are not yet fully developed. For example, it fails to explain how high-quality leader-member exchanges are created, trust and trustworthiness may play key roles, as explained above, however, the role of different cultural values and abilities of different people to acquire the ethical values is not really researched. There is also the problem of measurement of leader-member exchanges in LMX theory by Graen and Uhl-Bien (1995) and Schriesheim et al. (2001). No empirical studies have been carried out that use dyadic measures to analyse the LMX process and its effectiveness with the ethical leadership model and further investigate the role of trust.

CONCLUSION

To conclude this paper, the author has attempted to explain the leadership process carried out at IBM during the change management process using the LMX leadership model. This model was developed further by the author to explain the importance of ethical leadership together with the notion of trust. Trust was incorporated within the ethical leadership model adopted from Northouse (2007) to integrate it with the LMX leadership process. In doing this, the transformational change that was implemented by Gerstner at IBM was taken as an example of a practical ethical leader creating a high LMX. The emphasis has been to develop the LMX model further by the application of ethical leadership theories to the IBM case study on transformational change and to critically develop a discussion that shows the importance of trust in the transformational leader leading change at IBM. ■

REFERENCES

- Bass, B.M. (1985) *Leadership and performance beyond expectations*. New York: Free Press.
- Beauchamp, T.L. and Bowie, N.E. (1988) *Ethical theory and business*. NJ: Prentice Hall.
- Bowie, N.E. (1991) 'Challenging the egoistic paradigm', *Business Ethics Quarterly*, pp. 1-21.
- Ciulla, J.B. (1998) *Ethics, the heart of leadership*. Westport: Greenwood.
- Ciulla, J.B. (2001) 'Carving leaders from the warped wood of humanity', *Canadian Journal of Administrative Sciences*, 18(4), pp. 313-319.
- Ciulla, J.B. (2003) *The ethics of leadership*. Belmont: Wadsworth Thomson Learning.
- Covey, S.R. (1990) *Principle-centered leadership*. New York: Fireside.
- Dalla Costa, J. (1998) *The ethical imperative: Why moral leadership is good business*. MA: Addison- Wesley.
- De Pree, M. (1989) *Leadership is an art*. New York: Doubleday.
- De Pree, M. (1992) *Leadership jazz*. New York: Dell.
- Gerstner, L.V., Jr. (2003) *Who Says Elephants Can't Dance? Leading a Great Enterprise through Dramatic Change*. New York: Harper Business.
- Gilligan, C. (1982) *In a different voice: Psychological theory and women's development*. Cambridge: Harvard University Press.
- Graen, G.B. and Uhl-Bien, M. (1995) 'Relationship based approach to leadership: Development on leader member exchange (LMX) theory of leadership over 25 years', *Leadership Quarterly*, 6(2), pp. 219-246.
- Greenleaf, R.K. (1977) *Servant leadership: A journey into the nature of legitimate power and greatness*. New York: Paulist.
- Heifetz, R.A. (1994) *Leadership without easy answers*. Cambridge: Harvard University Press.
- Northouse, P.G. (2007) *Leadership: Theory and Practice*, 4th edn. MI: Sage Publications.
- Schriesheim, C.A., Castro, S.L., Zhou, X. and Yammarino, F.J. (2001) 'The folly of theorizing "A" but testing "B": A selective level of analysis review of the field and detailed leader member exchange', *Leadership Quarterly*, 12, pp. 515-551.
- Senge, P.M. (1990) *The fifth discipline: The art and practice of the learning organization*. New York: Doubleday.
- Sheppard, P. (2003) 'Leading the Turnaround: Lou Gerstner of IBM', *Wharton Leadership Digest*. Available at: <http://leadership.wharton.upenn.edu/digest/02-03.shtml> (Accessed: 5 December 2013).
- Weiss, H. (1978) 'Social learning of work values in organizations', *Journal of Applied Psychology*, 63, pp. 711-718.

APPENDIX 1 - CASE STUDY

LEADING THE TURNAROUND: LOU GERSTNER OF IBM

By Paul Sheppard, Wharton MBA Student and Deputy Editor, Wharton Leadership Digest



Lou Gerstner, retired Chairman and CEO of IBM, recently spoke at Wharton about his experience of leading one of the most celebrated turnarounds in corporate history.

In a pragmatic and modest speech, Gerstner was weary of drawing platitudes of leadership that could be applied to every situation. Rather he wanted to describe what happened at IBM and draw lessons from it.

When Gerstner took over in 1993, IBM had just announced a \$8.1 billion loss; the largest in US history. He had 100 days of cash left and IBM was already being written off by commentators as a dinosaur and an also-ran. Not surprisingly, IBM's workforce was demoralized and hostile.

Gerstner's first task was to analyze the problem. Despite having good people, great technology and a sound strategy, he found that IBM was suffering from a "success syndrome." Gerstner described IBM in the 1960s, 70s and 80s as "the greatest commercial institution ever created." But instead of continuing to build on this legacy, it had become insular, inward-looking and rigid.

Organizationally, it had become a decentralized fiefdom in which none of the business units communicated with each other. Gerstner realized that his overarching task was to lead a massive organizational and cultural change.

Gerstner quickly found ways to stop bleeding cash and identified the company's principal growth engines. He wanted to break the assumption that customers would always buy IBM because of its past achievements. He then started to rebuild the company around the customer.

To reintegrate the organization, he sought to provide total solutions to customers. To do so, he needed to transform almost every business process conducted by IBM. He cautioned his audience of star struck MBAs that managing a complete turnaround was not as glamorous as they might think. He quoted one of his senior managers who likened the implementation of the reengineering process to going to work every day and "setting your hair alight and then putting it out with a hammer."

Painful as the process was, it was successful. The business units had been reintegrated and Gerstner made \$14 billion of cost savings. Gerstner said that he learnt three fundamental lessons from his time at IBM; the importance of:

1. Focus. Gerstner stressed the how imperative it was for a leader to love their business and to "kill yourself to make it successful." There is no substitute for hard work and the desire to win. CEOs face a multitude of choices, often peddled by a multitude of self-interested advisors, but they need to focus on exploiting competitive advantages in core businesses. Accordingly, it is the CEO's responsibility to manage consultants, investment bankers and advertising agencies so to best serve their business rather than let them set the agenda.

- 2.** Execution. Gerstner said that execution is what really separates business leaders. As an ex-McKinsey Director, Gerstner said that consultants' "dirty little secret" was that it is not that difficult to come up with attractive strategies in public markets in which everyone has good information. The true differentiator was how you implement them.
- 3.** Personal leadership. Gerstner said that despite the volumes of business books written on leadership recently, he still thought that this was the most undervalued element of institutional change. When asked later for his advice of how MBA graduates should behave to strive to emulate his success, Gerstner said that as a start you should always strive to do the job you are doing better than the guy before you.

Finally, Gerstner wanted to discuss the importance and challenges of transforming corporate culture. For him, institutional culture is not what is said but it what is done. As an example of cultural change, Gerstner discussed abolishing IBM's notorious dress code. He said that at the time the public reception was as if he "had sold the company to the Russians." But for Gerstner, it was common sense for IBM's salesmen to dress as their customers were doing.

Gerstner said that changing the attitude and behavior of thousands of people is hard to accomplish but key to success. The work environment is the crucible for individuals' productivity. Management cannot change culture through words and policies alone. All leaders can do is create the conditions for transformation and invite employees to respond. Not surprisingly, he attributed IBM's success to the thousands of employees who were willing to react to his initiatives and work hard to make the elephant dance again.

GAME THEORY - ITS APPLICATIONS TO ETHICAL DECISION MAKING

STEFANO CAVAGNETTO
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The application of game theory according to Hargreaves-Heap and Varonfakis (1995) to understand human behaviour, and in particular ethical behaviour, is a valuable development, as game theory has gradually become one of the key frameworks to assist us in the understanding of social sciences. Esther (1982) and Aumann and Hart (1992) show that there are several studies that indicate the importance of a game theoretic framework in advancing our understanding of social behaviour and evolutionary sciences. Although the application of game theory in the above areas has largely been not formalised, its application in the fields of ethical conduct and human behaviour is at present developed in several respects with the gradual assistance of advances in related areas such as evolutionary biology and our understanding of group social behaviour.

Game theory tends to be dominated by its assumptions concerning the non-rational nature of the dynamics existing within social structures and these processes are generally ignored or are sometimes difficult to model. Assumptions that are made concerning the cognitive abilities and beliefs about individuals are generally unrealistic, and this at times is the main criticism of game theoretic applications in our understanding of ethical behaviour. These are the lines followed by Solomon (1999) in his discussion on game theory when it is used to model scenarios in business ethics and in general in the business area. In particular, game theory tends to excessively emphasise the destructive obsession of the quantifiable outcomes and an artificial concept of competition. This modelling of competition is not exhaustive of human behaviour, but rather an oversimplification of the social dynamics in place in many different human contexts.

The first objective of this paper is to offer a brief sketch of the historical developments that have taken place in game theory and some of its fundamental concepts through an analysis of the most important games that have found an application to the field of ethics. A second aim is that of providing the reader with a review of developments relating to evolutionary game theory that has deeply assisted our comprehension of ethical norms and their emergence in group behaviour. The final part of the paper will be dealing with some conclusive remarks from a methodological point of view on the main issues concerning applications of game theory to ethics.

A SHORT HISTORY OF GAME THEORY

Game theory's history can be roughly divided into three different periods. The first period is characterised by the development of the study of games linked with the development of research in probability theory and the development of probability calculus due to Pierre de Fermat and Blaise Pascal. In the literature this moment begins with a famous correspondence between the two French mathematicians dated 1654 (Hyksova, 2004). About sixty years later, the mathematician James Waldegrave had an important part in the creation of the concept that is nowadays known as an example of a mixed strategy solution of a matrix game. Waldegrave in a written correspondence with Pierre Remond de Montmort on the 13th of November, 1713, offered his solution for the card game *Le Her*. This game was quite popular in the 18th century, and it is a card game played by two players. In the literature they are usually referred to as Peter and Paul, the dealer and the receiver, respectively (Epstein, 2009). It begins when Peter deals Paul one card that is randomly chosen from an ordinary deck of 52 cards. After that, he then gives a card to himself. Both players cannot see the cards dealt to each other. The purpose is to keep the card of a value that it is higher than the value of the opponent (the king is the highest and the ace the lowest). If Paul is not happy with his card value, he can ask his adversary to swap with him, with the only exception when Peter has a king. On the other side, if Peter, the dealer, is not happy with the card value that he has after the exchange, he is then entitled to swap it for a card randomly picked from the remaining pack of cards. At this point, Peter is permitted to take a new card if and only if the new card is not a king, in which case he must keep his own previous card. Following the exchanges, Peter and Paul compare the two cards that they are holding. The player with the higher card value is the winner. In the case that both Peter and Paul hold the same card value, then the deck holder is the winner, i.e. Peter.

This game was previously studied by de Montmort and Nicholas Bernoulli in terms of winning strategies. Both scholars arrived at the conclusion that the deck holder should change each card carrying a value inferior to 8, while the opponent should change each card carrying a value less than 7. In questionable situations de Montmort was of the idea that no guidelines could be given, while Bernoulli thought that both players should change. On his side Waldegrave was investigating the possibility of proving the existence of a strategy that could maximise the probability of a player's win, independently from the strategy selected by the other opponent. Nowadays this is known as "minimax principle", and it will be discussed later on in this paper. As remarked in Hyksova (2004), the mixed strategy proposed by Waldegrave for the solution can be formulated in terms of Black and White chips and it can be shortened as follows: the deck holder (Peter) has to adopt the strategy <change 8 and lower> with the probability $P = 0.375$ and the strategy <keep 8 and higher> with the probability $P = 0.625$. On the other side the opponent, Paul, has to select the strategy <change 7 and lower> with the probability $P = 0.625$ and the strategy <keep 7 and higher> with the probability $P = 0.375$. As pointed out in Hyksova (2004), despite the fact that de Montmort included in his publication all the correspondence relating to *Le Her*, together with Waldegrave's contribution, this solution proposed by Waldegrave stayed ignored for a very long time.

The second period goes approximately from 1913 to 1928 and is characterised by the work of the famous set theorist Ernst Zermelo, the French mathematician Emile Borel, and by the first researcher in this area, the naturalised American mathematician John Von Neumann. In some sense the first theorem of game theory was proven by Zermelo. The theorem claims that in a game of chess three different outcomes are possible: white can force a win, black can force a win, or both sides can force at least a draw. The first modern formulation of a mixed strategy and the minimax solution was given by Borel between 1921 and 1927. He gave the minimax solution games with two players and with three or five possible strategies. Finally, by 1928 von Neumann proved the minimax theorem for zero-sum games, two players, and finitely many pure strategies for each player. In particular, when mixed strategies are taken into account, this form of games have exactly one (rational) payoff vector. From the notational point of view, these works introduced into the field of the well-known extensive normal form for a game (Hyksova, 2004).

The third era starts with the investigations carried out by Von Neumann and the economist Oskar Morgenstern at the beginning of the 1940s during the Second World War. In traditional accounts of the history of game theory, it is recognised in the literature that the comprehensive monograph *Theory of Games and Economic Behavior* published in 1944 by J. Von Neumann and O. Morgenstern developed the modern mathematical framework for the discipline. Undeniably, this publication represents the first important modern milestone in the development of this branch of applied mathematics and is normally regarded as being the starting point of game theory as an autonomous mathematical discipline. The monograph starts with a thorough formulation of economical problems and explains what might be the potential of game theory and its possible applications in modelling economic situations.

The work also lays down the foundations and a suitable framework of an axiomatic utility theory that is a classic reference for further research. The monograph also includes the general formal description of a game of strategy and an extensive study of the theory of finite two-player zero-sum games and certain types of zero-sum cooperative games with n players. The work of Von Neumann and Morgenstern widely contributed to the development of game theory as an independent field of research and thoroughly placed a great emphasis on its potential applicative aspects.

A second crucial milestone in the history of game theory is symbolised by John Forbes Nash's doctoral dissertation devoted to a full mathematical investigation of the theory of non-cooperative games. The idea of equilibrium point (today called Nash equilibrium) was discussed and its existence was demonstrated. The most important achievements of his dissertation were published in a short note, (Nash, 1950), and in a second more exhaustive paper published a year later (Nash, 1951); in the literature usually the name of Nash is also associated to a second idea that of Nash bargaining solution regarding two-player cooperative games for a certain type of games known as "cooperative games with no transferable payoffs". In this respect Nash formulated a system of axioms that a solution should satisfy as a set of requirements and demonstrated the existence of a unique solution with these requirements for the chosen set (Nash, 1951).

Definitely one of the first clear uses of game theory outside of the economic field was the application to political sciences. Remarkable in this sense was the work of L. Shapley and M. Shubik, *A Method for evaluating the distribution of power in a Committee System*, published in 1954. In this paper the authors investigate a possible solution for cooperative games in order to establish and determine the UN Security Council members' power.

In the late 1950s after Shapley's and Shubik's work, many other publications appeared that contributed to shape the literature of political sciences and made game theory central to the field in modelling several scenarios related to legislature, elections, politics of interest groups, lobbies, bargaining, etc. Nowadays game theory offers the suitable terminology and methods to resolve particular and general problems. Two fundamental works should be mentioned, the first is the work by R.D. Luce and A. A. Rogow, *A Game-Theoretic Analysis of Congressional Power Distributions for a Stable Two-Party System*, and the work by W. H. Riker, *A Text of the Adequacy of the Power Index*, published in 1956 and in 1959, respectively.

Current monographs on political sciences regard game theory as an indispensable tool and component of the discipline; the interested reader can see for example as reference works by J. D. Morrow and by P. Ordeshook (Morrow, 1994; Ordeshook, 1986). Even though game theory is not seen as the best provider solution tool for any given problem, and indeed it cannot provide an optimal solution to all problems, political scientists regard it as a powerful tool for analysis of a given political and social situation. As remarked in Hyksova (2002), in this framework game theory is regarded as a strong tool that "induces the decision-maker to think rationally and without emotions; this, in itself, often yields a general acceptable solution".

Currently game theory is one of the most important tools for the study of conflict and cooperation in the world of living beings ranging from animals to plants as well. Game theory has been used for the analysis, modelling, and understanding of several zoological applications, from fight to cooperation and communication of animals, and from analysis and modelling of coexistence of alternative traits to distributions of individuals in their habitats in different species. Many applications can be found also in botany where the theory has been applied successfully to seed dispersal, seed germination, root competition, nectar production, and flower size differentiation. The 1960s saw the appearance of different sparse and isolated research employing game theory to approach a few problems in biology, but most likely the cornerstone and ground-breaking work was *The Logic of Animal Conflict* by John Maynard Smith and George Robert Price. This work, published in 1973, inspired a large number of research endeavours and utilisation of game theory in evolutionary biology and contributed to create a solid framework for the further independent development of the field.

Maynard Smith's work *Evolution and the Theory of Games* appeared in 1982 summarises well the subsequent developments of these applications and their success in evolutionary biology. Indeed, *Evolution and the Theory of Games* demonstrated how game theory could help to offer the most insightful explanations of the theory of evolution and the principles of behaviour of animals and plants when they are analysed in a context where they can mutually interact. In the end, most likely evolutionary biology turned out to provide as a field of research and projects development the most promising applications of game theory (Hyksova, 2002).

INTRODUCTION TO SOME FUNDAMENTAL CONCEPTS AND THE PRISONER'S DILEMMA

Game theory can generally be explained as a framework that allows one to derive outcomes with assumed preferences for agents concerned. These outcomes may arise due to interactions amongst agents where certain preferences, called utilities, are key drivers.

The analysis of games depends on the outcomes and expectations of players, or agents. Situations where the expectations of other agents depend upon expectations of one-self will be generally governed by required outcomes and performances called utilities. Let us first examine the concept of utility prevalently used in game theory. An agent with required needs is generally defined as an economic agent. If such agents are considered as rational then their rational decision-making process can be described following the concept of utility. Utility here is described as a measure of an increase or decrease in the subjective welfare that is attained as a result of desired outcomes.

'Welfare' here is defined as some form of normative index indicating a measure that depicts the well being of an agent, for example, the welfare of different countries based on their per-capita income. In the areas of economics and game theory, where the focus is more on the relative welfare concerning people, the idea of 'utility' tends to denote a measure of subjective psychological fulfilment.

Game theory involves the domain of formed reasoning and as a result the idea of 'utility' requires a framework that is grounded in formal terms. The 'utility function' is therefore defined as a mapping that maps agents ordered preferences to real numbers. Let us suppose, for example, that:

*Agent A has a preference to outcome "X"
compared to outcome "Y" and outcome "Y" compared to outcome "Z".*

This scenario can be mapped using numbers and a utility mapping function as follows:

Outcome X = 3

Outcome Y = 2

Outcome Z = 1

In this example, we note that the property mapped by the utility function is order. In a game theoretic framework, a game is any situation where agents act in a way to maximise their utility by anticipating the response to their actions by other agents. Agents participating in games are called players. Players are assumed to have capacities that are collectively referred to as 'rationality'. A player is defined to be economically rational if and only if:

- 1.** A player evaluates outcomes in a game and ranks these outcomes with respect to their contributions to his/her welfare.
- 2.** A player calculates which sequence of actions leads to which outcomes.
- 3.** A player selects actions from a set of alternatives that produce the most preferred outcomes.

In such cases we may describe an agent as 'choosing' actions from a selection of possibilities. Such a kind of 'economic rationality' may be part of the behavioural dispositions of the agent. In this case, each player in the game is facing a choice and a strategy is defined as a pre-determined programme of play. In what are termed as 'simple games', from the point of view of logical structure, agents are supposed to have perfect information; for instance, chess is such a game.

In this game a player tends to choose actions by reflecting upon the series of responses and counter responses of the opponent and then considers which of these responses will result in the highest utility. Let us illustrate this further by a famous example called the Prisoner's Dilemma (PD). Usually in the literature the game is attributed to Merrill Flood and Melvin Dresher as the type of games that were discussed extensively at the RAND Corporation in the 1950s during the Cold War in the context of the exploration of different strategies to be pursued in increased development relating to global nuclear weapons.

The name "Prisoner's Dilemma" was given by the Canadian mathematician Albert Tucker (Poundstone, 1992). In 1950, Tucker presented the ideas of Flood and Dresher to an audience of psychologists at Stanford University, and in order to make these concepts more accessible to an audience of non-mathematicians, proposed a situation that describes a scenario where the police have arrested two possible suspects (Axelrod, 1984). They believe that these suspects have committed an armed robbery. However, the police are in an unfortunate situation as they lack evidence to support their claim about their robbery being committed together by these two possible suspects. However, the police have enough evidence to convict each of the suspects for one year for theft of the getaway car that was used. So, during the questioning process the following proposals are made to both the suspects by the police:

- 1.** If Suspect A (SA) confessed to the robbery claiming that Suspect B (SB) was involved and SB does not confess to his collaboration with SA, then SA will go free and SB will be convicted to twenty years, a similar situation also results if SB confesses and SA remains silent.
- 2.** If both SA and SB confess then, each of them will get five years.
- 3.** If neither SA nor SB confesses, then they each will be convicted for one year because of the car theft.

These options are represented in the matrix in Figure 1.

		PRISONER B	
		Confess	Remain Silent
PRISONER A	Confess	5,5	0,20
	Remain Silent	20,0	1,1

Figure 1: Pictorial representation of the Prisoner's Dilemma.

If we represent these options in term of utility functions representing Suspect A as player one and Suspect B as player two, then we have the following situation:

- Go free = 4*
- Sentenced for 1 year = 3*
- Sentenced for 5 years = 2*
- Sentenced for 20 years = 0*

If we now utilise these numbers to express each player's payoffs in the different options represented above, we can represent them on a single matrix as follows:

		PLAYER 2 (B)	
		Confess	Refuse
PLAYER 1 (A)	Confess	2,2	4,0
	Refuse	0,4	3,3

Figure 2: A Prisoner's Dilemma matrix of payoffs.

We note that each cell in the matrix provides a payoff to both players, and player 1's payoff appears as a first numbers in each of the pairs. So for example, (2, 2) represents five years in prison for each suspect, this matrix can therefore be compared with the one in Figure 1.

The situation is therefore such that each player is able to evaluate their two possible actions by comparing and contrasting the personal payoffs that each will receive, and these are represented by the numbers in each pair shown in the cells of the matrix in Figure 2. Now, let us consider the situation from the point of view of player 2. If player 2 confesses, then based on the utilities and options in the matrix, player 1 gets a payoff of 2 due to confessing and a payoff of 0 if he refuses to confess; therefore player 1 is better off confessing independently from what player 2 does in this situation. So, in a similar way player 2 also comes to an evaluation that points to confessing. So, we note that if both players confess then both will be convicted for 5 years, and in this case, we say that confessing strictly dominates refusing to confess for both players, so the dominant strategy is to confess.

First of all, let us notice that both players can arrive at this outcome by using a mechanical process called iterated elimination. Using the matrix in Figure 2 we can see that for player 1 the payoffs for each of the cells in the top row are higher in value than those in the bottom row; therefore for player 1 the utility maximising strategy is not to choose the options in the bottom row, this means, denying to confess, independently from what player 2 does. So, as player 1 will not play the bottom row strategy, we can simply erase the bottom row or shift along the orange arrows to the higher pay off options along the matrix as indicated in Figure 2.

It is now obvious from Figure 2 that player 2 will also not refuse to confess because the payoff from confessing is higher than refusing to do so. Again, in this case as before we can erase the one cell column on the right of the matrix or again move along the orange shaded arrows which will now converge to the point of the light green shaded equilibrium cell. Through this iterative procedure we can determine almost mechanically the dominant strategy, in this case that is represented by the strategy pair <confess, confess> for both suspects.

The order in which the rows are deleted in the above process does not really matter; we would arrive at the same solution even if we had started by deleting the right column first. The strategies chosen by agents reflect the ones that lead to higher payoffs and these point to the situation of joint confession as the solution for this PD game where both players are being motivated by being economically rational. When the PD is generally discussed, one often hears that the police inspector must separate the suspects into different rooms, and this is done with the aim of preventing any mutual communication between the suspects. Because in the case of possible communication the suspects would surely realise that each of them is better off if both refuse to confess, and this means that they could make an agreement to do so; collusion is therefore barred in this PD example. We will discuss later examples where cooperation can be introduced in such PD type examples.

In general, the PD models a scenario where there are advantages from cooperation (each player would prefer the strategy <refuse, refuse> than they both select the strategy <confess, confess> but every player has an incentive to a 'free ride' (namely to select the second strategic option) independently from the behaviour of the other player. Despite the attractiveness of the name of the game, its value goes well beyond comprehending the incentives for prisoners to select the strategy <confess, confess>, but because there are numerous situations that have analogous logical structures. Every time each of two players has two possible strategies, let's say R (denoting the strategy 'Remain silent') and C (denoting the strategy to 'Confess'), the first player prefers (C, R) to (R, R) to (C, C) to (R, C), and the second player prefers (R, C) to (R, R) to (C, C) to (C, R), the dilemma represents the situation that the player is facing. A classic example in economy where the situation can be easily modelled using a variant of the PD is the model of a duopoly where two companies manufacture an identical good, for which every company charges either a low price or a high price. In this situation every company aims at the highest possible profit. In this case, the two strategies 'Charge High Price' and 'Charge Low Price' correspond to the strategies 'Remain Silent' and 'Confess'. A reader interested on several different examples derived from the PD and a discussion in depth about the assumptions around the incentives for this type of games can consult Osborne (2002).

Let us now suppose that the two suspects do value each others' future lives; if this is the case, then we could reasonably assume that such a condition will be reflected in their respective utility functions and also in their payoffs, and it is therefore the logic of the way the PD situation is set up that produces the inefficient outcome and not the psychological makeup of the two suspects. Following the terminology of game theory, the optimal (2, 2) position is referred to as the equilibrium position, technically known as the Nash Equilibrium (NE) from the name of the mathematician John Forbes Nash. Given the strategies of all other players in the game, we say that a set of strategies is a Nash Equilibrium (NE) when no player could improve their payoff. Therefore, if iterative elimination takes us to a unique outcome, this is the game's unique NE.

Before going on, let us see some of the assumptions that play a crucial role in the Nash equilibrium theory. As in the case of the rational decision maker, it is assumed that every player select the best possible action offered. Of course, in a given game scenario the best possible available action depends for each player on the actions selected by other players. This implies that when a player will choose an action, that player will have in mind the actions that the other players will select. This means that each player will create a belief based on the actions of the other players.

Of course the obvious question here is how this can be done, on which basis can such a belief be created? The main assumption here is that each player has a certain set of beliefs that is based upon their experience in the past in playing the game and that this experience is sufficient and extensively rich enough to know how their opponents in the game will behave. Nobody tells the player how the other players will behave and which course of actions will be chosen; however, the past involvement of the player leads to some level of certainty about these future actions (Osborne, 2002).

This point is quite subtle but very important. The assumption is that every participant in the game has experience in playing it; one can assume that the player views every round of the game in isolation. The result of this is twofold. On one side, the specific player does not familiarise with the behaviour of specific adversaries, and as a consequence, does not make the actions of the strategy chosen depending on the actions of the specific opponent they are facing. On the other side, the player does not expect that the current actions deriving from the selected strategy will affect the other participant's future behaviour (Osborne, 2002).

The best way to imagine this situation is to consider the following idealised situation. "For every player in the game there is a population of many decision-makers who may, on any occasion, take that player's role. In each play of the game, players are selected randomly, one from each population. Thus each player engages in the game repeatedly, against ever-varying opponents" (Osborne, 2002). Thus it is the experience of the player that guides the player to certain beliefs concerning the actions of characteristic opponents and not any detailed group of opponents.

To sum up, the concept outlined above has two components. First, each player selects an action consistently with the model of rational choice adopted, given the set of beliefs about the actions of the other players. Second, the beliefs of each player concerning the actions of the other players are correct. As remarked in Osborne (2002), these two elements are the founding conceptual elements embodied in the notion of Nash equilibrium described above.

Having elaborated upon some basic concepts and their role in game theory we will turn now to a specific application in the field of ethics.

GAME THEORY AND ETHICAL DECISION MAKING

We can date back the application of game theory to ethics around 1954 when the philosopher Richard Braithway gave a lecture titled "Theory of games as a tool for the moral philosopher". He argued that several of the problems encountered in the areas that discuss distributive justice in ethics have similar structures as the bargaining problem. The application of game theory to ethics was not really an original development during this period, elements of game theory analysis of certain ethical problems can be found in the works of several philosophers such as Thomas Hobbes and David Hume, while further details of this work can be found in Gauthier (1969), Kavka (1986), Hampton (1986), Van der Schraaf (1998). Several years after the work of Braithway, Brain Barry published his work "Political Argument", followed by David Lewis' work "Convention" (Barry, 1965; Lewis, 1969) that provided further details to Braithway's ideas.

However, it is not until the late 1960s when the first publication in a series by David Gauthier appeared providing formalised detail to the bargaining situation and its application to ethics. Surveying the literature, concerning the applications of game theory to ethics, one can generally classify the areas being discussed into three main parts:

1. The functionalist approach - where the focus of game theory is to establish the functions of morality.
2. The contractarianism approach - where game theory is used to formalise social contract theory.
3. The evolutionary approach - where evolutionary game theory is utilised to recover and establish the origin of moral norms.

Below we shall discuss these separate approaches further in some detail, elaborate on their outcomes, and present some of the problems that authors have commented upon.

THE FUNCTIONALIST APPROACH

A good example to consider when discussing the functionalist approach is the "Gunner" example presented by Edna Ullmann-Margalit, in her work "The Emergence of Norms", the interested reader can see Ullman-Margalit (1977).

In this work Ullman-Margalit argues for the emergence of moral norms and argues that such norms provide agents with a framework to cooperate and coordinate their actions in certain scenarios and situations where the following of self-interest would otherwise prevent such a situation from occurring. She takes the example of two artillery men facing a choice to either stay and use their weapons and fight against the enemy or flee for their safety. If both decide to stay and face the enemy, they may have a high chance of being injured in the attack, but there is a high probability that they will stop the enemy from advancing further.

However, if one artillery man stays and the second one flees, the brave artillery man is certain to die in battle while the other one will escape safely. So, each artillery man has a choice of either fleeing or staying and fighting, this is represented in Figure 3 as a matrix.

		GUNNER NO. 2	
		Stay	Flee
GUNNER NO. 1	Stay	2,2	0,3
	Flee	3,0	1,1

Figure 3: Illustrating the Ullmann-Margalit Example.

The choices are represented as rows for artillery man 1 (A1) and columns for artillery man 2 (A2). We note that, as before in Figure 2, each cell in the matrix is shown to represent the particular outcome of each possible pair of choices facing the artillery men.

The first number represents how A1 could rank his outcome taking into account the relative possible outcomes of others, ranks are here represented as numbers denoting utility, and the second number in the pair represents the ranking of A2. Let us now consider the situation of A1, suppose that A2 decides to stay and face the enemy, to defend his position, in this case it is best for A1 to flee, he will survive without getting hurt. The matrix shows that he will obtain a higher ranking which is 3 rather than 2, ($3 > 2$). A similar situation results if we consider A2 fleeing, then it is best for A1 to flee also, he will survive the battle, although he may face imprisonment for fleeing in the face of the enemy attack.

So, for each individual artillery man it would be at an advantage to flee, despite the actions of the other. Following the reasoning of iterative elimination carried out with the PD example, we note that from the point of view of utility maximisation, both artillery men would be better off if they stayed in their respective positions and faced the enemy, even though this may seem paradoxical showing that the outcome of individual rational action is being suboptimal. Ullmann-Margalit argues that in this example rationality appears to point to outcomes that are not optimal, morality binds the individual gunners to stay and fight, to face the enemy and defend their positions, so it seems as if the function of morality is to assist us in preventing the failures of rationality.

Ullmann-Margalit claims that it is the function of the artillery men that binds them to stay and not to follow the rational choice of fleeing and saving their lives. We note that there are several criticisms that can be made towards such a functional approach towards our understanding of moral behaviour. First, there are recognised hurdles with the functionalist approach when it is utilised to explain areas of moral behaviour in the social sciences. One needs to be aware of the fact that if a practice or an institution follows certain functions this does not necessarily explain the origin or the maintenance of such a function. For example, the function of the public education system may be to provide an opportunity for the citizens of the state to obtain an education. However, until there is a causal connection between the apparent function and its bringing about into existence and maintaining the education system, no real explanation has been provided by following such reasoning.

Similarly, one may argue that even though moral norms may contribute to bringing about certain outcomes that are not realisable through uncoordinated individual rational action, no real explanation can be said to be existing unless one demonstrates that somehow the function of providing education plays a motivating force in contributing towards human action and is therefore causally effective in the consequences that may arise with possible beneficial outcomes, that are also optimal in a game theoretic framework.

Secondly, it is questionable if morality corresponds to mutually advantageous outcomes. We are often morally motivated to act in ways that cause disadvantages to people around us. A common example taken is the prohibition against slavery that is willingly entered into by an individual. Such a situation may have certain advantages to the slave as he will be able to acquire enough funds to settle due debts and for the master also as he would have some assistance for housework on a daily basis; however this is not only prohibited morally but is also illegal.

Thirdly, the functionalist viewpoint tends to assume that the moral demands appear to be in conflict with our individual rational decision making abilities, according to the above artillery example the morality of both artillery men is supposed to correct the pending sub-optimal option that results due to so-called 'rational deliberation'. However on the functionalist account of morality, moral agents appear to act irrationally as the artillery men exclude any considerations of guilt-avoidance or regret or even their patriotic feelings towards their country and fellow soldiers, this tends to beg the question, "Why be moral?"; functionalism does not appear to provide us with any answer to this question.

This leads us to the fourth and final criticism. The objectives of functionalism seem to be to provide us with explanations for the emergence and persistence of moral norms by observing the functions that are performed by agents. However, morality as a guide to action, the normative approach is not really focused upon. Clearly, one can argue and question if there is any difference between (i) ascertaining what the function(s) of morality are and (b) questioning whether a certain group of norms are to be followed in a situation facing the agent, but we are at a loss on how this question can be answered if a functionalist approach is taken as our viewpoint.

We note that in the artillery example discussed above, the question of moral motivation arises as a kind of deliberation that exists outside of individual rational choice, that is not really entertained as part of the rational choice process. Is there any way that we can understand morality as part of individual rational choice? The approach that has been used and the one that we will discuss below regards morality as the intended interaction between ideal circumstances and rational agents. This follows similar ideas to those developed in the 'social contract' where morality arises as a consequence of a kind of bargaining process. As a result of this, the introduction of game theory, primarily those areas concerned with bargaining and cooperative game theory have generated interest in the development of social contract theory. The works of John Harsanyi, Richard Braithwaite, John Rawls, Brian Barry and David Gauthier have formulated versions of such a theory (Harsanyi, 1955; Braithwaite, 1955; Barry, 1965; Rawls, 1971; Gauthier, 1986).

By utilising areas of bargaining theory into a game theoretic framework, there has been an attempt to show that:

1. When rational agents are in an idealised bargaining situation, they will tend to find an agreement on a distribution of benefits of cooperations amongst themselves.
2. There is a particular form to this distribution.
3. This distribution determines what is just.
4. Rational agents will agree with the conditions of the bargaining process.

Let us discuss how such a bargaining situation is characterised in the artillery example above. Without any co-operation, the artillery men are bound to flee and face captivity for the remainder of their lives. If we now suppose that it may be possible for the two artillery men to come to some kind of binding agreements (however, the problem is that it is not obvious how the benefits of such a co-operative agreement could be distributed) then we could consider an example where the artillery men could come to a situation where they decide to flee with a probability of 1/3 and stay and face the enemy with a probability of 2/3. The numbers (0, 1, 2, 3) in the matrix in Figure 3 only represent the rankings of the outcomes, by assigning probabilities we are now providing greater information concerning the relative rankings of the different outcomes.

The utility of "2", for example, that stands for the co-operative outcome and means that the artillery man is in a position where he is indifferent between this particular outcome and the alternative "0" which stands for the worst outcome with a probability 1/3 and "3" which is the best outcome with a probability 2/3. In this case, we can define what is called a 'Bargaining Area' which represents a range of different outcomes. Suppose now, that the artillery men are provided with a pair of dice and they agree to throw both dice and be governed by the following conditions:

1. If a total is equal to 6 or less, then A1 will flee therefore achieving his utility ranking of 3.
2. If both dice total more than 6 then A1 will stay and face the enemy thereby achieving the worst utility ranking of 0.

The expected utility of this deal for A1 can now be calculated as follows:

$$5/12 (3) + 7/12 (0) = 1.25$$

While A2 can expect $3 - 1.25 = 1.75$ from this situation. Thus the artillery men can realise an entire range of outcomes forming the shaded green area called the bargaining area as shown in figure 4.

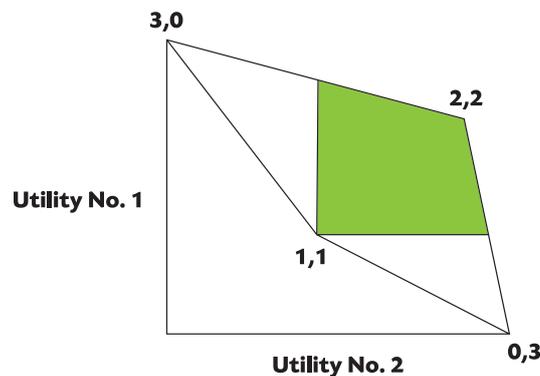


Figure 4: Illustrating the Bargaining Area.

From this bargaining area we note that the optimal outcome of the agreement between both gunners will be (2, 2). Each outcome that provided the artillery men an expected utility of greater than 1 appears to be rationally acceptable. The application of bargaining theory to ethical reasoning, therefore, provides further detail to PD type cases, we now consider how this has been developed further by the work of David Gauthier in explaining the contractarian approach.

THE CONTRACTARIANISM APPROACH

The most influential areas of contractarian theory are those developed by David Gauthier presented in his seminal work, "Morals by Agreement" (Gauthier, 1986). This work utilises extensively game and bargaining theory ideas, some of which have been touched above and attempts to provide us with an answer to the question posed earlier, namely "Why be moral?". In this respect, we could say that Gauthier's contractarian theory does contain several differences compared with the work developed by Rawls, Harsanyi, and others, we discuss some of these ideas presented by Gauthier briefly here.

The first part of this work provides us with a general account of "practical reason" and the "condition of human-kind" in relation to moral motivation; Gauthier (1986) then continues to discuss the "principles of conduct" that rational agents should agree upon – a kind of contract similar to the social contract. The third part of his work is a much discussed account concerning "practical rationality"; indeed this part is essential to Gauthier's argument as it aims to demonstrate that everyone under "normal circumstances" has some reason to accept the constraints imposed by those principles, this part essentially presents the answer to the question "Why be moral?". Finally, Gauthier argues that the principles of conduct, that he details, are indeed principles of morality.

Gauthier points out that we tend to misconceive practical rationality. He argues that the main aim of rationality is not to determine our principles of decision making – for example, to select the best option at every time when we are faced with choices. Gauthier asserts that our aim should be to reason in ways that are utility maximising. He develops his arguments in "Morals by Agreement" in terms of "dispositions to choose" and precisely by utilising the idea of "constrained maximisation" - the disposition to co-operate with others even when circumstances dictate that defecting is the more advantageous option as in the arbitrary example.

If we assume, as Gauthier does, that agents are at an advantageous position in certain circumstances when acting in certain ways that are not maximising utilities, the question we then face is to explain how to act as such a 'constrained maximiser' is economically rational. Gauthier argues that in certain circumstances if our tendencies to choose are rational, then it follows that our choices determined by these tendencies are also rational. For Gauthier, if a course of action is better, from a constrained point of view, then any other action that may follow may also be rational to adopt given certain conditions. However, to carry out such an action may not be in the best interests of all concerned.

Gauthier, therefore, seeks to establish that if a mode of deliberation is rational, then acting accordingly can also be rational, even if such an action requires performances that are not considered to be optimal from the game theoretical point of view. If Gauthier's arguments carry substance, we note that it can, therefore, be rational to adhere to certain norms even though they may require following some course of actions that are not the best from the point of view of utility maximisation. Gauthier's work has been developed further by different revisionist accounts of practical rationality (see Gauthier (1994), (1996), (1998a and b), and for revisionist accounts the interested reader can see for example McClennen (1990)). Gauthier's defence of 'constrained maximisation' represents a significant revision of standard game theoretic approaches to such decision making problems. Most game theorists argue that Gauthier's idea concerning "modes of deliberation" under "constrained maximisation" conditions can be modelled in a more complex kind of decision game theory (Binmore, 1994).

However, there are doubts whether a game theoretic approach to our comprehension of the bargaining process can assist us to predict the outcome of the deliberation of rational agents involved in required decisions given certain conditions. Such approaches to our understanding of the decision making process tends to assume that there is a unique outcome with rational motivations to such deliberations, while this may be plausible under certain circumstances, generally this is far from obvious in most situations.

Gauthier's development may be acceptable in explaining the emergence of fundamental norms arising from hypothetical situations in which large groups of agents are bargaining over principles. Nonetheless, one could say that it is questionable whether this is an appropriate methodology to follow in modelling the process of rational choice leading to the emergence of particular moral norms being followed. At this point, it is appropriate to consider an alternative viewpoint being offered by Evolutionary Game Theory (EGT). EGT is a third mode in which game theory has been developed to its application to ethics.

THE EVOLUTIONARY GAME THEORY APPROACH

Some important insights into how certain kinds of game equilibria can lead to the evolution of choices were offered by the development of Evolutionary Game Theory (EGT) and its application to ethics. Gintis (2000, 2009) states that "evolutionary game theory is a universal language for the unification of behavioural sciences". There are several good examples of such unifying works; Binmore (1998, 2005a) models social history as a series of convergent situations that arise due to efficient equilibria encountered in different transaction games.

EGT has also been successfully applied to the field of evolutionary biology where species and/or genes are treated as agents/players from a game theoretical viewpoint. In EGT, moves amongst a choice of possible options are not arrived at by economically rational agents. Instead, agents are disposed to particular strategies by their very nature, and the success and failure of a particular strategy is determined by the number of copies of itself that it will have to play in the games of succeeding generations, given a population in which other kinds of strategies that an agent acts are also distributed at particular frequencies. In this approach, the players represent strategies and the individuals are the executors of these strategies who get the benefits/costs associated with the different outcomes. To elaborate on this further, our discussion will now follow the work of Skyrms (2004), who introduces the idea of "replicator dynamics". As an example, let us first consider how natural selection works for any animal that may have heritable features.

From evidence provided in biological studies, it can be seen that any animal that may have heritable features that are likely to increase its expected number of offspring in a given environment, has the tendency of leaving a greater number of off-spring than others. So long as the environment remains stable, this off-spring are more likely to inherit the features in question, and therefore the proportion of these features in the population will gradually increase with successive generations. A natural question arising now is the following: how does game theory assist us to explain such evolutionary dominance?

One important characteristic of an organism's environment is to maximise reproductive fitness by adopting certain strategies that provide optimal solutions given the strategies of other populations. In EGT we no longer think of agents as choosing strategies when they leave one game to enter another; the focus is not to find the equilibrium of games, instead the aim is to seek equilibria that are further explored as they gradually alter over time. We therefore model strategies as competing against each other and we say that one strategy is more efficient than the other if it has more copies of itself in the next generation; this allows us to investigate the modification and change in a distribution of strategies in the population at the moment the sequence of games unfolds (Skyrms, 2004). So, we note that instead of understanding morality as the consequence of complex processes involving bargaining between informed agents following rationality, the focus now in EGT is rather to move away from such an approach and see morality as an unintended consequence of interactions between agents that arises due to repeated interactions between small groups. As a result of this, rather than assuming full information and rationality as a condition amongst agents, EGT requires less taxing assumptions concerning cognitive and deliberative skills of agents compared with earlier game theoretic models.

Let us now consider the following example to illustrate these ideas further. The example comes from Rousseau who describes the state of nature as being similar to a stag hunt (Rousseau 1964, pp. 166-167). Skyrms (2004) also considers a more contemporary treatment of a similar game situation and considers the stag hunt as modelling the social contract.

Imagine two hunters, who are faced with a hunting decision, they either choose to hunt for rabbits (during their hunt their chances of hunting for rabbits are not influenced by the actions of others around them) or they can choose to hunt for stag. However, since both hunters prefer to have venison for dinner, and if they were to hunt for stag they will only be successful if the other hunter also agrees to hunt for stag. So, the options open to them are to hunt for stags or to hunt for rabbits. Figure 5 illustrates the utility matrix for the different options. We noted earlier that in the PD case, there is a conflict between individual rationality and mutual benefit; in a similar way in the stag hunt example what is rational for one hunter to choose will depend upon his beliefs about what the other one will choose.

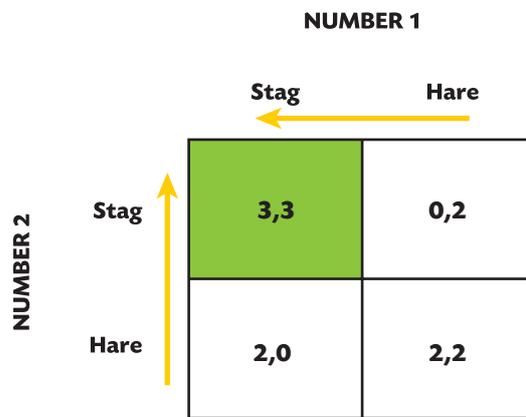


Figure 5: Illustrating the Example of the Stag Hunt.

Let the two hunters be represented by the numbers 1 and 2 as in the diagram. So, the pair (Stag, Stag) will represent the utility ranking (3, 3) where both hunters hunt for stag. We note that there are two rational outcomes to the stag hunt:

1. Either both hunters hunt the stag as a team.
2. Each hunts rabbits by himself.

Each would prefer to cooperate in hunting the stag, but if the other player's motives or actions are uncertain, the rabbit hunt is a risk-free alternative. If they both go for option 1, they have to both cooperate to hunt and catch the stag. When we solved the PD, we saw that one strategy was better regardless of what the other player was doing. Let us see if this dominant solution concept works here. If hunter 2 goes for a stag then hunter 1 should go for a stag as well since $3 > 2$. But if hunter 2 is going after rabbits then hunter 1 should hunt rabbits as well since $2 > 0$. So, we note that sometimes hunter 1 prefers hunting stag and other times he prefers hunting rabbits; thus our dominant solution concept is not sufficient for this game and consequently we must introduce another method for attaining a solution to the game.

Remembering that conditions for attaining the Nash equilibrium are as follows:

1. A game is said to be in NE when no player has any incentive to deviate from his strategy given the strategies of all other players.
2. At least one NE exists in all finite games.

In our example let us look at the (stag, stag) outcome, and we note that this is a NE point following the iterative reasoning developed earlier. Now we note that if we consider (rabbit, rabbit) this too is a NE because hunter 1 would prefer to hunt for rabbits if the second hunter is hunting for rabbits as well. These examples illustrate that cooperation in game theoretic modelling is an important aspect to consider as the evolution of cooperation in such models is an important indicator for determining more than one NE.

We note from our discussion above that EGT can be utilised to explain how cooperation may emerge amongst rational agents to assist in reaching their aims. Skyrms (1996) and other authors have also shown that agents with self-interested motives may also develop reasoning frameworks such as the 'Golden Mean' and versions of Gauthier's 'constrained maximisation' idea under relevant circumstances. These developments tend to support the view that evolution tends to favour the emergence of certain patterns of behaviour that tend to conform to moral norms and also the development of cognitive frameworks that tend to support characteristics related to moral reasoning.

Most of the authors who have developed the evolutionary approach using game theory point to several advantages of such an approach compared to the ones we discussed earlier, and these advantages can be briefly listed as follows:

1. In EGT norms arise as unintended consequences due to repeated actions of the rational agents.
2. There is no consequential connection among the efficiency of outcomes and morality in the evolutionary game theory paradigm. We could therefore say that one advantage with respect to Gauthier's claims for 'constrained maximisation' is that since in EGT the focus is on equilibrium and not determining efficient situations concerning utility maximisation, the 'function' of moral norms are to select stable equilibria. So, following the norm is individually rational.

However, there are also several reasons that point us to be more careful concerning the claims and successes relating to the evolutionary approach. As the functionalist approach, the focus of EGT is one explanation to explain the emergence of norms and their stability, but it does not supply us with any kind of framework to criticise and evaluate these moral norms. It is, therefore, not clear and evident to what extent such a paradigm offers to us an alternative to the moral theories already available. Another important criticism that has been pointed at the application of EGT to ethical decision making is the idea of the rational agent; this criticism can be thought of as a general criticism relating to the application of the whole of game theory to our understanding of ethical norms. A rational agent is a kind of one-dimensional entity who is supposed to determine preference rankings over possible outcomes. However, differences of character and other psychological variables concerning the agent are not really considered in the application process. Recent developments in game theory have made efforts to incorporate the notion of the player's "reputation" to explain the emergence of cooperation in iterated plays of games such as that seen in the PD case, while further examples of this can be found in Kreps and Wilson (1982).

CONCLUSION

The aim of this paper has generally been two-fold. First, to provide a concise historical introduction to the field of game theory leading to the discussion of the Prisoner's Dilemma and the use of pay off matrices. Secondly, three approaches where the application of game theory to ethical decision making are considered and their criticisms lead us to the development of Evolutionary Game Theory. The functionalist approach presents the argument developed by Ullmann-Margalit that the function of morality is to assist us in preventing failures of rationality. However, the five examples presented following this discussion show us that the emergence of norms could be explained by a more evolutionary approach. Careful reasoning indicates that an evolutionary game theory approach to ethical decision making may provide us with a suitable framework that explains the emergence of norms used to guide agent behaviour during the ethical decision making process; however, such a framework does not assist us in formulating an evaluation of such norms for individual agents.

Despite the successful application of evolutionary game theory to decision making, a critical area that will require further development is to consider collection of agents forming a group, for example, a board of directors; in such a case the emergence of norms guiding ethical decision making will depend upon several different psychological factors concerning not only a single agent but the group of agents in question. Such differences will need to be incorporated into any kind of evolutionary game theoretic approach when considering collective ethical decision making. ■

REFERENCES

- Aumann R. and Hart S., ed. (1992) *Handbook of Game Theory with Economic Applications*, vol. 1, Amsterdam: Elsevier.
- Axelrod, R. (1984) *The Evolution of Cooperation*. New York: Basic Books.
- Barry, B. (1965) *Political Argument, International library of philosophy and scientific method*. London: Routledge & Kegan Paul.
- Binmore, K. (1994) *Playing Fair (Game Theory and the Social Contract, vol 1)*. Cambridge: The MIT Press.
- Id. (1998) *Just Playing (Game Theory and the Social Contract, vol. 2)*. Cambridge: The MIT Press.
- Id. (2005) *Natural Justice*. New York: Oxford University Press.
- Braithwaite, R. B. (1955) *Theory of games as a tool for the moral philosopher*. Cambridge: Cambridge University Press.
- Brennan, G. and Philip P. (2004) *The Economy of Esteem: An Essay on Civil and Political Society*. Oxford: Oxford University Press.
- Cremaschi, S. (2005) *L'etica del Novecento*. Roma: Carocci.
- Id. (2007) *L'etica moderna*. Roma: Carocci.
- Dreier, J. (2004) *Decision Theory and Morality*. In *The Oxford Handbook of Rationality*. Oxford: Oxford University Press.
- Epstein, R. (2009) *The theory of Gambling and Statistical Logic*. Boston: Academic Press.
- Esther, M. S. (2004) 'How Psychology Made Its (Limited) Way Back Into Economics', *History of Political Economy*, 36, pp. 735-760.
- Frank, R. (1988) *Passions within Reason*. London: W. W. Norton & Company, Inc.
- Gauthier, D. (1967) 'Morality and Advantage', *Philosophical Review*, 76, pp. 460-475.
- Id. (1969) *The Logic of 'Leviathan': the Moral and Political Theory of Thomas Hobbes*. Oxford: Clarendon Press.
- Id. (1986) *Morals by Agreement*. Oxford: Clarendon Press.
- Id. (1994) 'Assure and Threaten', *Ethics*, 104, pp. 690-721.
- Id. (1996) 'Commitment and Choice: An Essay on the Rationality of Plans', in Farina, F., Hahn, F. and Vannucci, S. (eds.) *Ethics, Rationality, and Economic Behaviour*. Oxford: Oxford University Press, pp. 217-244.
- Id. (1998a) 'Intention and Deliberation', in Danielson, P. (ed.) *Modeling Rationality, Morality, and Evolution*. Oxford: Oxford University Press, pp. 41-54.
- Id. (1998b) 'Rethinking the Toxin Puzzle', in Coleman, J. and Morris, C. (eds.) *Rational Commitment and Social Justice: Essays for Gregory Kavka*. Cambridge: Cambridge University Press, pp. 47-58.
- Id. (2008) 'Friends, Reasons and Morals', in Verbeek, B. (ed.) *Reasons and Intentions*. Aldershot: Ashgate, pp. 17-36.
- Gibbard, A. (1990) *Wise Choices, Apt Feelings: A Theory of Normative Judgment*. Cambridge, MA: Harvard University Press.
- Hald, A. (2003) *A History of Probability and Statistics and Their Applications before 1750*. Hoboken, NJ: Wiley.
- Id. (1998) *A History of Mathematical Statistics from 1750 to 1930*. New York: Wiley.
- Hampton, J. (1986) *Hobbes and the Social Contract Tradition*. Cambridge: Cambridge University Press.
- Hardin, R. (1988) 'Bargaining for Justice', *Social Philosophy and Policy*, 5, pp. 65-74.
- Id. (2003) *Indeterminacy and Society*. Princeton: Princeton University Press.
- Hargreaves-Heap, S. and Varonfakis Y. (1995) *Game Theory: A Critical Introduction*. London: Routledge.
- Harsanyi, J. C. (1955) Cardinal Welfare, Individualistic Ethics, and Interpersonal Comparisons of Utility. *Journal of Political Economy* 63: pp. 309-321.
- Kavka, G. (1986) *Hobbesian Moral and Political Theory*. Princeton: Princeton University Press.
- Kreps, D. M. and Robert W. (1982) 'Reputation and Imperfect Information', *Journal of Economic Theory*, 27(2), pp. 253-79.
- Kuhn, S. T. (2004) 'Reflections on Ethics and Game Theory', *Synthese*, 141(1), pp. 1-44.

- Lewis, D. (1969) *Convention: A Philosophical Study*. Cambridge: Harvard University Press.
- Mackie, J. (1977) *Ethics*. London: Penguin Books Ltd.
- McClennen, E. F. (1990) *Rationality and Dynamic Choice: Foundational Explorations*. Cambridge: Cambridge University Press.
- Mele, A. and Piers R., eds. (2004) *The Oxford Handbook of Rationality*. Oxford: Oxford University Press.
- Morris, C. W. (1999) 'What is this Thing Called 'Reputation''', *Business Ethics Quarterly*, 9(1), pp. 87-102.
- Nash, J. (1950) 'The Bargaining Problem', *Econometrica*, 18(2), pp. 155-162.
- Osborne, M. J. (2002) *An Introduction to Game Theory*. Oxford: Oxford University Press.
- Poundstone, W. (1992) *Prisoner's Dilemma*. New York: Doubleday, 1992
- Rawls, J. (1971) *A Theory of Justice*. Cambridge: Harvard University Press.
- Ross, D. (2012) 'Game Theory', in Zalta, E.N. (ed.) *The Stanford Encyclopedia of Philosophy, Winter Edition*. [Online]. Available at: <http://plato.stanford.edu/archives/win2012/entries/game-theory/> (Accessed: 15 March 2014).
- Rousseau, Jean-Jacques. (1964) *Discours sur l'origine et les fondements dell'inégalité parmi les hommes, vol. III, Oeuvres complètes*. Paris: Éditions Gallimard.
- Rubinstein, A. (1982) 'Perfect Equilibrium in a Bargaining Model', *Econometrica*, 50(1): pp. 97-109.
- Skyrms, B. (1996) *Evolution of the Social Contract*. Cambridge: Cambridge University Press.
- Id. (2004) *The Stag Hunt and the Evolution of Social Structure*. Cambridge: Cambridge University Press.
- Smith, J. M. (1982) *Evolution and the Theory of Games*. Cambridge: Cambridge University Press.
- Solomon, R. (1999) 'Game Theory as a Model for Business and Business Ethics', *Business Ethics Quarterly*, 9(1), pp. 11-29.
- Sugden, R. (1986) *The Economics of Rights, Co-operation and Welfare*. Oxford: Basil Blackwell.
- Id. (1991) 'Rational Bargaining', in Bacharach, M. and Hurley, S. (eds.) *Foundations of Decision Theory*. Oxford: Basil Blackwell.
- Id. (2001) 'The Evolutionary Turn in Game Theory', *Journal of Economic Methodology*, 8(1), pp. 113-30.
- Ullmann-Margalit, E. (1977) *The Emergence of Norms*. Oxford: Oxford, University Press.
- Vanderschraaf, P. (1998) 'The Informal Game Theory in Hume's Account of Convention', *Economics and Philosophy*, 14(2), pp. 215-247.
- Velleman, J. D. (1997) 'Deciding How to Decide', in Cullitty, G. and Gaut, B. (eds.) *Ethics and Practical Reason*. Oxford: Oxford University Press, pp. 29-52.
- Verbeek, B. (2002) *Instrumental Rationality and Moral Philosophy: An essay on the virtues of cooperation*. Dordrecht: Kluwer Academic Publishers.
- Id. (2007) 'The Authority of Norms', *American Philosophical Quarterly*, 44(3), pp. 245-258.
- Id. (2008) 'Conventions and Moral Norms: the Legacy of Lewis', *Topoi*, 27(1-2), pp. 73-86.
- Verbeek, B. and Morris, C. (2010) 'Game Theory and Ethics', in Zalta, E.N. (ed.) *The Stanford Encyclopedia of Philosophy, Summer Edition*. [Online]. Available at: <http://plato.stanford.edu/archives/sum2010/entries/game-ethics/> (Accessed: 15 March 2014).
- Von Neuman J. and Morgenstern O. (1944) *Theory of Games and Economic Behavior*. Princeton: Princeton University Press.



PROGRAMMING LANGUAGE PARADIGMS & THE MAIN PRINCIPLES OF OBJECT-ORIENTED PROGRAMMING

JAN BARTONÍČEK

This paper's goal is to briefly explain the basic theory behind programming languages and their history while taking a close look at different programming paradigms that are used today as well as describing their differences, benefits, and drawbacks.

GENERAL DEFINITION OF PROGRAMMING LANGUAGES

Programming language is so-called 'formal' language, created to make communication between the computer and its programmer easier. The very first computers were programmed using switches and plugboards, but this concept quickly evolved into software programming. To start with, programmers used machine code, which was hard to read and debug, and the invention of programming languages came to make these tasks easier.

Programming language is a set of commands, strings of characters readable by programmers but easily translatable to machine code; it has syntax, grammar, and semantics. Syntax is a set of rules that define how the commands have to be arranged to make sense and to be correctly translatable to the machine code. Grammar is a set of rules of using different punctuation, quotation marks, semicolons, and other symbols to divide and clarify the syntax of a particular language. The last component of programming language is semantics, a set of meanings assigned to every command of the language and is used to properly translate the programme to machine code.

Programming languages are often divided into three generations:

The first generation of programming languages were used to directly control the processor and were written mainly in binary or machine code. It was very hard to write the programmes and even harder to debug them.

The second generation of languages are also called low-level languages, and they use symbolic addresses and simple instructions to make programming easier and faster. These languages have access very close to the hardware itself, and they are still used to write highly-optimised code for specific hardware.

The third generation of languages use a high level of abstraction, using advanced commands, variable names, and pointers. These languages are mostly hardware independent and portable (Nasir, 1996).

BRIEF HISTORY OF PROGRAMMING LANGUAGES

The very first device to be called a computer was the Pascaline, an automatic mechanical calculator invented by Blaise Pascal in the year 1642. It was able to perform addition, but because of its complicated nature, it did not gain popularity. In 1833, Charles Babbage, a mathematician, devised plans for his "analytical engine", a steam powered machine able to carry out almost any mathematical operation. It was programmed by exchanging gears in the machine that made it extremely impractical. The design was so advanced that it was not possible to build it with the level of technology at the time. Ada Augusta King, Countess of Lovelace, called Ada Lovelace for short, was a pioneer in the computing field. She made major enhancements to the analytical machine, such as subroutines and conditional execution.

The next big advancement in computing came a hundred years later with the publication of Alan Turing's paper called "On computable numbers, with an application to the Entscheidungsproblem" in the year 1936. In it, Alan Turing proposed a theoretical machine, later named the Universal Turing Machine, which consisted of a read/write head with memory for holding instructions and an infinite tape comprised of cells able to hold one symbol each. The head was capable of moving above the tape, read its contents, alter it, and write new data to the tape. This paper introduced basic concepts of computing and its publication marks the start of a rapid development in computer technology (Armbruster *et al.*, 2001a).

Not long after the Turing's paper, the first digital computers started to be constructed. The first one to be finished was the ENIAC (Electrical Numerical Integrator and Calculator) in the year 1942. It was programmed using switches and plugboards, which was extremely impractical and time-consuming.

Interested in the success of ENIAC, a mathematician working at the Institute of Advanced Study, John von Neumann, started to work on improving the ideas behind computers, and he introduced ideas that are now collectively called the "Von Neumann architecture". He stated that computers should be static in their hardware design and their only part subject to change should be their software, making them much easier and quicker to reprogramme (Armbruster *et al.*, 2001b).

Another revolutionary woman, Grace Murray Hopper, while working on the UNIVAC, ENIAC's competitor, constructed a first compiler, a machine or later a block of code that was able to translate commands into machine code. She introduced the first programming language, called Assembly, which used slightly more readable commands in a three-address machine code ([ADD 00X 00Y 00Z] that would be used to add together X and Y and assign the output to Z).

The next major step in development of programming languages was the announcement of FORTRAN (FORmula TRANslation). It was designed by scientists at IBM and featured a revolutionary compiler with ability to optimise the compiled code. It became the very first successful high-level programming language. The first programming language that implements Object-oriented principles is Smalltalk released in the year 1970. In fact, it is purely Object-oriented, which means no data or functions can exist outside of objects (Armbruster *et al.*, 2001c).

One of the widely used languages of today is C++, which was created as an Object-oriented version of C, a very popular language invented in 1972 for development of the UNIX system. C++ inherited a wide variety of features from C, including its ability to use low-level commands to create fast and tuned programmes.

Two of the three major languages of today were both released in the year 1991, first one being Java, focusing on object-oriented approach and simplicity of the language, relying on extension libraries. The second one is called Python and it features a simple and English-like syntax, which makes it easy to use and effective. The last major language is C#, developed as a modernization to the C language. It was made public in the year 2000 as a part of the Microsoft's .NET Framework project. It is a high-level, multi-paradigm language focused on the effectiveness of program creation. (Armbruster *et al.*, 2001d)

PROGRAMMING PARADIGMS

By the word paradigm, we understand a set of patterns and practices used to achieve a certain goal. In this essay, the word 'approach' is used as a synonym to 'paradigm'. For an idea to become a paradigm, it should be picked up globally in many independent organisations and societies. There are many programming paradigms in use today, but only the three major paradigms are in this essay's discussion.

PROCEDURAL PARADIGM

Procedural paradigm is the approach to programming that was used from the beginning of computing. In this paradigm, the programme comprises of a list of instructions for the computer to execute in the order in which they were written, unless stated otherwise. It is a simple approach, and tends to be easily readable when the programme is reasonably short. Larger programmes written with a procedural paradigm in mind can be very hard to read, manage, and debug. Most procedural languages have flow control structures, IF

statements used to branch the code execution, FOR and WHILE for repeated execution, and GOTO for 'jumping' between lines of code.

When talking about a procedural paradigm, we cannot forget to mention its subset, called a structural paradigm which omits the GOTO command, meaning that the execution of the programme has to go through the entire programme without skipping any commands.

Programming languages based on procedural approach includes most of the early languages like Assembly, FORTRAN, and some more recent languages, for example, C and PHP.

Following is an example of procedural implementation of factorial function in pseudo-code, an English-like code used for language agnostic representation of programmes:

```
START
Initialize n, f = 1
Read n from the user
For i between 1 and n do:
  f = f * i
Return f
END
```

FUNCTIONAL PARADIGM

Functional paradigm is fundamentally different from the procedural paradigm in the way programmers develop their programmes. As opposed to the procedural approach, in which the programmers define the way the programme functions, in the functional approach, the programmer defines the desired outcome and cannot define the way the functions are executed. Functional programming relies on the concept of λ -calculus (lambda-calculus), which defines a way to convert any computable (as defined in Turing's paper "On computable numbers") function to a mathematical function expressible in functional languages. The most important functional programming language is LISP (LISt Processing). Some more examples of functional languages are Scheme (a dialect of LISP), Haskell, and Mathematica.

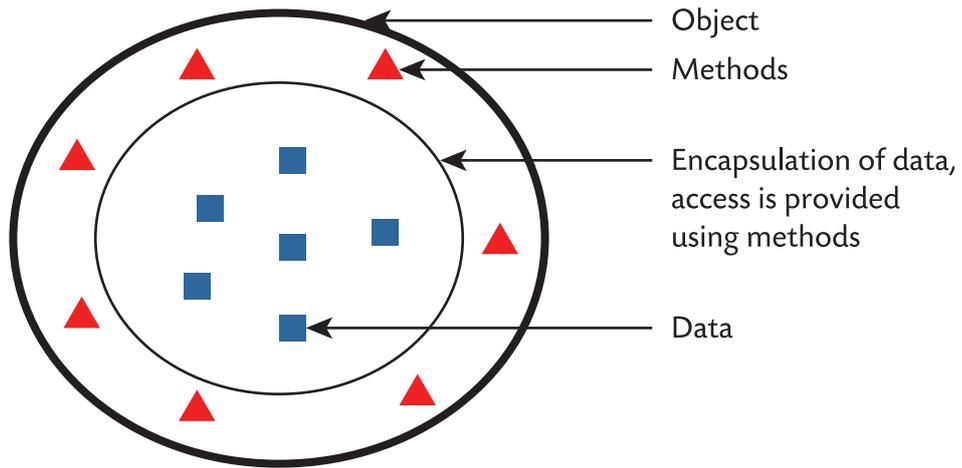
The following is an example of functional implementation of a sum function in Haskell (Computerphile, 2013):

```
sum :: [int] --> int
sum [n] = n
sum(n, ns) = n + sum ns
```

OBJECT-ORIENTED PARADIGM

The Object-oriented paradigm was developed by Alan Kay while he was working on Smalltalk. It was developed to make large projects easier to manage and share the workload among coworkers and is simplified thanks to the modularity of objects.

The main focus of the Object-oriented paradigm is an object. Object is a way of grouping data structures and functions that can be carried out on the data, which are called methods (Oracle, 2013a). Using the proper typing of the data and methods, the programmer can achieve a high level of encapsulation. For further description of object, see the graphic below.



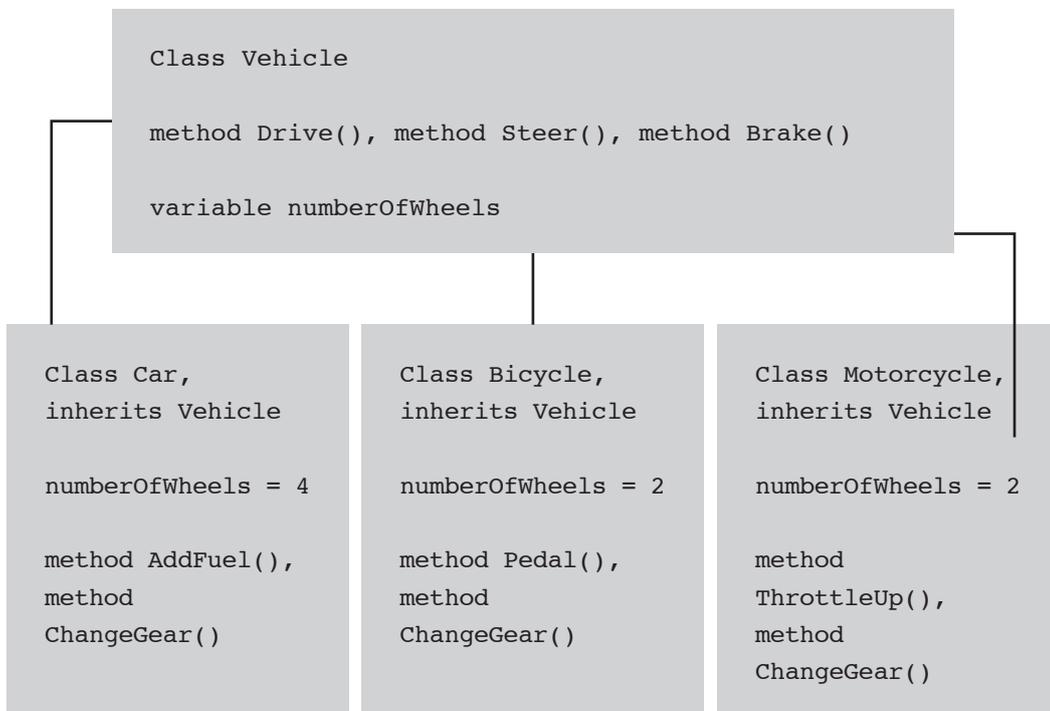
Object-oriented programming is based on four main concepts:

THE CONCEPT OF CLASS

Class is a template from which objects are created. It contains the description of all the data structures and all methods of the resulting objects. Most classes have their constructors, methods, which initialise the created objects' variables depending on the data given.

THE CONCEPT OF INHERITANCE

Inheritance is the ability of classes to inherit data structures and methods from other classes (Oracle, 2013b). For example, we can imagine a parent class vehicle and its child classes: Car, Bicycle, and Motorcycle. For further description of inheritance, see the graphic below:



An object created from the class Bicycle shown in the graphic will have not only the methods and variables declared in the Bicycle class, but all the methods and variables inherited from the Vehicle class. The complete class Bicycle without the use of inheritance is shown in the graphic below.

```

Class Bicycle

method Drive(), method Steer(), method Brake(), method Pedal(),
method ChangeGear()

variable numberOfWheels = 2

```

THE CONCEPT OF ENCAPSULATION

Encapsulation is a property of a well-written object. The programming language provides the programmer with tools to prevent other objects or programmes to access the data held within the object directly, allowing him to specify the ways the data can be manipulated using public methods, which are used to validate input data before storing it.

Closely related to encapsulation is the notion of modularity. Modularity of objects, the isolation of the working code from the outside world, is used to make larger programs easier to develop and manage. The programmer does not need to understand how a certain object works, he only needs to know which methods to use for accomplishing his goals. For example, the programmer does not understand how the engine of a Motorcycle from the previous example works, but he knows that he needs to call the method ThrottleUp() in order to increase the speed.

THE CONCEPT OF POLYMORPHISM

Polymorphism is the ability of objects to process multiple data types in the same object. This ability is based on one of the notions used in most programming paradigms called function overloading, which allows the programmer to specify different functions under the same name, whose execution will be dependent only on the data type of a given argument. For example, the programmer would write two different functions under the name Print() for outputting information to the screen. First one would be defined as Print(int input) and it would handle printing integers and the second one would be defined as Print(string input) and it would handle printing strings of characters. This allows the programmer to use the function Print() to print integers and strings of characters instead of using two different functions PrintInt() and PrintString().

OBJECT-ORIENTED LANGUAGES

The first programming language to implement features of the Object-oriented paradigm was Smalltalk. One of the main contributors to its development, Alan Kay, is the creator of the Object-oriented paradigm. It was released in the year 1970. It is purely object based, which means that no data or methods can exist outside of an object. The next programming language focused on the Object-oriented paradigm was a set of extensions for C collectively called 'C with Classes', which later led to the development of one of the most influential Object-oriented language of today, C++.

Another well-known Object-oriented language is Java, widely used today for creation of programmes ranging from servlets for interactive websites to mobile and computer games. It focuses on cross-platform compatibility using Java Virtual Machine to run the same code on a wide range of different types and architectures of hardware. Although practical for portability, this approach makes Java programmes less effective in resource usage and slower than other programming languages.

CONCLUSION

Although it is not without its quirks, the Object-Oriented paradigm is the most frequently used paradigm of today. It owes its popularity to the simplicity of large project management using object modularity and encapsulation. Every programming paradigm has its own advantages and disadvantages for many usage scenarios and that is why most of the currently used programming languages support multi-paradigm approach, which allows the programmer to choose the best development practice for his specific needs. ■

REFERENCES

- Armbruster, F., Brooks, C., Christos, B., Fuller, K. (2001a) *The Birth of Modern Computing and Programming Ideas*. Available at: <http://www2.lv.psu.lv.edu/ojj/ist-240/reports/spring2001/fa-cb-bc-kf/1200-1940.html> (Accessed: 12 October 2013).
- Armbruster, F., Brooks, C., Christos, B., Fuller, K. (2001b) *The Concepts become reality*. Available at: <http://www2.lv.psu.lv.edu/ojj/ist-240/reports/spring2001/fa-cb-bc-kf/1941-1950.html> (Accessed: 12 October 2013).
- Armbruster, F., Brooks, C., Christos, B., Fuller, K. (2001c) *Programming as we know it begins*. Available at: <http://www2.lv.psu.lv.edu/ojj/ist-240/reports/spring2001/fa-cb-bc-kf/1951-1970.html> (Accessed: 12 October 2013).
- Armbruster, F., Brooks, C., Christos, B., Fuller, K. (2001d) *The Arrival of the Internet Languages*. Available at: <http://www2.lv.psu.lv.edu/ojj/ist-240/reports/spring2001/fa-cb-bc-kf/1991-2001.html> (Accessed: 12 October 2013).
- Computerphile (2013) *Programming Paradigms – Computerphile*. Available at: <http://www.youtube.com/watch?v=sqV3pL5x8PI> (Accessed: 21 October 2013).
- Nasir, M. J. B. M. (1996), *Generations of Programming Languages*. Available at: http://www.doc.ic.ac.uk/~nd/surprise_96/journal/vol2/mjbn/article2.html (Accessed: 15 October 2013).
- Oracle (2013a) *What Is an Object?* Available at: <http://docs.oracle.com/javase/tutorial/java/concepts/object.html> (Accessed: 10 October 2013).
- Oracle (2013b) *What Is Inheritance?* Available at: <http://docs.oracle.com/javase/tutorial/java/concepts/inheritance.html> (Accessed: 10 October 2013).

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