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DISCRETE SIMULATION SOFTWARE RANKING – A TOP LIST OF THE WORLDWIDE MOST POPULAR AND USED TOOLS

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ABSTRACT

This paper documents a work on all-purpose discrete event simulation tools evaluation. Selected tools must be suitable for process design (e.g. manufacturing or services industries). Rather than making specific judgments of the tools, authors tried to measure the intensity of usage or presence in different sources, which they called "popularity". It was performed in several different ways, including occurrences in the WWW and scientific publications with tool name and vendor name. This work is an upgrade to the same study issued 5 years ago (2011), which in its turn was also an upgrade of 10 years ago (in 2006). It is obvious that more popularity does not assure more quality, or being better to the purpose of a simulation tool; however, a positive correlation may exist between them. The result of this work is a short list, of 19 commercial simulation tools, with probably the nowadays' most relevant ones.

1 INTRODUCTION

Most of scientific works related to tools comparison analyze only a small set of tools and usually evaluating several parameters separately, avoiding to make a final judgment, due to its subjectivity.

Simulation languages have been replaced by simulation software packages/tools. High market prices of simulation tools in the past decades, added to other factors like: ease of construction of a simulation tool; the emerging graphics facilities; the wide field of applications and the absence of strong standards or languages; lead to a large, or may be too large, tools offer (Dias, 2005).

Thus, for instance, in the Industrial Engineering Magazine (1993/July) there is a list of 45 commercial simulation software products. The sixth biannual edition of simulation software compiled by James J. Swain in 2003 identified about 60 commercial simulation products, 55 in 2005, 48 in 2009, 43 in 2013, 55 in 2015 (Swain, 1991-2015). The annual 2004 SCS edition - "M&S Resource Directory" lists 60 simulation products (Klee, 2004). In the "Simulation Education Homepage" (Simulation tools list by William Yurcik) there were more than 200 simulation products, including non-commercial tools.

This work started with Swain´s list, removing non discrete event simulation environments, and adding some tools found in more than one list sources.

As aforementioned, this tools comparison was performed previously in 2006 and 2011, and is now extended with more parameters and relevant changes are discussed.

In this scenario of such a large simulation tools' offer it is unfeasible to perform a consistent experiment. The comparison, based on features or characteristics is also very difficult or non-conclusive because most of them have similar features lists.

The measure here called "popularity" was the way that we found to overcome those difficulties, identifying the tools that are potentially the best or most used. Choosing a popular simulation tool ma bring benefits in two different perspectives:

- If you are a company, it is easier to find simulation specialists with know-how on a popular tool;
- If you are a simulation specialist, it is easier to find companies working with a popular tool.

The second *way* includes educational purposes because students should be the future simulation specialists. Nevertheless, popularity should never be used as a unique parameter for simulation tools selection. If so, new tools, would never gain market share - and this is a generic risk, not a simulation particularity. Therefore, the popularity may be seen as a significant "blind" factor to be used in conjunction with direct evaluation mechanisms like features comparison and experimentation.

Product names in this paper are trademarks or registered trademarks of their respective owners.

2 METHODOLOGY

Our evaluation method, in order to identify a short list containing the most popular or important tools, was essentially based in the intensity or level of presence on the following categories:

- Winter Simulation Conference scientific publications;
- Document database oriented sites;
- Presence in selected reviews, surveys, comparisons, among other selected sources.
- Social networks;
- WWW (Internet);
- Web searches' trend (Delta) over the last 5 years (new). It is calculated based on the number of search results on each of the last 5 years - percentage – in relation to the total number of search results. The final value of this category is obtained by multiplying the obtained percentage with the assigned weight.

2.1 Technique

For the purpose of measuring the web-presence, Google searching engine was used. The reasons are:

- It is the most used search engine on the Web +65% of searching actions in 2015 (https://searchenginewatch.com/sew/news/2391446/googles-search-share-goes-to-yahoo-comscore-reports).
- Google owns different sources of relevant information (e.g. Books, YouTube, Maps, Translator);
- It supports a VBA (Visual Basic for Applications) methods for getting the number of search results, therefore, for this project we also developed a procedure - Excel macro - for automatically updating data in an Excel sheet.
- It supports restricted search to specific domains (e.g. scribd.com, books.google.com, linkedin.com, facebook.com).
- In nowadays Google has in fact become a synonym of the word "search" (https://searchenginewatch.com/sew/how-to /2048976/major-search-engines-directories)

2.2 Factors Description and Tuning

We used 50 parameters/factors. This represents an increase of 10 new parameters, in comparison to the previous 2011 paper. Nonetheless, some parameters were excluded for several reasons, for instance docstoc.com was closed, therefore the number of new parameters is actually higher than 10 – around 15.

All parameters can be consulted in Table 2. Each category comprises a set of specific parameters. For each tool we additionally defined the two following labels:

- "**Tool**" represents the search string containing the name of the simulation tool, the word "simulation" and some additional words to avoid finding pages out of the topic due to common English words used as tools names. (e.g. "Arena", "Extend", "Quest" etc.).
- "**Vendor**" represents the search string containing the name of the simulation tool vendor.

"**T**" is also used as abbreviation of "Tool" and "**TV**" as "Tool"+"Vendor".

Factors values, representing the number of occurrences, vary from units to millions. The sum of all of them together would lead to irrelevant factors mixed with absorbent factors. To reduce the impact of different orders of magnitude, the use of mathematical functions was studied, in order to "control" big numbers, although keeping relative differences. Square and cubic root, Natural and ten base logarithms were the evaluated possibilities.

After an extensive iterative and empiric process, the cubic root was chosen, once it was proven to consider both small and big numbers adequately - see Figure 1 (cubic root (x) = x^1/3). The use of a cubic root of a number in place of the number itself, is the same as comparing the volume of cubes, using only the value of their width. The use of this function is not solidly supported, notwithstanding that the use of a different one would not lead to significant changes in the relative position of the tools. Figure 2 illustrates the values for the parameters factors adjusted, followed by the original raw values.

	^1/2	^1/3	LN	LOG10
1000000	1000	100	14	6
100000	316	46	12	5
10000	100	22	9	4
1000	32	10	7	3
100	10	5	5	2
10	3	2	2	1
1	1	1	0	0

Figure 1: Possible Functions to Factors Adjustment.

3 SEARCH RESULTS ANALYSIS

All parameters were divided into each of the aforementioned categories. Table 2 shows the description of all parameters. The results obtained for each parameter will now be analyzed, separately for each category. Figure 2 indicates the factor weights applied for each string related to WSC, whether T and TV, as well the obtained raw results and the same results, considering the factor applied.

As the figure suggests, the results obtained for each parameter of WSC (T and TV) vary – almost all the tools have higher values in WSC T, which is expected since its search string is less restricted however, multiplying the cubic root of the search results for a **factor weight** of each parameter, the **parameter factor values** were obtained. The same was done for all parameters. In this case, weights 3 and 4 were respectively assigned to WSC T and WSC TV search strings thus, in some cases, while raw search results may be higher in TV than in T, the pondered values may not. Arena, ProModel, AutoMod and SIMROCESS are the tools with the most presence in the WSC and Plant Simulation, QUEST, SimCAD Pro and ShowFlow are the ones with the least WSC presence. Figure 3 to Figure 7 show the results for the remaining sets of parameters.

DES Tools	#1 WSC (T) Factor #1 value = raw^(1/3)	#1 WSC (T) Raw Result	#2 WSC (TV) Factor #2 value = raw^(1/3)	#2 WSC (TV) Raw Result
Weight	3		4	
Average	12,0		11,3	
Arena	20,3	306	21,7	162
ProModel	19,6	275	19,2	112
FlexSim	11,6	58	12,3	29
Simul8	14,4	108	8,6	10
WITNESS	16,3	165	13,9	42
ExtendSim	10,6	44	14,8	51
Simio	11,6	58	12,1	28
Plant Simulation	4,8	4	0,0	0
AnyLogic	14,8	115	14,3	46
SIMPROCESS	22,3	409	11,8	26
AutoMod	18,9	249	14,3	46
Micro Saint	10,6	44	4,0	1
QUEST (Delmia)	5,7	7	7,3	6
Enterprise Dynamics	9,4	31	8,6	10
ProcessModel	6,5	10	8,6	10
SimCAD Pro	5,1	5	5,8	3
GPSS World	11,0	49	14,3	46
SLX + Proof 3D	10,6	44	16,9	76
ShowFlow	4,3	3	5,8	3

Figure 2: Factor values for WSC T and WSC TV.

Figure 3 indicates the parameters categorized as documents databases. As the figure indicates, three new parameters, in comparison to the former 2011 ranking, were added: Scopus, Google Books and number of published books related to the tool. Arena, ProModel and SIMPROCESS are the tools with most presence in these documents databases. In their turns, SimCAD Pro, SLX + Proof 3D and Showflow are the ones with the lowest factor parameter values.

Figure 5 shows the selected reviews, comparison, surveys, among other sources. This list contains the items from the former 2011 ranking and six more, four of which were published post 2011, making a total of 27 parameters. The first three columns refer to relevant reviews with some kind of tools evaluation and their results were used here with proportional scoring. All the others are just binary scores when the tool name is referenced in the specified sources. Considering all the obtained average factor parameters values, Arena, ProModel and Simul8 obtained the best results, whilst ProcessModel and GPSS obtained the lowest values.

Figure 4 shows the obtained factor values for the social networks parameters. As can be seen, despite the increasing importance of social networks in nowadays, particularly in spreading several kinds of information, the lack of significant presence of some tools in this frame should be stressed, c.f. Micro Saint, GPSS World and ShowFlow. On the other hand, Arena and FlexSim are the tools with the most presence in social networks. In comparison to the former 2011 ranking, twitter and google plus social networks were added.

The case of social networks is a particular case, since some tools purposely opt to have a higher presence on certain social networks, disregarding the remaining, which affects the overall rate obtained in this ranking. For instance, ExtendSim has a higher presence in YouTube and Linkedin, disregarding the remaining and Simio has a greater presence in facebook. Figure 6 and Figure 7 shows the obtained factor values for the parameters of Google search results.

As Figure 6 suggests, Arena, ProModel, Micro Saint and ProcessModel are the tools with higher Google search results. On the other hand, SimCAD Pro, GPSS and SLX obtained the lowest values.

As Figure 7 suggests, the reason for the high factor weights assigned to each of these properties is that the percentage of the searches of more recent years, in comparison to the results without time restrictions is too low. Therefore, and since a greater emphasis on these parameters was to be given, higher factor weight values were assigned. As the results indicate, Arena and Simio are the tools with the best result for these parameters, indicating that these are the 2 tools with most growth in search results

over the last 5 years. While Arena is a much older simulation tool, it should also be stressed that it continues to grow as it obtained the highest value for these parameters. ShowFlow got the lowest value.

DES Tools	#3 amazon.com (T)	#4 Scholar.Google (T)	#5 scholar.google.com (TV)	#6 scribd.com (TV)	#7 scopus.com (T) (New!)	#8 books.google (T) (New!)	#9 # of books (New!) - in English
Weight	2	1	1	1	1	1	2
Average	3,1	11,6	8,0	3,0	3,9	9,3	2,2
Arena	5,9	21,1	17,3	5,4	6,5	13,4	3,8
ProModel	5,0	16,0	12,2	5,5	5,4	13,2	4,0
FlexSim	3,4	12,8	9,2	4,4	5,3	7,9	2,0
Simul8	3,6	12,8	8,0	2,8	3,9	8,8	3,8
WITNESS	2,5	16,0	10,9	2,8	5,2	9,7	4,2
ExtendSim	4,3	14,7	10,9	3,3	4,5	9,4	3,2
Simio	6,3	9,6	6,2	2,3	4,0	7,2	2,5
Plant Simulation	4,0	9,5	7,4	4,1	2,8	9,7	3,8
AnyLogic	5,5	16,0	10,6	3,4	5,7	10,3	2,9
SIMPROCESS	0,0	18,5	6,5	2,6	5,7	26,2	2,0
AutoMod	0,0	13,6	7,8	3,0	5,1	11,7	0,0
Micro Saint	3,2	9,5	4,4	1,3	3,4	10,3	2,9
QUEST (Delmia)	3,2	11,4	8,4	4,5	2,8	8,7	0,0
Enterprise Dynamics	2,5	7,8	5,7	1,8	2,2	4,9	2,0
ProcessModel	2,9	8,5	8,5	3,2	2,4	6,6	0,0
SimCAD Pro	0,0	3,6	3,3	1,4	1,7	1,7	0,0
GPSS World	7,4	9,0	6,8	2,2	3,0	10,9	2,0
SLX + Proof 3D	0,0	5,2	5,3	1,0	3,8	4,0	0,0
ShowFlow	0,0	4,5	2,5	1,3	0,0	2,1	2,0

Figure 3: Documents digital libraries parameters.

DES Tools	#37 youtube.com (TV)	#38 linkedin.com (TV)	#39 facebook.com (TV)	#40 twitter.com (TV) (New!)	#41 plus.google.com (TV) (New!)
Weight	1	2	3	1	1
Average	5,0	10,1	9,2	2,3	1,8
Arena	15,0	78,7	17,5	2,8	3,5
ProModel	6,5	7,1	13,4	2,5	4,0
FlexSim	13,4	10,1	27,0	5,8	4,8
Simul8	4,8	14,0	17,5	7,1	3,1
WITNESS	11,4	11,1	15,6	4,8	2,0
ExtendSim	5,3	20,6	3,0	1,0	0,0
Simio	3,1	6,1	18,1	3,3	1,8
Plant Simulation	10,9	4,3	16,6	4,6	3,1
AnyLogic	1,7	4,0	3,0	1,7	2,5
SIMPROCESS	0,0	4,4	0,0	0,0	0,0
AutoMod	1,9	7,2	0,0	0,0	0,0
Micro Saint	0,0	3,2	0,0	0,0	0,0
QUEST (Delmia)	8,0	2,5	9,7	1,3	1,8
Enterprise Dynamics	3,7	6,8	10,6	2,2	1,8
ProcessModel	5,6	3,8	11,7	2,8	3,3
SimCAD Pro	3,1	3,2	10,3	3,3	1,9
GPSS World	1,0	0,0	0,0	0,0	0,0
SLX + Proof 3D	0,0	4,0	0,0	0,0	0,0
ShowFlow	0,0	0,0	0,0	0,0	0,0

Figure 4: Social networks parameters.

DES Tools	#10 Mustafee 2007 "A GRID COMPUTING FRAMEWORK FOR	#11 Abu-Taieh, 2007; CSP - COMMERCIAL SIMULATION PACKAGES	#12 VIVACE review 2004 Kim et.al "TECHNIQUES TO	#13 Simulation Tools.bib, 2010 http://www.idsia.ch/~andre /sim/simland.html	#14 ORMS Survey 2009	#15 WSC 2010 sponsorship	#16 Systemflow list 2009 (http://www.systemflow.com /software_list.htm)	#17 Google Directory www.google.com/Top/Scie	#18 Wikipedia - List of discrete event simulation software http://en.wikipedia.org/wiki/	#19 ORMS Survey 2003	#20 PMC short list (2010)	#21 www.averill-law.com/ simulation-training-software.htm	#22 SimServ WhitePaper (2004) Jaroslaw Chrobot	#23 IIE Exhibitors (2011) (Institute of Industrial	#24 Simul8Site (2006)	#25 WSC 2005 sponsorship	#26 Solution Simulation (2004)	#27 Hlupic, 2000	#28 Babulak 2008	#29 Pemberton Cyrus 2004 Simulation Software http://pt.scribd.com/doc/38	#30 Edwin Valentin (2002)	#31 (Klingstam and Gullander, 1999)	#32 (Pérez et al., 2013)	#33 (Jadrić et al., 2015)	#34 (Pezzotta et al., 2013)	#35 (Vieira et al., 2014)	#36 (Terzi and Cavalieri, 2004)
	3	2	2	3	4	3	2	2	2	1	2	1	1	2	1	1	1	1	2	1	1	2	3	1	1	4	1
Arena	2,2	2,9	3,5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ProModel	2,1	2,3	3,1	1	1	1	1	1		1	1	1	1	1	1	1		1		1		1	1				
FlexSim	0,6	2,9	2,5	1	1	1	1			1		1	1	1		1	1	1		1			1				
Simul8	4,1	2,7	2,2	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1							
WITNESS	3,2	2,3	3,3	1		1	1	1			1	1	1		1			1	1	1	1	1	1				
ExtendSim	2,6	2,0	3,2	1	1	1	1	1		1		1	1	1	1	1						1	1	1			
Simio				1	1	1		1	1														1			1	
Plant Simulation	1,9	2,0	1,0	1	1	1	1		1	1		1	1				1				1		1		1		
AnyLogic	2,7	3,2	2,1	1	1	1	1	1	1	1						1	1						1				
SIMPROCESS	2,7	2,3		1			1	1		1		1			1			1									
AutoMod	1,3	3,2	2,4	1		1	1			1	1	1	1		1	1	1		1	1	1	1					1
Micro Saint	1,3	1,2	1,0	1	1		1			1		1	1			1				1		1					
QUEST			3,4	1			1				1	1	1		1		1					1					
Enterprise Dynami	2,1	2,3	2,3	1			1	1	1	1	1		1		1	1		1			1		1				
ProcessModel	0,6		1,0							1		1			1												
SimCAD Pro	1,3	2,7	1,0	1	1			1	1	1				1			1										
GPSS World		2,0							1	1					1			1									
SLX + Proof 3D			1,0	1	1		1	1	1			1				1											
ShowFlow	0,6	2,1	1,0	1	1			1		1			1					1			1	1					1

Figure 5: Parameters of selected reviews.

DES Tools	#42 WWW (T)	#43 WWW (TV)	#44 WWW (site)	#45 Google PageRank 2016
	0,5	1	0,5	
	1/3	1/3	1/3	
Arena	30,6	38,9	26,0	2,5
ProModel	20,3	32,4	35,6	2,5
FlexSim	18,2	28,4	32,7	2,0
Simul8	17,1	21,5	22,6	2,0
WITNESS	17,5	24,1	39,4	2,0
ExtendSim	12,1	22,2	15,7	2,5
Simio	17,0	18,6	41,5	2,5
Plant Simulation	22,6	43,1	5,5	2,5
AnyLogic	19,8	19,7	9,9	2,5
SIMPROCESS	17,0	13,0	26,0	2,0
AutoMod	15,7	18,1	4,8	2,5
Micro Saint	11,4	9,5	92,3	2,0
QUEST	14,4	25,2	36,8	3,0
Enterprise Dynami	9,9	16,8	7,9	2,5
ProcessModel	11,8	24,7	71,3	1,5
SimCAD Pro	8,7	13,4	12,9	1,5
GPSS World	10,0	14,3	7,9	2,0
SLX + Proof 3D	8,5	11,9	9,2	2,0
ShowFlow	7,0	11,2	28,2	1,5

Figure 6: Parameters of Google search results.

DES Tools	#46 Web searches post-2011 (new!)	#47 Web searches post-2012 (new!)	#48 Web searches post-2013 (new!)	#49 Web searches post-2014 (new!)	#50 Web searches post-2015 (new!)
	11	12	13	14	15
Arena	3,29	3,34	3,21	2,84	1,93
ProModel	1,16	1,12	0,95	0,76	0,51
FlexSim	1,35	1,33	1,21	1,01	0,67
Simul8	2,11	1,78	1,61	1,34	0,97
WITNESS	1,10	1,01	0,88	0,68	0,39
ExtendSim	1,56	1,39	1,05	0,76	0,44
Simio	2,16	2,06	1,89	1,52	1,08
Plant Simulation	1,65	1,61	1,66	1,42	1,03
AnyLogic	1,98	1,83	1,37	0,89	0,38
SIMPROCESS	0,82	0,90	0,78	0,48	0,44
AutoMod	1,06	1,12	0,76	0,29	0,16
Micro Saint	1,08	1,19	1,20	0,48	0,11
QUEST	0,91	0,99	0,91	0,63	0,45
Enterprise Dynami	1,40	1,56	1,47	0,97	0,51
ProcessModel	0,69	0,77	0,74	0,52	0,32
SimCAD Pro	1,30	1,52	1,20	0,89	0,33
GPSS World	0,88	0,98	0,85	0,46	0,31
SLX + Proof 3D	0,64	0,70	0,65	0,39	0,33
ShowFlow	0,06	0,05	0,06	0,03	0,01

Figure 7: Parameters of Web search trend results (Delta).

4 OBTAINING THE FINAL CLASSIFICATIONS OF THE RANKING

The final score each tool obtained in each category of parameters is illustrated in Figure 8. In the first place, the values of each parameter, for each tool, were summed. In order to neutralize different categories scales, those values have been normalized, as follows. The average and standard deviations of the obtained results were calculated (A and B). The upper ceiling (C) corresponds to A+1.5*B. Each category score is then calculated dividing its sum by C, and multiplying it by 10, truncating the maximum value to 10. As result, all categories scores are between 0 and 10. These values are the indicated in Figure 8. To obtain the final score, a pondered average between the assigned weights to the categories and its values was performed.

Like in all rankings, also in this one there are groups of tools that are closely ranked and others that are isolated, regarding their classifications. In fact, apart from Arena – by far the best classification tool with 9,9 out of 10 points – and from the last four tools – SimCAD Pro, GPSS World, SLX + Proof 3D and ShowFlow – the remaining tools are closely ranked. In fact, three classification clusters can be identified: third cluster ranging from position 10 to 15; second cluster from 6 to 9; and first cluster from 2 to 5. The tools in these positions are closely ranked and, as such, their final classification is highly dependent on the weights assigned to each separately parameter and to the categories themselves. Regarding the low results that some of the tools achieved in the social network parameters, it can be explained by the fact that some of these tools opt for specific social networks. For instance, even though ExtendSim has a low overall social network result, by analysing Figure 4 it is clear that this simulation tool opts for specific social networks – in this case the tool has a presence in YouTube and Linkedin above the average. To better analyze the impact each category as on the simulation tools, the chart on Figure 9 was created.

DES Tools	WSC	DOCS	REVIEWS	SOCIAL	WWW	Growth	tot. (WSC docs social WWW)	Rank 2016
Arena	10	10	10	10	9	10	9,9	1
ProModel	10	9	9	5	9	5	7,6	2
FlexSim	6	7	7	9	8	6	7,2	3
Simul8	6	7	9	7	6	8	7,23	4
WITNESS	8	8	9	7	8	4	7,2	5
ExtendSim	7	8	8	4	5	5	6,2	6
Simio	6	6	4	5	8	9	6,1	7
Plant Simulation	1	6	7	6	7	8	6,1	8
AnyLogic	8	8	8	2	5	7	5,92	9
SIMPROCESS	9	10	4	1	6	4	5,0	10
AutoMod	9	6	7	1	4	4	4,83	11
Micro Saint	4	5	5	0	10	4	4,8	12
QUEST (Delmia)	3	6	4	3	8	4	4,8	13
Enterprise Dynamics	5	4	7	4	4	6	4,8	14
ProcessModel	4	5	1	4	10	3	4,7	15
SimCAD Pro	3	2	5	3	3	5	3,7	16
GPSS World	7	6	2	0	3	4	3,18	17
SLX + Proof 3D	7	3	3	1	3	3	2,9	18
ShowFlow	3	2	5	0	5	0	2,4	19

DES Tools	Ranking 2006	*R2006 - R2011*	Ranking 2011	in 5 years	Ranking 2016
Arena	1	0	1	0	1
ProModel	2	-2	4	2	2
FlexSim	10	3	7	4	3
Simul8	7	5	2	-2	4
WITNESS	5	2	3	-2	5
ExtendSim	6	0	6	0	6
Simio		NEW	14	7	7
Plant Simulation	17	8	9	1	8
AnyLogic	15	10	5	-4	9
SIMPROCESS	4	-8	12	2	10
AutoMod	3	-5	8	-3	11
Micro Saint	14	-1	15	3	12
QUEST	8	-2	10	-3	13
Enterprise Dynamics	16	5	11	-3	14
ProcessModel	12	-1	13	-2	15
SimCAD Pro	-	-	16	0	16
GPSS World	18	-1	19	2	17
SLX + Proof 3D	11	-6	17	-1	18
ShowFlow	-	-	18	-1	19

Figure 8: Final score of each tool and Ranking comparison 2006-2011.

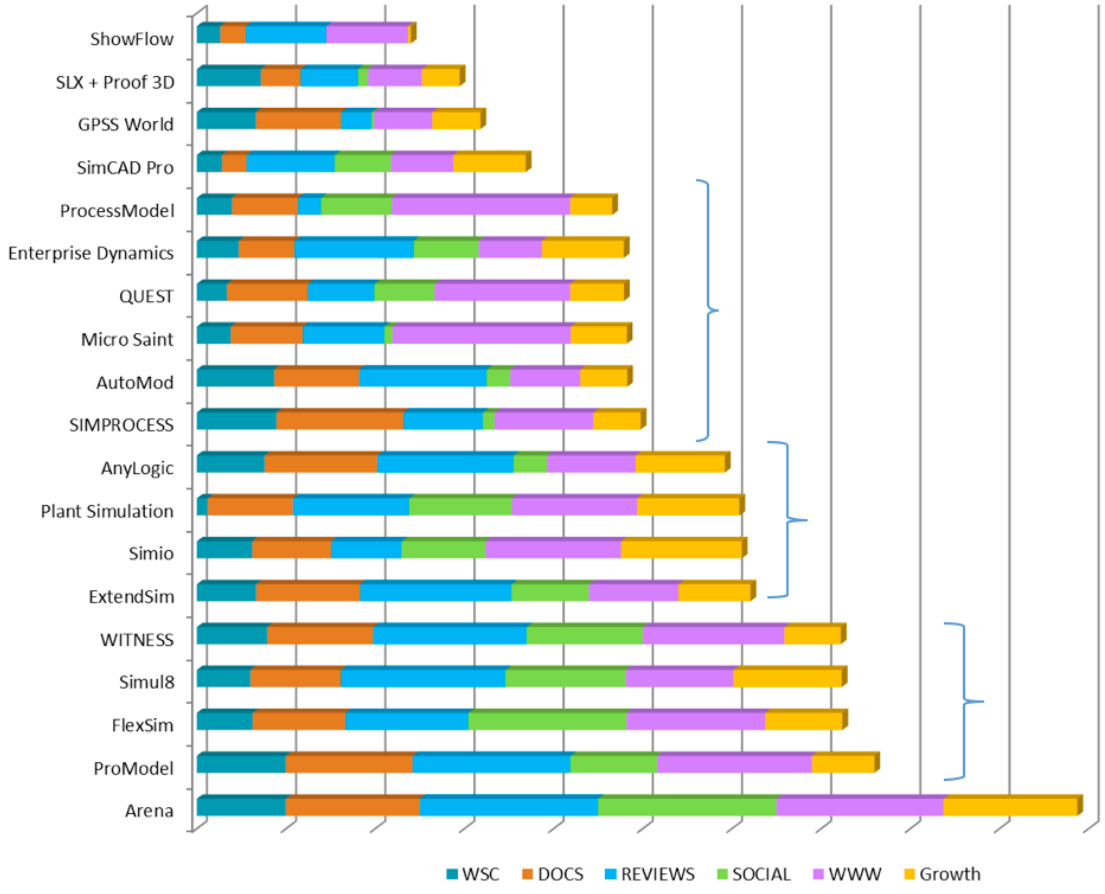

Figure 9: Scoring distribution (with three clusters).

5 COMPARISON WITH FORMER 2006 AND 2011 RANKINGS

In this ranking we introduced the trend in web searches. Moreover, some social networks parameters were introduced, as well as some documents databases parameters, including the number of books. Figure 8 shows tools rankings evolution from 2006 (Dias et.al 2007) to 2011 (Dias et al., 2011) and to 2016.

Whilst Arena constantly keeps its number 1 position, ProModel regained its second position and FlexSim keeps its climb to the first places, now achieving the podium. The climb of ProModel and FlexSim made Simul8 drop to the fourth place, however it is still in a noteworthy position. In its turn, ExtendSim keeps its sixth place – the same place the tool was in 2011 and even in 2006 and Simio registers the biggest climb this year's top – 7 places. AnyLogic had also registered a huge climb in the former 2011 ranking – 10 places – however in this ranking the tool dropped 4 places. On the other hand, AutoMod keeps dropping in the top, after having achieved the podium in 2006.

6 CONCLUSIONS

This paper documents an updated version of a ranking of discrete simulation tools (Dias et al., 2006 and 2011). This list was created based on the subjective evaluation of a parameters set. Different parameters may be used alternatively with different weights producing other results. Even though this subjectivity, we believe that the Top 10 "popular" discrete simulation commercial tools are included in this list of 19 simulation tools. As well as it is most likely that this list includes the top 10 "most used" and "best" contemporary simulation tools. Moreover, the strengths and weaknesses of each tool, regarding the considered categories, were also analyzed.

In measuring popularity some other relevant parameters could be considered like the number of sold licences in the industry area (with a company size factor) or used at universities for education purposes. Although it is quite difficult to reliably collect these types of data.

As a conclusion of this research study, we were able to identify a simulation tool in the first place (Arena), stands out from the remaining tools. Thereafter, a first cluster of simulation tools appear (ProModel, FlexSim, Simul8 and WITNESS), followed by a second cluster (ExtendSim, Simio, PlantSimulation and AnyLogic) and a third cluster (Simprocess, Automod, Micro Saint, QUEST, Enterprise Dynamics and Process Model). Despite the dependency of these rankings to the subjective weights of each category, the authors were able to observe that the mentioned clusters would still be the same. The difference would be that tools would change rankings inside each cluster.

The contexts of the simulation tools, whether in the academic environment or in the industry is in constant change and thus this study should be regularly updated. Hence an upgraded version of this ranking should be developed.

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A APPENDIX

Table 1 Factors Description.

#	Factor Name	Description
1	WSC "only Tool"	Occurrences of **"Tools" in** www.informs-sim.org. (Institute for Operations Research and Management Science - Simulation Society) (includes all **Winter Simulation Conference** – papers 1997-2011April)
2	WSC "TV"= "Tool+Vendor"	Occurrences of **"Tools" + "Vendor" in** www.informs-sim.org (same source as **#1**))

#	Factor Name	Description
3	amazon.com	Occurrences of "Tools" + "Vendor" in site:amazon.com
4	Scholar.Google "T"	Occurrences of "Tools" in site:Scholar.Google
5	Scholar.Google	Occurrences of "Tools" + "Vendor" in site:Scholar.Google
6	scribd.com	Occurrences of "Tools" + "Vendor" in site:scribd.com
7	scopus.com	Occurrences of "Tools" in site:scopus.com
8	books.google T	Occurrences of "Tools" in site:books.google.com
9	# of books	Number of books published in english
10	Mustafee 2007	Mustafee N. 2007 "A Grid Computing Framework For Commercial Simulation Packages". Brunel University, West London, PhD Thesis. bura.brunel.ac.uk/ bitstream/2438/4009/1/Fulltext(Thesis).pdf
11	Abu-Taieh, 2007	Abu-Taieh. 2007. Commercial Simulation Packages - CSP. I.J. of SIMULATION Vol. 8 No 2. ISSN 1473-804x (http://ducati.doc.ntu.ac.uk/uksim/journal/Vol-8/No-2/paper-7.pdf)
12	VIVACE review 2004	VIVACE review: "Techniques to Model the Supply Chain in an Extended Enterprise", Kim et.al, 2004.
13	SimulationTools.bib 2010	List with Simulation Tools with Short Description. By Andrea Emilio Rizzoli. SimulationTools.bib, 2010 http://www.idsia.ch/~andrea/sim/simlang.html
14	ORMS Survey 2009	Swain J. 2009. Simulation Software Survey. OR/MS. Institute for Operations Research and the Management Sciences (INFORMS). Lionheart Publishing. 1991-2009. www.lionhrtpub.com /orms/surveys/Simulation/Simulation.html
15	WSC 2010 sponsorship	Sponsors of the Winter Simulation Conference 2010 (Memory registered in year 2011)
16	Systemflow list 2009	Simulation Software List – System flow Simulations, Inc. (2005-2009)http://www.systemflow.com/software_list.htm
17	Google's Simul. S/W	Google Directory of Simulation Software www.google.com/Top/Science/Software/Simulation/
18	Wikipedia - List of Simul.S/W	Wikipedia - List of discrete event simulation software http://en.wikipedia.org/wiki/List_of_discrete_event_simulation_software
19	ORMS Survey'03	Swain J. 2003. (See Factor #14)
20	PMC short list (2010)	List of the simulation tools where the PMC Company have competency (http://www.pmcorp.com/sim_services.shtm)
21	www.averill-law.com	Averill-law list of simulation training software: (www.averill-law.com/simulation-training-software.htm)
22	SimServ WhitePaper (2004)	Sim-Serv organization white paper about simulation tools. Jaroslaw Chrobot. 2004. (http://www.sim-serv.com/wg_doc/WG1_White_Paper_discussion.pdf)
23	IIE Exhibitors (2011)	Exhibitors of the IIE Conference (2011) (Institute of Industrial Engineers) (http://www.iienet2.org/annual2/details.aspx?id=6790)
24	Simul8Site (2006)	Brooks homepage (Simul8) identification of concurrency (www.simul8.com/products/webdemo.htm)
25	WSC 2005	Sponsors of the Winter Simulation Conference 2005 (Memory registered in year 2006)
26	Solution Sim. 2004	Sponsors of the conference "Solution Simulation 2004". http://www.simsol.org/2004%20files/SimSol%20onsite%202004%20revised.pdf
27	Hlupic, 2000	Hlupic V. 2000. Simulation software: an operational research society survey of academic and industrial users. In (J. Joines et. al., eds.) Proc. WSC 2000. (Piscataway, New Jersey), IEEE, 1676-1683.
28	Babulak 2008	Babulak B and Wang M. 2008. Discrete Event Simulation: State of the Art. Int. Journal Online Engineering (iJOE), Vol 4, No 2 (2008) ISSN: 1861-2121

#	Factor Name	Description
29	P. Cyrus 2004 Sim. S/W	Simulation Software List by Pemberton Cyrus, 2004 http://pt.scribd.com/doc/38056975/Simulation-Software-2004-05-28
30	Edwin Valentin (2002)	Tools systematic evaluation based on experimentation (Valentin, 2002). (http://www.tbm.tudelft.nl /webstaf/edwinv/SimulationSoftware/index.htm)
31	Klingstam and Gullander, 1999	Klingstam, P., and P. Gullander, 1999, Overview of simulation tools for computer-aided production eng.: Computers in Industry, v. 38, p. 173-186.
32	Pérez et al., 2013	Pérez, J. B., J. M. Corchado, J. Fähndrich, P. Mathieu, A. Campbell, M. C. Suarez-Figueroa, A. Ortega, E. Adam, E. M. Navarro, and R. Hermoso, 2013, Trends in Practical Applications of Agents and Multiagent Systems: 11th International Conference on Practical Applications of Agents and Multi-Agent Systems, Springer International Publishing.
33	Jadrić et al., 2015	Jadrić, M., M. Ćukušić, and A. Bralić, 2015, Comparison of discrete event simulation tools in an academic environment: Croatian Operational Research Review, v. 5, p. 203-219.
34	Pezzotta et al., 2013	Pezzotta, G., R. Pinto, F. Pirola, P. Gaiardelli, and S. Cavalieri, 2013, A Critical Evaluation and Comparison of Simulation Packages for Service Process Engineering: XVIII Summer School Francesco Turco. A CHALLENGE FOR THE FUTURE: the role of industrial engineering in a global sustainable economy.
35	Vieira et al., 2014	Vieira, A., L. Dias, G.Pereira, J.Oliveira, 2014, Comparison of Simio and Arena simulation tools, ISC, Skovde, Sweden.
36	Terzi and Cavalieri, 2004	Terzi, S., and S. Cavalieri, 2004, Simulation in the supply chain context: a survey: Computers in industry, v. 53, p. 3-16.
37	youtube.com	Occurrences of "Tools" + "Vendor" in site:youtube.com
38	linkedin.com	Occurrences of "Tools" + "Vendor" in site:linkedin.com
39	facebook.com	Occurrences of "Tools" + "Vendor" in site:facebook.com
40	twitter.com	Occurrences of "Tools" + "Vendor" in site:twitter.com
41	plus.google	Occurrences of "Tools" + "Vendor" in site:plus.google.com
42	WWW only "Tool"	Number of pages with **"Tools"**+"simulation"(the "simulation" string was used restrict to internet pages in the field)
43	WWW "TV"	Number of web pages with "Tools"+"Vendor"+"simulation"
44	"Site" in WWW	Occurrences of vendor's site address in WWW
45	Google PageRank'16	Google "PageRank" (page importance evaluation). Current value (2016).
46	Web searches post 2011	Factor of the ratio of post 2011 searches in comparison to searches without restrictions.
47	Web searches post 2012	Factor of the ratio of post 2012 searches in comparison to searches without restrictions.
48	Web searches post 2013	Factor of the ratio of post 2013 searches in comparison to searches without restrictions.
49	Web searches post 2014	Factor of the ratio of post 2014 searches in comparison to searches without restrictions.
50	Web searches post 2015	Factor of the ratio of post 2015 searches in comparison to searches without restrictions.

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