DISCRETE SIMULATION TOOLS RANKING –
a Commercial Software Packages comparison based on popularity

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KEYWORDS
Simulation languages, Survey, Review, Web-Presence

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 judgements 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 (in 2006). It is obvious that more popularity does not mean necessarily 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 simulation tools.

INTRODUCTION

Most of scientific works related to tools comparison/reviews analyse only a small set of tools and usually evaluating several parameters separately avoiding to make a final judgement due to the subjective nature of such task.
Simulation languages have been replaced by simulation packages/tools.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 identifies about 60 commercial simulation products, 55 in 2005 and 48 in 2009 (Swain, 1991-2009). 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, incl. 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. Some other relevant simulation

tools like SIMPRO don't appear in our list due to lower web-presence (see Table 2).
This tools comparison was performed previously in 2006, and is here extended with more parameters and relevant changes are discussed.

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

MOTIVATION – WHY MEASURING *POPULARITY*?

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.
To choose a popular simulation tool is positive in two *ways*:
- 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.
So, the popularity may be seen as a significant "blind" factor to be used in conjunction with direct evaluation mechanisms like features comparison and experimentation

DEVELOPMENT – *POPULARITY* EVALUATION

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:
- WWW (Internet);
- Winter Simulation Conference scientific publications.
- Document database oriented sites (*new*)
- Social networks (*new*)
- Selected set of sources (e.g. scientific surveys, lists and homepages).

TECHNIQUE

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

- It is the most-used search engine on the Web (http://searchenginewatch.com/3630718) – around 61% of all searching actions in 2008
- Google *owns* different sources of relevant information (books, youtube, synonyms, maps, translator, etc.)
- It supports a function for getting an approximated number of results (for this project we developed also a function 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).

FACTORS DESCRIPTION AND *TUNING*

We used **around 40 parameters/factors** for evaluating each simulation tool, listed in Table 1. For each tool we 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", "Witness", "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".

In the **factors** where the results represent the number of occurrences, the values may 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 uses of mathematical functions were 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 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 it-self, is the same as comparing the volume of cubes, using only the value of the their width.

	^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

Almost all factors between #1 and #20, were adjusted using the cubic root of the number of occurrences, multiplied by *"Factor Weight"* (indicated under the label of each column).

In each of those columns in the datasheet is a pair of values -The right sided values represent the "raw" number of occurrences;
-The left sided values represent the result of the cubic root of those values, multiplied by the *"Factor Weight"*. Those values are then directly added to the respective tool scoring. Above the left side of each column is the average of the adjusted values. Each of those averages shows up the real influence of each factor in the tool's score. Those values are named as **"Average Effective Factor Weight"**.

The complete list with factors description (in Table 1) is organized in **two groups**.

The first group includes all factors that are calculated based on Google search results (approximate number of results). This group is split into two tables: Figure 2 (with Winter Simulation Conference, Documentation sites and Social Networks Scoring) (#1→#10) and Figure 3 (with general searches in WWW, including tools URL web-presence and Google's and Yahoo page rankings) (#11→#18).

Figure 2 WSC, DOCs and Social

Figure 3 WWW Searches and Site ranking

The second group is based on a selection of scientific works of review/survey, software lists and conference activities and sponsorships. The 20 factors used in this group are in one table in Figure 4 (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) (#24→#44).

Figure 4 Selected Sources

Figure 5 Ranking Total Scores and Prices

Figure 5 (and Figure 7) contains the table with Total Scoring. Columns #19 to #22 have the scores of the first group (Winter Simulation Conference, Documentation sites, Social Networks Scoring and WWW). Columns #23 and #45 have the sub-totals of the two Groups, where the #45 is the scoring of the second group - Selected Sources. The column #46 has

the Final Score of this Paper Research, adjusted to a 0-10 scale, using the square root mathematical function.

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**))
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	docstoc.com	Occurrences of "Tools" + "Vendor" in site:docstoc.com
8	youtube.com	Occurrences of "Tools" + "Vendor" in site:youtube.com
9	linkedin.com	Occurrences of "Tools" + "Vendor" in site:linkedin.com
10	facebook.com	Occurrences of "Tools" + "Vendor" in site:facebook.com
11	WWW only "Tool"	Number of web pages with **"Tools"**+"simulation"(the "simulation" string was used to count only the internet pages in the simulation area)
12	WWW "TV"	Number of web pages with "Tools"+"Vendor"+"simulation"
13	N. of WWW Links to "Site"	Number of web pages pointing with a link to the "Site" of the "Vendor" (in Google)
14	"Site" in WWW	Occurrences of vendor's site address in WWW
15	Domain age,	Vendor's site years old (factor not used, just information)
16	Google PageRank'06	Google "PageRank" (Google automatic evaluation about page importance). Record from 2006.
17	Google PageRank'11	Google "PageRank" (Google automatic evaluation about page importance). Current value (2011).
18	Yahoo (new!)	Yahoo "PageRank" Yahoo evaluation about page importance. *checkpagerank.net*. Current value (2011).
19	WSC	Sum of WSC related factors: #1 + #2 (Factors adjusted with cubic root function)
20	DOCS	Sum of Documents Repositorium related factors: from #3 to #8 (Factors are adjusted with cubic root function)
21	SOCIAL	Sum of Social Networks Activity related factors: #8 + #9 + #10 (Factors are adjusted with cubic root function)
22	WWW	Sum of general WWW webpresence factors: from #11 to #18 (Factors are adjusted with cubic root function)
23	Tot (WSC docs social WWW)	Total Sum of Factors related to Google Search engine used for measuring webpresence (from #19 to #22)
24	Mustafee 2009	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
25	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)
26	VIVACE review 2004	VIVACE review: "Techniques to Model the Supply Chain in an Extended Enterprise", Kim et.al, 2004.
27	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
28	ORMS Survey 2009	Swain J. 2009. Simulation Software Survey. OR/MS Today magazine, Institute for Operations Research and the Management Sciences (INFORMS). Lionheart Publishing. 1991-2009. www.lionhrtpub.com /orms/surveys/Simulation/Simulation.html
29	WSC 2010 sponsorship	Sponsors of the Winter Simulation Conference 2010 (Memory registered in year 2011)

#	Factor Name	Description
30	Systemflow list 2009	Simulation Software List – System flow Simulations, Inc. (2005-2009)http://www.systemflow.com/software_list.htm
31	Google's Simul. S/W	Google Directory of Simulation Software www.google.com/Top/Science/Software/Simulation/
32	Wikipedia - List of Simul.S/W	Wikipedia - List of discrete event simulation software http://en.wikipedia.org/wiki/List_of_discrete_event_simulation_software
33	ORMS Survey'03	Swain J. 2003. (See Factor #28)
34	PMC short list (2010)	List of the simulation tools where the PMC Company have competency (http://www.pmcorp.com/sim_services.shtm)
35	www.averill-law.com	Averill-law list of simulation training software: (www.averill-law.com/simulation-training-software.htm)
36	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)
37	IIE Exhibitors (2011)	Exhibitors of the IIE Conference (2011) (Institute of Industrial Engineers) (http://www.iienet2.org/annual2/details.aspx?id=6790)
38	Simul8Site (2006)	Brooks homepage (Simul8) identification of concurrency (www.simul8.com/products/webdemo.htm)
39	WSC 2005	Sponsors of the Winter Simulation Conference 2005 (Memory registered in year 2006)
40	Solution Simulation 2004	Sponsors of the conference "Solution Simulation 2004". http://www.simsol.org/2004%20files/SimSol%20onsite%2020 04%20revised.pdf
41	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.
42	Babulak 2008	Babulak B and Wang M. 2008. "Discrete Event Simulation: State of the Art" International Journal of Online Engineering (iJOE), Vol 4, No 2 (2008) ISSN: 1861-2121
43	P. Cyrus 2004 Sim S/W	Simulation Software List by Pemberton Cyrus, 2004 http://pt.scribd.com/doc/38056975/Simulation-Software-2004-05-28
44	Edwin Valentin (2002)	Tools systematic evaluation based on experimentation (Valentin, 2002). (http://www.tbm.tudelft.nl /webstaf/edwinv/SimulationSoftware/index.htm)
45	Selected Sources Total	Sum of Factors related to the 20 selected sources, from #24 to #44.
46	Total Score	Total sum of all factors. Calculated as SQRT(#23+0,8*#45)/K. The 0,8 coefficient was defined to balance the relative weight between web presence and selected sources. The K divisor was used to adjust scale to 0-10.
47	Price	Software tools prices from (Swain, 2009 or 2003) in thousands of Dollars (K$). Minimum, Average and Maximum prices mentioned, when available. Not used for scoring.
48	Ranking 2006	Ranking of our 2006 ranking
48		Ranking changes analysis for each tool
50	Ranking 2011	Current Ranking.

COMPARISON WITH FORMER 2006 RANKING

In this ranking we introduced the **social networks** communities presence that are used every day (e.g. Facebook, Linkedin, youtube), and show recent activity.

Another set of factors was introduced – the number of occurrences on **documents** database oriented sites (e.g. amazon.com, Scholar.Google, scribd.com, docstoc.com, youtube.com).

The two new sets of factors are basically fed by people in the spirit of web 2.0. It is remarkable that a **page rank reduction** has occurred on many vendors' sites. This could mean that users share more among them rather than being connected to vendor's websites.

Figure 6 shows tools rankings evolution between 2006 and 2011 (Dias et.al 2007).

The four most popular tools are Arena, Simul8, Witness, and Promodel. Simul8 registered a significant increase of its popularity level, as well as AnyLogic, Plant Simulation and Enterprise Dynamics.

A tool like Siemens Tecnomatix – Plant Simulation is more popular now than 5 years ago basically as a result of the distribution of Digital Factories Packages by big automotive companies to their suppliers.

There is one new "player" (Simio) that climbed directly to a noticeable position.

Simprocess, SLX and Automod registered a significant popularity loss.

Tool(s)	Site	Ranking 2006 (#48)	R2006-R2011 (#49)	Ranking 2011 (#50)
Arena	www.arenasimulation.com	1	0	1
Simul8	www.simul8.com	7	5	2
WITNESS	www.lanner.com	5	2	3
ProModel (Service	www.promodel.com	2	-2	4
ExtendSim	www.extendsim.com	6	1	5
AnyLogic (eXperimental	www.xjtek.com	15	9	6
FlexSim	www.flexsim.com	10	3	7
AutoMod	www.appliedmaterials.com/services-software/libr:	3	-5	8
Plant Simulation -	www.plm.automation.siemens.com/en_us/produc	17	8	9
QUEST; DPM POWERTI	www.delmia.com	8	-2	10
Enterprise Dynamics	www.incontrolsim.com	16	5	11
SIMPROCESS (SIMSCR	www.simprocess.com	4	-8	12
ProcessModel	www.processmodel.com	12	-1	13
Simio NEW	www.simio.com		NEW	14
Micro Saint + IPME	www.maad.com	14	-1	15
SimCAD Pro	www.createasoft.com	-	-	16
SLX + Proof 3D + Proof !	www.wolverinesoftware.com	11	-6	17
ShowFlow (based on Ta	www.showflow.com	-	-	18
GPSS World for Window:	www.minutemansoftware.com	18	-1	19

Figure 6 Ranking comparison 2006-2011 and Tool's Site

LIST OF OTHER SIMULATION TOOLS

The process of tools selection, lead to the exclusion of many simulation tools. They were not suited for discrete event simulation or because of their lower popularity score. In the following Table 2 is the list of such software tools.

Table 2 List of other simulation tools

AP3, Capstone, COCODRIS (realistic 3D), COOPS, Crystal Ball, CSIM-19 (c++,c), DecisionPro, DESMO , Factory Explorer, G.R.A.S.P., GAUSS, HighMast, HOCUS, iGrafx, INSIGHT , INSTRATA, IRT_PETRINWZ, KanbanSIM, Lean Modeler, MAST, ModSim, NET, NETWORK II.5 (CACI), OMNEST, OPTIMA, PACE, PCModel, PIMSS, Process Charter, Proplanner Manufacturing Process Management Software, QGERT, Resource Manager, SDI Supply Chain (Supply Chain Builder), SIGMA, Siman/Cinema, SIMFACTORY II.5 (CACI), SIMPRO, SimPRO (other), DOSIMIS-3, SIMULA, SLAM, SLIM, SLOOP/TERMINAL, TOMASWeb, VISSIM (traffic), VS7; VS6; VSE Visual Simulation Environment, WebGPSS, WORKSPACE, XCELL+
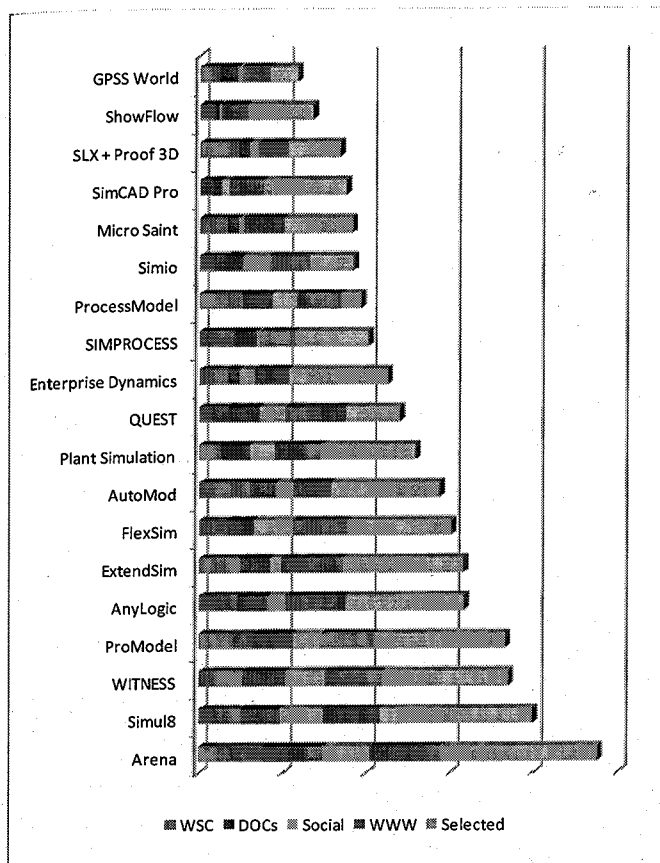
Figure 7 Scoring distribution

CONCLUSION

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. Anyway, even with subjectivity, we believe that the **Top 10** "popular" simulation commercial tools are included in this list (of 19). As well as it is most probable that this list includes the top 10 "most used" and "best" contemporary simulation tools.

The chart in Figure 7, can help to visualize the strengths and weaknesses of each tool, in a comparative analysis.

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.

One relevant improvement to this study may consist on giving more weight to recent references, using some **time-line** approach to analyse trends. Some effort have been made using Google but searching with multiple keywords was not yet successful in searching the historical data of the search engine.

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Site of the INFORMS simulation society (www.informs-sim.org)

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BIOGRAPHY

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Appendix

Figure 8 Table from 2006 Ranking (Dias et al. 2006)

Figure 9 Full Table With 2011 Tools Comparison