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(US). WRIGHTON, Michael [US/US]; 144 N. Sierra Bonita Avenue, Apt. #2, Pasadena, CA 91106 (US).

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(74) Agents: SCHMITT, Ross, A. et al.; Ladas & Parry, 5670 Wilshire Boulevard, Suite 2100, Los Angeles, CA 90036-5679 (US).

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(71) Applicant (for all designated States except US): CALIFORNIA INSTITUTE OF TECHNOLOGY [US/US]; 1200 East California Boulevard, Mail Code 210-85, Pasadena, CA 91125 (US).

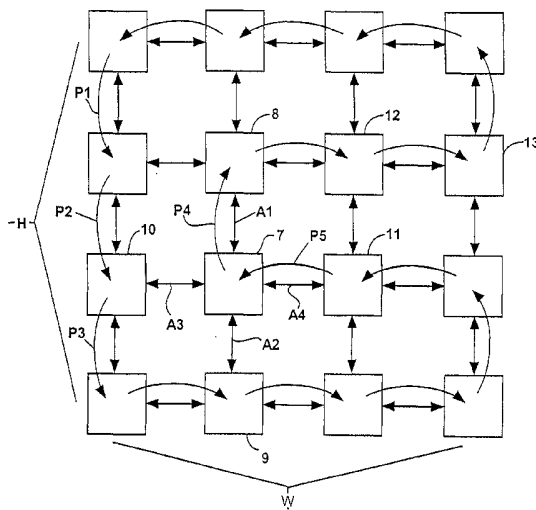
(72) Inventors; and

(75) Inventors/Applicants (for US only): DEHON, Andre' [US/US]; 1270 Cordova, Apt. #9, Pasadena, CA 91106

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(54) Title: ELEMENT PLACEMENT METHOD AND APPARATUS



(57) Abstract: A method and a device for performing placement of a plurality of elements for circuit design. A potential location is assigned to each element and a placement engine is assigned to each potential location. Pairing operations are performed, in parallel, between placement engines to determine whether to perform exchange of the elements associated with the engines. Exchange determination is based both on a cost function and on randomness considerations. Also self-placement is allowed, where the placement engines are implemented on the same hardware system on which the elements are to be placed.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

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# INTERNATIONAL SEARCH REPORT

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<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC 7 G06F17/50	
According to International Patent Classification (IPC) or to both national classification and IPC	
<b>B. FIELDS SEARCHED</b>	
Minimum documentation searched (classification system followed by classification symbols) IPC 7 G06F	
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched	
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, INSPEC, WPI Data, PAJ, COMPENDEX, IBM-TDB	
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>	
Category °	Citation of document, with indication, where appropriate, of the relevant passages
X	PRITHVIRAJ BANERJEE ET AL: "PARALLEL SIMULATED ANNEALING ALGORITHMS FOR CELL PLACEMENT ON HYPERCUBE MULTIPROCESSORS" IEEE TRANSACTIONS ON PARALLEL AND DISTRIBUTED SYSTEMS, IEEE INC, NEW YORK, US, vol. 1, no. 1, 1990, pages 91-106, XP000113912 ISSN: 1045-9219 abstract page 91, left-hand column, line 1 -page 92, left-hand column, line 7 page 93, left-hand column, line 5 -page 98, left-hand column, line 46
Y	figures 3A,3B,4,6
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1-8, 11-27, 30-33, 38-46	9, 10, 29, 34-37, 58-60
<input checked="" type="checkbox"/> Further documents are listed in the continuation of box C.	
<input checked="" type="checkbox"/> Patent family members are listed in annex.	
* Special categories of cited documents :	
*A* document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) *O* document referring to an oral disclosure, use, exhibition or other means *P* document published prior to the international filing date but later than the priority date claimed	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. *&* document member of the same patent family
Date of the actual completion of the international search  <p style="text-align: center;">10 May 2004</p>	Date of mailing of the international search report  <p style="text-align: center;">19/07/2004</p>
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer  <p style="text-align: center;">Radev, B</p>

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 03/25941

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>BANERJEE P ET AL: "A parallel simulated annealing algorithm for standard cell placement on a hypercube computer"            IEEE INTERNATIONAL CONFERENCE ON COMPUTER-AIDED DESIGN: ICCAD-86. A CONFERENCE FOR THE EE CAD PROFESSIONAL. DIGEST OF TECHNICAL PAPERS (CAT. NO.86CH2353-1), SANTA CLARA, CA, USA, 11-13 NOV. 1986,            pages 34-37, XP001161135            1986, Washington, DC, USA, IEEE Comput. Soc. Press, USA            ISBN: 0-8186-0744-0            the whole document</p> <p style="text-align: center;">---</p>	1,30,31, 38,47
X	<p>HORVATH E I: "A parallel force direct based VLSI standard cell placement algorithm"            PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON CIRCUITS AND SYSTEMS. (ISCS). CHICAGO, MAY 3 - 6, 1993, NEW YORK, IEEE, US, vol. 2, 3 May 1993 (1993-05-03), pages 2071-2074, XP010115536            ISBN: 0-7803-1281-3            the whole document</p> <p style="text-align: center;">---</p>	1,30,31, 38,47
X	<p>US 6 243 851 B1 (PATTERSON CAMERON D ET AL) 5 June 2001 (2001-06-05)</p>	52-57
Y	<p>abstract            column 5, line 34 - line 62            column 6, line 8 - line 11            column 8, line 51 - line 58            column 9, line 63 -column 10, line 5            column 15, line 5 - line 8</p> <p style="text-align: center;">---</p>	58-60
Y	<p>TOGAWA N ET AL: "MAPLE: A SIMULTANEOUS TECHNOLOGY MAPPING, PLACEMENT, AND GLOBAL ROUTING ALGORITHM FOR FIELD-PROGRAMMABLE GATE ARRAYS"            IEEE/ACM INTERNATIONAL CONFERENCE ON COMPUTER-AIDED DESIGN. DIGEST OF TECHNICAL PAPERS (ICCAD). SAN JOSE, NOV. 6 - 10, 1994, LOS ALAMITOS, IEEE COMP. SOC. PRESS, US,            6 November 1994 (1994-11-06), pages 156-163, XP000529819            ISBN: 0-8186-6417-7            the whole document</p> <p style="text-align: center;">---</p>	9,10,29
	-/--	

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 03/25941

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>US 3 654 615 A (FREITAG HARLOW) 4 April 1972 (1972-04-04) abstract column 1, line 1 - line 8 column 2, line 25 - line 28 column 14, line 45 - line 64 column 16, line 59 -column 17, line 4 figures 5A-5H</p> <p style="text-align: center;">---</p>	34-37
A	<p>TOGAWA N ET AL: "An incremental placement and global routing algorithm for field-programmable gate arrays" DESIGN AUTOMATION CONFERENCE 1998. PROCEEDINGS OF THE ASP-DAC '98. ASIA AND SOUTH PACIFIC YOKOHAMA, JAPAN 10-13 FEB. 1998, NEW YORK, NY, USA,IEEE, US, 10 February 1998 (1998-02-10), pages 519-526, XP010275950 ISBN: 0-7803-4425-1 the whole document</p> <p style="text-align: center;">---</p>	9,10,29
A	<p>US 5 495 419 A (ROSTOKER MICHAEL D ET AL) 27 February 1996 (1996-02-27) abstract column 4, line 62 -column 6, line 19 column 7, line 56 - line 65 column 14, line 3 - line 23 column 28, line 22 -column 29, line 12 figures 2-4,14-228</p> <p style="text-align: center;">---</p>	1,30,31, 38,47
A	<p>ERENYI I ET AL: "FPGA-based fine grain processor array design considerations" ELECTRONICS, CIRCUITS, AND SYSTEMS, 1996. ICECS '96., PROCEEDINGS OF THE THIRD IEEE INTERNATIONAL CONFERENCE ON RODOS, GREECE 13-16 OCT. 1996, NEW YORK, NY, USA,IEEE, US, 13 October 1996 (1996-10-13), pages 659-662, XP010217207 ISBN: 0-7803-3650-X the whole document</p> <p style="text-align: center;">-----</p>	1-60

# INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6243851	B1	05-06-2001	US 6457164 B1	24-09-2002
US 3654615	A	04-04-1972	DE 1538604 A1	09-10-1969
			FR 1502554 A	07-02-1968
			GB 1132728 A	06-11-1968
			NL 6616899 A	02-06-1967
US 5495419	A	27-02-1996	US 5781439 A	14-07-1998
			US 5636125 A	03-06-1997
			US 5745363 A	28-04-1998
			US 5742510 A	21-04-1998
			US 5903461 A	11-05-1999