TELEWORKING in COMPUTER-AIDED CIRCUIT DESIGN

Anatoly Petrenko, Prof., DSc, FIEE

Abstract **This proposal is relevant to innovative remote design tools and methodology, which allow to create WEB-based CAD framework for design of different technical systems (first of all, for Microelectronics). The WEB-based CAD framework implementation uses the Internet tools and protocols to support the co-operation of several groups of designers working on the common tasks at their different stages.**

Keywords- Distributed Design, web-based design environments, remote access to CAD tools, distributed ECAD, IP-based Design.

1. Internet design environment

General tendency of globalization of economy inevitably leads to globalization of innovation engineering decisions. Moreover, in the Programme of Creation of Information Society in Europe among 10 principal directions of information technologies implementation the fast Internet to provide cooperative common forms of engineering work and training is mentioned.

That is why the distributed design environment has nowadays become one of major issues. It demands co-operation of **various** designers. Examples of such collaborative projects are well-known projects: **VELA** (**www.cbl.ncsu.edu/vela/)** and **WELD** (**www.cad.eecs.berkley.edu/~newton**). It is being carried out on demand of **DARPA (**Defense Advanced Research Projects Agency). The emphasis of this project is not any particular collaborative design system but examination of capabilities of a distributed framework for generic EDA transactions.

The informative environment of Internet supplies CAD systems with extra feathers such as:

- Remote access to CAD tools and collective designing with a partners;
- Access to all sorts of information resources and network electronic on-line catalogues and libraries;
- Various engineering network services: data exchange, use of varied software application (for example, distributed databases), communication with partners, etc;
- Special CAD browsers for viewing, printing and exchanging of CAD models in various data formats which provide the translation of geometrical and digital CAD data to VRML and HTML formats;
- New level of functional cooperation via COBRA, COM, JAVA and DCOM technologies;
- Multi-user teamwork development of collaborative CAD applications and collaborative use of CAD applications. A common project can be carried out in national corporate network (Intranet) limits without access to Internet.

2. Project description

Advantages and challenges of Distributed design were discussed regularly by a panel of experts from industry and academia assembled at Design Automation Conferences (DAC 1998-2002) and WEB-based CAD tools development accords to one of the major trend of scientific researches which are carrying on by universities and companies specialized on practical realization of virtual laboratories with WEB-based CAD tools

The goal of the proposed project is developing methodology of WEB-based CAD tools re-engineering on the example of original Eastern European software system ALLTED (**ALL TE**chnologies **D**esigner) being developed in the former Soviet Union for the simulation, analysis, optimization and design of nonlinear dynamic systems of any type and size: electrical, mechanical, hydraulic, pneumatic, thermal, electromagnetic, etc. or there mixed combinations. It is applying to MEMS(Microelectronic mechanical systems) , robotics, numerical control machines tools, aircraft and automotive industries, heavy equipment and test equipment, agricultural and other applications, where different drives, transmissions, control units, valves, elements, etc. are used. At the aria of electronic circuits and systems design it will help considerably to improve objects' performance, reliability and maintainability.

Sufficiently to say, that the first ALLTED system versions, which were set for EC series computers, were acknowledged in former Soviet Union as standards for design of electronic circuits in such leading industries, as Ministry of Radio Technical industry, Ministry of efense Defense industry, Ministries of General Machine- and and Middle machine-building.

The proposed research uses:

- Novel mathematics method and algorithms for ill-conditional steady state and stiffness transient analysis, optimization variable order procedures with parametrical and functional constrains based on multiple criterion, tolerance assignment and centering, statistical yield maximization;

- Automatic procedures of determination of secondary response parameters (delays, rise and fall times, frequency band, resonance frequency,

etc.) and calculation of functions of these parameters, in following these secondary parameters and their functions become variables which are optimized or for which sensitivities, permissible tolerances and statistical characteristics (including histograms) are calculated;

- Common approach to simulate hybrid objects consisted of different physical phenomena elements: electronic, hydraulic, pneumatic, mechanical, etc. and automatic procedures of common mathematical equation formation;

- User-defined models for object elements, procedures of these model parameters identification, models library management.

3. *Original ALLTED Numerical Background*

The following novel numerical methods and algorithms are implemented in ALLTED :

1. The new **solution curve-search method** for Steady State (DC) Analysis which provides the **quick descent to the solution point** region from any starting point in opposite to Newton's method of non-linear equations which strongly depends upon an initial point selection or Davidenko's method of continuation solving with a variable parameter (parameter sweep method) which provides the gradual descent to the solution point region .
2. **The Diagonal Modification Method** which helps considerably preserve convergence of linearized equations solution without re-ordering when matrix element values change from one iteration to another iteration by changing "bad" pilot matrix element, getting two solutions with the same repaired matrix and constructing from them the initial solution in hand.

3. The **Implicit Linear Multi-step Variable-order Integration Method** for Transient Analysis(TR) which uses high order back differences that allows to estimate at each time step an error for each possible integration method order (k<7) and to select the proper one resulting in minimization of solution time for prescribed accuracy**.**
4. **The Optimization Variable-order Methods** which is equivalent to taking into consideration **five** terms of Tailor's series for the Goal function, including terms with matrices of **third** and **forth derivatives** (classical Gradient of quasi-Newton's Methods are based on using only three terms of the same Tailor's series). But matrices of two additional terms, which **considerably improve determination of a direction to the optimal point**, are calculated through the known matrices of first and second derivatives.

5. **The Optimal Tolerances Assignment Method** which is based on applying Optimization procedures to the special Goal function being constructed with taking into account the prescribed deviations of Controlled Output Parameters.

6. **Statistical Yield Maximization Method** which provides "centering" the solution point in the region of acceptable solutions, created into a multi-dimensional space by constraints (parametrical and functional) and selected distribution laws of components parameters values.

The means of adjusting ALLTED to new application area (say, MEMS Design) include:
1. New components mathematical models incorporating (in equations form)
2…New graphical symbols for components, if any
3.New sections in library with components parameters OF(Goal functions), LIMIT (Functional Constraints) and FUNC (Functions of Output Parameters) libraries upgrading if any
4.Numerical procedures constants adjusting for new types of tasks.

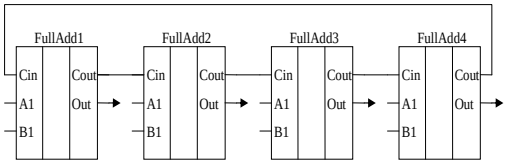
4. *Comparison of four well-known CAD tools to the ALLTED*

OrCAD.v.9.x, ViewAnalog, Protel 99, HSPICE	**ALLTED**
Nearly all existing simulators use SPICE algorithms created 30 years ago in Berkley by prof. Pederson. These algorithms are not perfect and often result a divergent solutions. That is why additional features for improvement of convergence have been forcedly introduced to HSPICE and other systems.	ALLTED is based on original algorithms different from SPICE algorithms in almost all analyses, and first of all, in DC- and TR-analyses. Moreover, algorithms of ALLTED are tailored to solve ill-conditional and stiff tasks.
The merit of commercial software tools is large libraries of components with model parameters supplied by semiconductor manufacturers.	All well-known component models are available in ALLTED, including novel BISIM3v3 model, with default parameter values. User can modify the value of any component parameters when getting them from manufacturer.

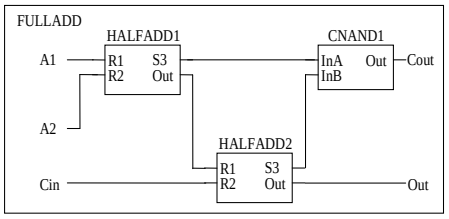
It is pleasing that finally there has been added the capability for user to change not component built models parameters only, but also these models themselves and behavior models	This capability was available in ALLTED since 1989. We have all the time been insisting upon it in our presentations and contributions at conferences.
In the last versions of commercial programs there appeared optimization subsystems. However, they seem to be limited both in selection of methods (e.g. gradient methods) and possible criterion functions.	Since 1990 in ALLTED there was added a very powerful optimization subsystem. It is based on original variable order algorithms (1 to 4) whereas in other tools mostly algorithms of 1 and 2 order are used. Moreover, a subsystem for tolerance specification has been realized that is absent in other examined software tools.
A capability of calculation of signal delay, rise, fall and top point undulation have been added in the HSPICE finally.	In ALLTED these capabilities are particular cases of more powerful procedure of calculation of secondary parameters introduced in 1990. Moreover, it is possible to calculate functions of these secondary parameters

5. Practical comparison of ALLTED and HSPICE performances

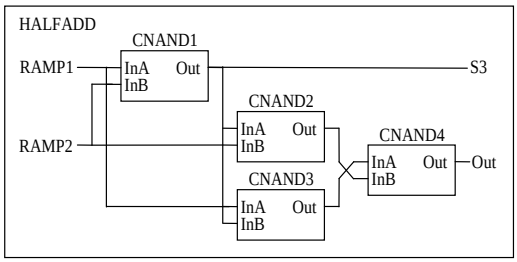
The circuit ***FADD32*** from the workbench circuits set of the North Carolina Microelectronics Center , which contains 200 transistors being described by *BISIM*3*v*.3 models, was selected for practical comparison of ALLTED and HSPICE running (fig.1)



a



b

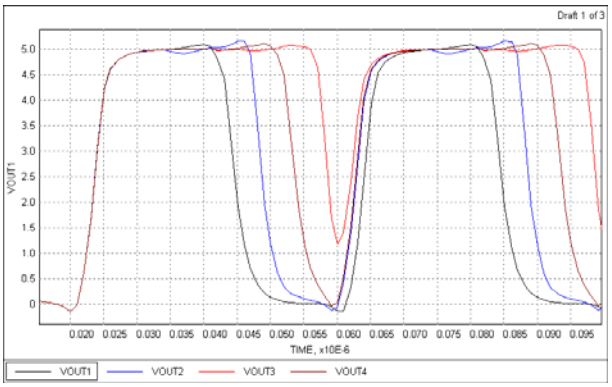


c

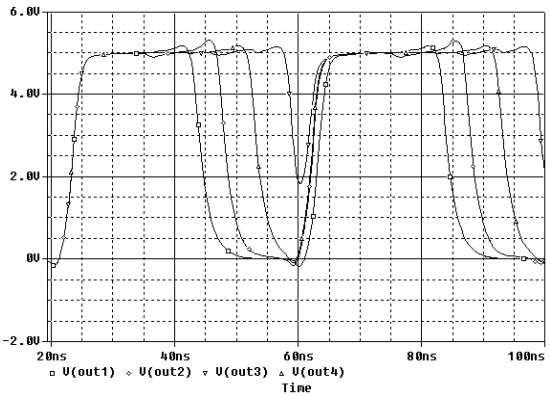
Pic. 1. Test circuit *FADD*32: *a* – its structure; *b* –subcirciut *FULLADD*; *c* – subcirciut *HALFADD*.

The circuit simulation results are shown on fig.2.

Running time depends upon used hardware (*HSPICE* was running on a workstation with OS



a



b

Pic. 2. Simulation results: *a* –by *ALLTED*; *b* –by *HSPICE*

UNIX), but *ALLTED* makes approximately 5 – 8 times less then HSPICE calculation steps during simulation of this and other different circuits.

6. Conclutions

The WEB-based design environment is extremely needed. It would enable user to select appropriate tool and even enable tools to communicate with each other, i.e. make them compatible with each other.

This design environment should be adaptive, convenient for users depending on design task, level of transferred data, conditions of work, condition and performance of the network.

It would be useful to study peculiarities of using of WEB-based CAD systems (similar to ALLTED) for providing trainers with distant (remote) access to standard-cell libraries of sub-circuits, so called IP **(Intellectual Property***)*, without revealing the internal structure of these sub-circuits. To realize this the only things transferred to a client is the names of macromodels and their inputs/outputs. When user's task is being simulated on the IP provider's server the detailed IP models are used. Thus, to take a final decision user can get the results of simulation of his circuit without paying for the IPs he used it for.

REFERENCES

1. Petrenko A., Ladogubets V., Tchkalov V., Pudlowski Z. "ALLTED-a Computer-Aided System for Electronic Circuit Design", UICEE.(UNESCO), Melbourne, 1997,240 p.

2. Petrenko A. "Developing Educationaland User Applications of Network-oriented Electronic Design within COPERNICUS Telematics Programm", ***The Intern. Jounal of Applied Engineering Education*** , TEMPUS Publications, vol. 14, Number 6, 1998, pp. 442-448.

3. Petrenko A." Optimal Circuit Designer", **Proc. of the European Conference on Circuit Theory and Design** (ECCTD'99), Italy,1999

4. M.Spiller, R.Newton. "EDA and the Network", ***Proc.of the Internationasl Conference on Computer-Aided Design",*** 1997, pp.470-475.

5. L. Geppert." IC Design on the World Wide Web", ***IEEE Spectrum***, June 1998.

6. A.Fin, F. Fummi." A Web-CAD Methodology for IP-Core Analysis and Simulation", *Proc. of Design Automation Conference (DAC),* 2000, pp.597-600.

7.Silva M., Katz R. The case for design using the World Wide Web. ***Proc. of the Design Automation Conference***, pp. 579-585, 1995.

8.Benini L., Bogliolo A., De Micheli G. Distributed EDA tool integration: the PPP paradigm. ***Proc. of the International Conference on Computer Design***, pp.448-453, 1996.

9.Lavana H., Khetawat A., Brglez F., Kozminski K. Executable workflows: a paradigm for collaborative design on the Internet. ***Proc. of the Design Automation Conference***, pp. 553-558, 1997.

10.Regli W. Internet-Enabled Computer-Aided Design. ***IEEE Internet Computing***, v.1,N 1, pp. 39-50, 1997.

11.Hauck S., Knoll S. Data security for Web-based CAD**.** ***Proc. of the Design Automation Conference***, pp. 788-793, 1998

12.Chan F., Spiller M., Newton R. WELD-An environment for Web-based electronic design. ***Proc. of the Design Automation Conference***, pp.146-151, 1998.

13..Petrenko A. "East-West European technology Transfer Training Program", Proc. of Fourth World Conference on Engineering Education, October 1995, St.-Poul, USA, vol. l, pp27-30.

14..Petrenko A. ALLTED, All-Technology System Designer. *Proc. of European Design and Test Conference*, Paris, France, April 1996.

15. Petrenko A. Networked CAD for Distributed Design (Tutorial T8). *Europian Conference on Circuit Theory and Design*, Helsinki, Findland, Augest 28-31, 2001.