CTU
CZECH TECHNICAL UNIVERSITY IN PRAGUE

THESIS SUPERVISOR'S REPORT

I. IDENTIFICATION DATA

Thesis title:	**Novel Geometric-Programming Formulations in Computer-Aided Design of Integrated Circuits**
Author's name:	**Adam Bosak**
Type of thesis :	bachelor
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Cybernetics
Thesis reviewer:	Mgr. Jakub Marecek, Ph.D.
Reviewer's department:	Department of Computer Science

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment — **challenging**

How demanding was the assigned project?

While serving as an external examiner for the PhD dissertation of Dr. Dmytro Mishagli at UCD, I have asked a number of questions as to the layout and timing closure problems utilizing the Statistical Static Timing Analysis models that Dr. Mishagli introduced in his dissertation. By definition, these questions went beyond the scope of the PhD dissertation. In this undergraduate project, we have been exploring some of these questions, with quite some success.

Fulfilment of assignment — **fulfilled**

How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.

Adam Bosak has demonstrated the scalability of some of the formulations of gate sizing utilizing a model for the propagation of histogram-approximation of delays through the circuit, similar in spirit to Statistical Static Timing Analysis of Dr. Mishagli, while showing the lack of scalability of other formulations. This has exceeded my expectations of the project.

Activity and independence when creating final thesis — **A - excellent.**

Assess whether the student had a positive approach, whether the time limits were met, whether the conception was regularly consulted and whether the student was well prepared for the consultations. Assess the student's ability to work independently.

Dr. Mishagli and I met with Adam once or twice a week and Adam has always managed to impress us with the progress since the last meeting.

Technical level — **A - excellent.**

Is the thesis technically sound? How well did the student employ expertise in his/her field of study? Does the student explain clearly what he/she has done?

The project required a good grasp of a number of fields, including mathematical optimization, applied probability and Monte Carlo simulations, circuits and systems, and last but not least, Python programming. Adam has demonstrated the breadth and depth of his Computer Science training very well.

Formal level and language level, scope of thesis — **A - excellent.**

Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?

The dissertation is written in good English and the level of formalization is perfectly appropriate for an undergraduate dissertation. With some more effort, this could result in one or two journal papers, I imagine.

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Selection of sources, citation correctness	**A - excellent.**
Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the standards?	
Adam has cited all important sources.	

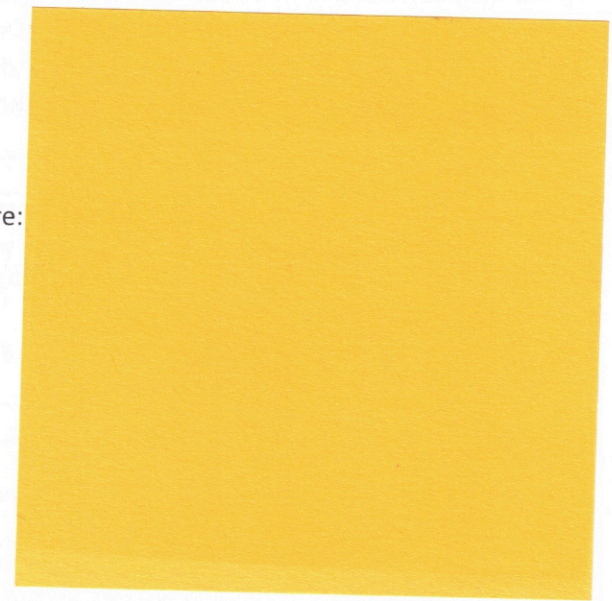
Additional commentary and evaluation (optional)
Comment on the overall quality of the thesis, its novelty and its impact on the field, its strengths and weaknesses, the utility of the solution that is presented, the theoretical/formal level, the student's skillfulness, etc.
I am sorry to see Adam leave the Czech Technical University for a Masters at the Danish Technical University, but wish him the best of luck there – and beyond!

III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

Summarize your opinion on the thesis and explain your final grading.

The grade that I award for the thesis is **A - excellent.**

Date: **6.6.2022**

Signature: 

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25th May 2022

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Czech Republic

Re: Bachelor's thesis by Mr Adam Bosák entitled *Novel Geometric-Programming Formulations in Computer-Aided Design of Integrated Circuits*

I am a Postdoctoral Research Engineer at University College Dublin. Together with Dr Jakub Mareček, I have co-supervised (was a supervisor-specialist) the work of Mr Adam Bosák that he completed as a part of his undergraduate studies.

The thesis by Mr Bosák is dedicated to formulation of optimisation problems for Integrated Circuits (ICs) using statistical delay models. One of the problems that the designers of Very Large-Scale Integration (VLSI) circuits face daily is the minimisation of the critical path's delay subject to power and area constraints by choosing scaling factors of transistors. While being studied and understood well for deterministic delays, very few researchers attempted to solve the sizing problem using statistical frameworks.

The main achievement of the work is the proposed two formulations of the statistical gate sizing problem, one uses a mixed-integer programming and the second one falls into geometric programming. While the first formulation is NP-hard, the second formulation is a convex optimisation problem, which allows it to be solved efficiently. Solution of these problems required determination of the critical path's delay, which is a standalone problem. As a result, the two corresponding approaches to the Statistical Static Timing Analysis (SSTA) were developed and realised by Mr Bosák as well.

The delays in the thesis are described on a distribution level using histograms. A substantial part of the work is dedicated to the core elements of SSTA algorithms: the statistical maximum and convolution operations for such a histogram approximation. These operations are shown how to perform using optimisation techniques. A mixed-integer formulation of SSTA relies on an ingenious solution of representing the histograms with a unary notation. At the same time, the second proposed formulation via Geometric Programming is straightforward and has lower complexity. Both formulations are analysed and compared against each other and a deterministic approach from the literature.

The thesis is well structured and easy to follow. It is well illustrated, and the plots are of professional quality. However, the thesis has some weaknesses. Firstly, the motivation and statement of the problem are done very briefly in the Introduction chapter. The importance of the considered problems is only mentioned, and the need for two different formulations of SSTA becomes clear only when one carefully reads the corresponding chapter. Secondly, sometimes the text is written as a non-academic one, although this can be considered as a distinguished style of the Author.

During the work on the thesis, Adam demonstrated high level of programming skills, constant interest and ability of finding solutions independently. He has deepened his knowledge of discrete calculus, statistics and optimisation techniques. Very often, only minor hints were needed in order to help Adam to discover a solution to problems and challenges he had.

In my opinion, the work is performed at the highest international level, and Mr Bosák deserves a BSc degree.

Yours sincerely

Dmytro Mishagli, MSc, PhD
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