



UNIVERSITI PUTRA MALAYSIA

**DEVELOPING AN INTEGRATED SYSTEM DESIGN
MODEL FOR FORM FLEXIBILITY OF INDUSTRIALIZED
RESIDENTIAL TIMBER BUILDING**

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**DEVELOPING AN INTEGRATED SYSTEM DESIGN MODEL FOR FORM
FLEXIBILITY OF INDUSTRIALIZED RESIDENTIAL TIMBER BUILDING**

By

SIVA. JAGANATHAN

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia
in Fulfilment of the Requirements for the Degree of Master of Science**

March 2011

DEDICATION

To my beloved parent Shayamala and Jaganathan



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment
of the requirement for the degree of Master of Science

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Chair: Associate Professor Rahinah bt. Ibrahim, PhD

Faculty: Design and Architecture

This study examines the integration of timber industrialized building system (TIBS) during the design process of a building project. Currently in Malaysia, timber has been mainly used for non-structural purposes. The study finds the fragmented process of design, manufacturing and assembly physical building elements and components of the prefabrication processes limiting design flexibility, hence, the final industrialized building forms are limited. This form limitation is inhibiting the consideration of using industrialized building system (IBS) by architects during design of their building projects. The objectives of this study are understanding the IBS design involved and proposing an integrated system design for producing an IBS building. In order to address, the study conducted an ethnography research method on a residential house that was built using prefabricated timber framing system to document the various stages of a timber IBS lifecycle, such as the design, the

manufacturing/production and the assembly processes. The study found the existence of multiple task interdependencies that required varied design decision-makings during the iterative design process. In addition to that it also found the lack of integration between the form finding categories such as functional space design, physical building elements and components design during the application of a system design in IBS building's. The ethnography findings highlight the need for a systematic design process and approach of the physical building components that supports off-site manufacturing/production and assembly-able construction, which in turn would allow designing a flexible form for timber industrialized building system. The ethnography results then led to the development of an integrated system design model for industrialized building in timber and the development of the spacer architectonic building system that supports form flexibility of architectural design. The integrated system design model actually merges the design development and detailed design/construction documentation phases of the architectural design lifecycle thereby shortening the duration of the design phase while reducing redundant design flaws occurred during the manufacturing/production and assembly-able construction. These contributions are expected to enhance timber as a green building that supports sustainable development as per recommended by the Construction Industry Master Plan 2006-2015.

Key words: Industrialized building system; architecture design process; form flexibility; timber framing.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah master sains

**MEMBANGUNKAN SEBUAH MODEL REKABENTUK SISTEM
BERSEPADU UNTUK KEANJALAN PERUMAHAN PEMBINAAN
BERINDUSTRI KAYU**

Oleh

SIVA. JAGANATHAN

March 2011

Pengerusi: Prof. Madya Rahinah bt. Ibrahim, PhD

Fakulti: Rekabentuk dan Senibina

Kajian ini mengkaji integrasi sistem pembinaan berindustri kayu (TIBS) semasa proses merekabentuk sebuah projek pembinaan. Kini di Malaysia, kayu sering tidak digunakan terutamanya untuk tujuan struktur. Kajian ini mendapati proses rekabentuk berfragmen, pembuatan dan perhimpunan unsur-unsur bangunan fizikal dan komponen-komponen proses prefabrikasi menyekat keanjalan rekaan, justeru, bentuk terakhir bangunan industri adalah terhad. Bentuk yang terhad ini menghalang pertimbangan untuk menggunakan sistem pembinaan berindustri (IBS) oleh arkitek-arkitek semasa merekabentuk projek-projek bangunan mereka. Objektif kajian ini adalah untuk memahami rekabentuk IBS yang terlibat dan mencadangkan sebuah rekabentuk sistem yang bersepadu untuk menghasilkan sebuah bangunan IBS.

Untuk mengatasi permasalahan ini, sebuah kajian dilakukan dengan menggunakan

kaedah penyelidikan etnografi ke atas sebuah rumah kediaman yang dibina menggunakan sistem kerangka kayu pasang siap untuk mendokumentasikan pelbagai fasa-fasa kitaran hayat sebuah produk kayu IBS, seperti rekabentuk, pembuatan/pengeluaran dan proses pemasangan. Kajian ini mendapati wujudnya pelbagai tugas berganda yang saling bergantung di antara satu sama lain yang memerlukan kepelbagaian membuat keputusan tentang rekabentuk semasa proses merekabentuk yang iteratif.

Tambahan pula, ia juga mendapati kurangnya integrasi di antara kategori-kategori pencarian bentuk seperti rekabentuk ruang berfungsi, unsur-unsur bangunan fizikal dan komponen-komponen rekabentuk semasa pmengaplikasi sebuah sistem rekabentuk sebuah bangunan IBS. Dapatan etnografi memperlihatkan keperluan adanya sebuah proses merekabentuk yang bersistematik dan pendekatan penggunaan komponen-komponen bangunan fizikal yang menyokong pembuatan di luar tapak pembuatan/pengeluaran dan pembinaan yang mudah dipasang, yang dipercayai akan membolehkan rekaan satu bentuk yang anjal bagi sistem pembinaan berindustri kayu. Dapatan etnografi juga kemudian membawa kepada pembangunan sebuah model rekabentuk sistem bersepadu bagi pembinaan berindustrikan kayu dan pembangunan “*spacer architectonic building system*” yang menyokong pembentukan anjal dalam rekabentuk senibina. Model rekabentuk sistem bersepadu sebenarnya menggabungkan fasa perincian rekabentuk/ dokumentasi pembinaan di dalam kitaran hayat rekabentuk senibina yang mampu memendekkan tempoh fasa merekabentuk sementara mengurangkan kecacatan rekabentuk yang berulang semasa pembuatan/pengeluaran dan pembinaan mampu pasang.

Sumbangan kajian ini diharapkan dapat memartabatkan kayu sebagai satu sumber bangunan hijau yang mampu menyokong pembangunan lestari sesuai dengan apa yang disarankan oleh Pelan Induk Industri Pembinaan 2006-2015.

Kata kunci: sistem pembinaan berindustri; proses merekabentuk senibina; keanjalan bentuk; kerangka kayu.



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APPROVAL

I certify that a Thesis Examination Committee has met on 21 March, 2011 to conduct the final examination of Siva Jaganathan on his thesis entitled “DEVELOPING AN INTEGRATED SYSTEM DESIGN MODEL FOR FORM FLEXIBILITY OF INDUSTRIALIZED RESIDENTIAL TIMBER BUILDING” in accordance with Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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This thesis was submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or other institution.

The logo of Universiti Putra Malaysia (UPM) is a shield-shaped emblem. It features a red and white design with a central vertical element and a large 'U' shape. The letters 'UPM' are prominently displayed in red at the top left of the shield.

SIVA. JAGANATHAN

Date: 21 March, 2011