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# Mass Customizing PV Solar Homes

*Toward Sustainable Development*

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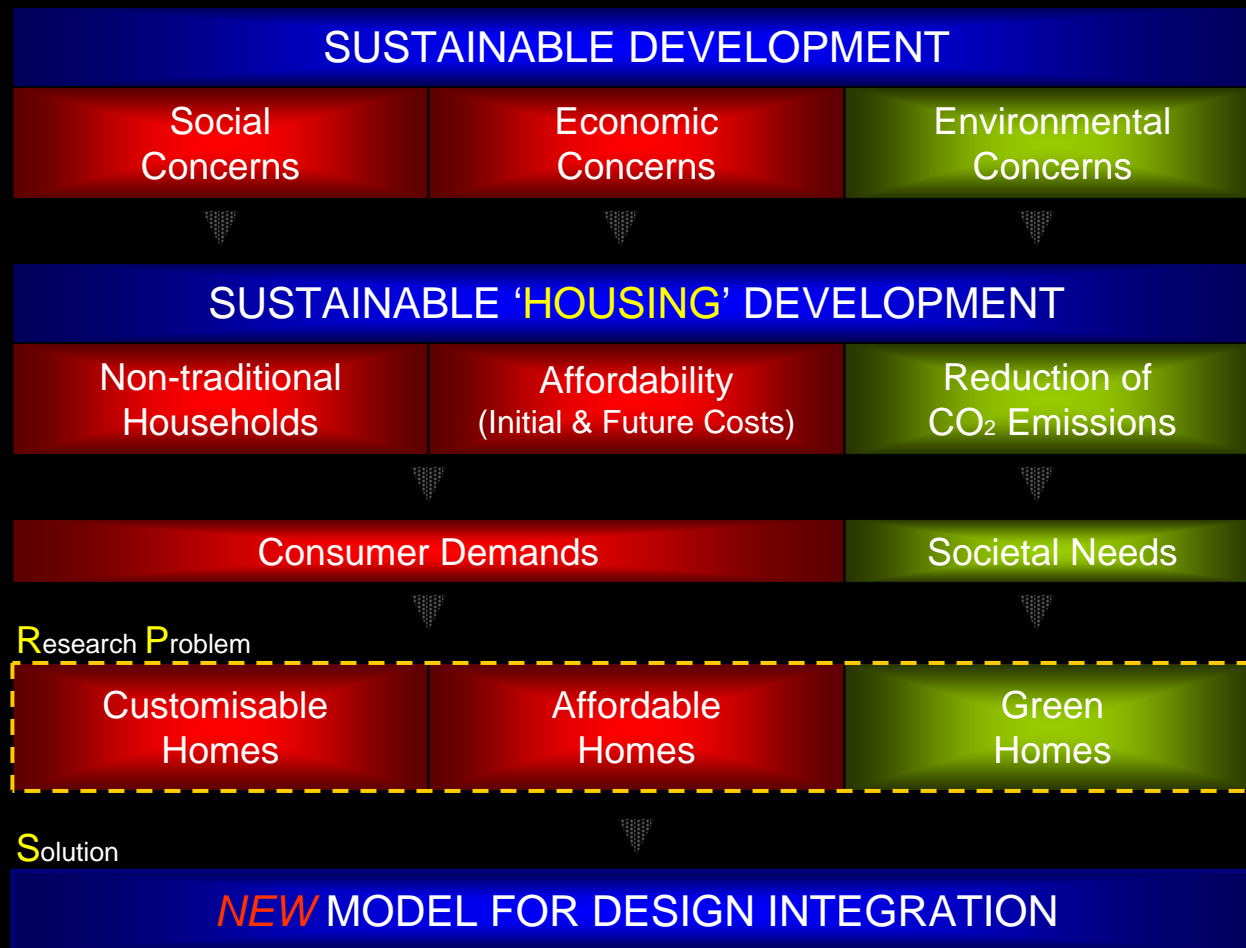
Natural Resources Canada

Course Lecturer

School of Architecture

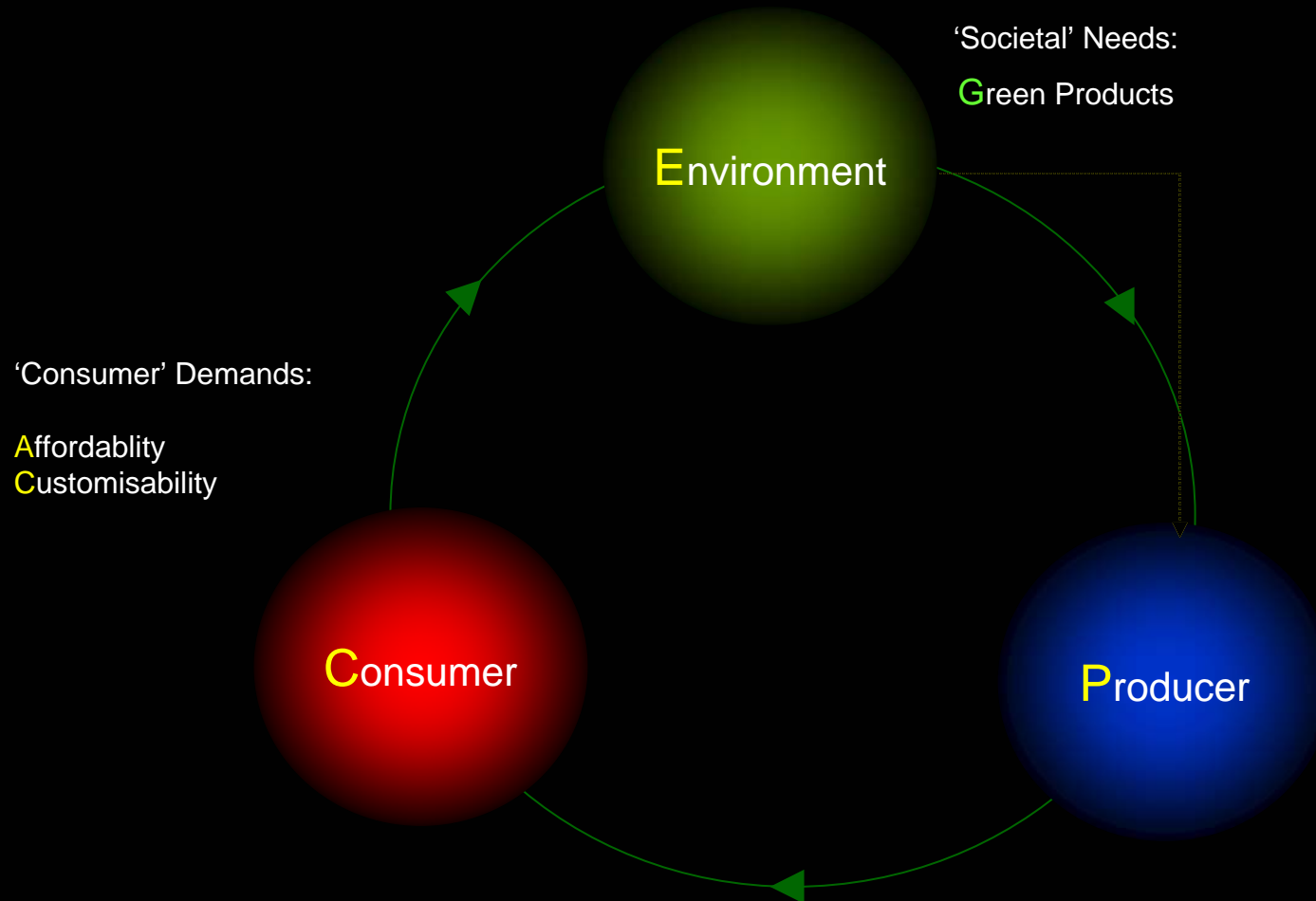
McGill University

# Research Problem: How to Integrate Different Design Approaches?



# Production and Consumption Cycle

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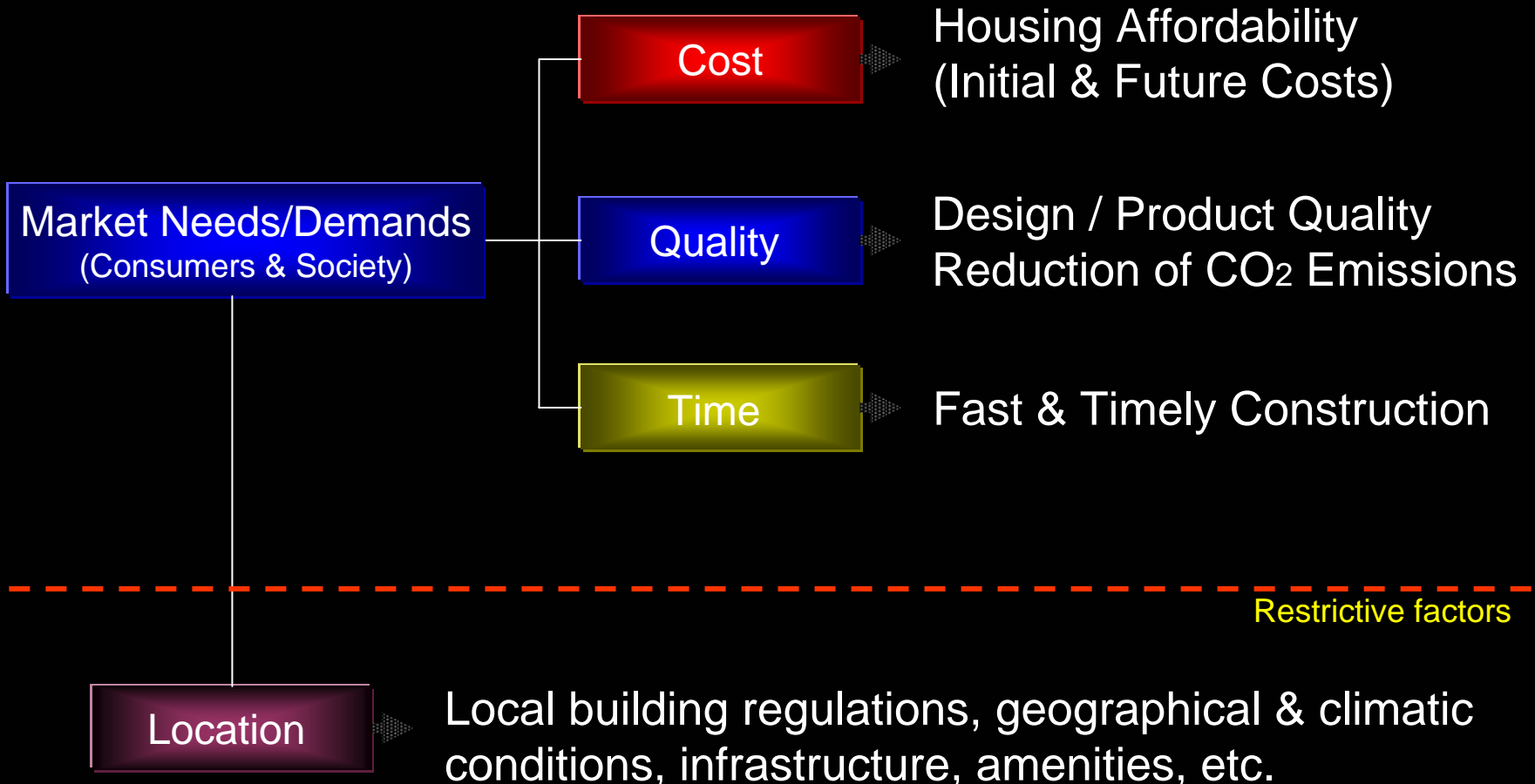


'Marketable' PV Solar Homes  
In Subdivision Development

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## Four major influences on a homebuilding project

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## Consumer Demands for Quality Homes

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1970s : Reliability of products

1980s : High quality became a requisite for market entry

1990s : The concept of quality had grown from  
'Reliability' to '**Individualisation**' of products

Consumers are no longer satisfied with **generic, monotonous** products; rather, they prefer to purchase **customised** products

(Source: Anderson 1997)

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## Today's **Homebuilders** & their Design Approaches

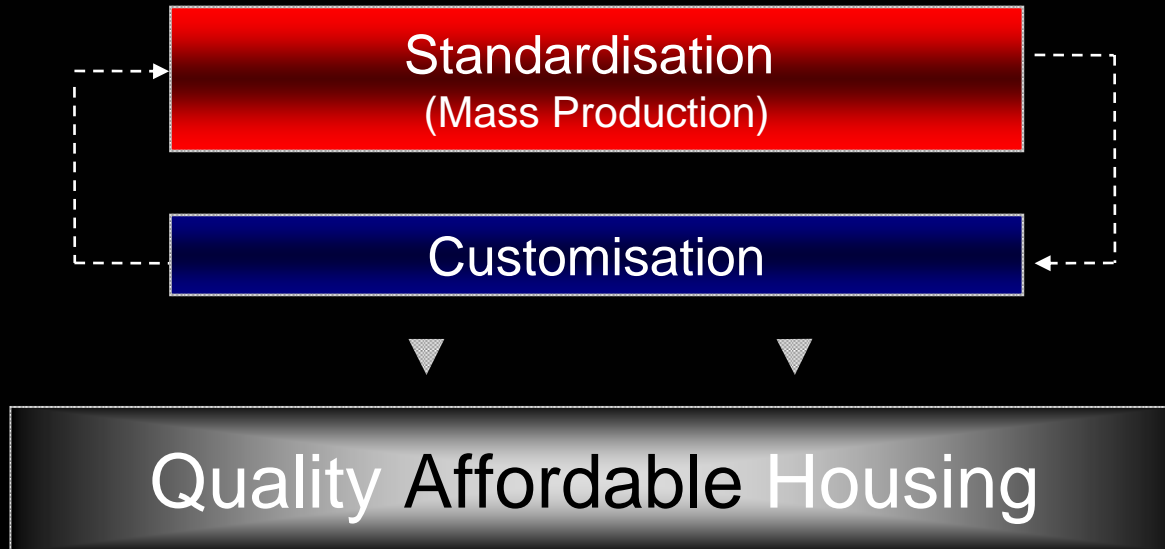
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- ▣ Production Builder : **Speculative** (or production) design
- ▣ Semi-custom Builder : **Semi-custom** design
- ▣ Custom Builder : **Custom** design

	STANDARDISATION LEVEL	CUSTOMISATION LEVEL
Ready-built home	High	Low
Semi-custom home	Medium	Medium
Custom home	Low	High

# Production GAP

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## Case Studies of

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## Housing Manufacturers in Japan

Daiwa House Industry Co., Ltd.

PanaHome Corp.

Resco House Co., Ltd.

Sekisui Chemical Co., Ltd.

Toyota Motor Co.

Misawa Homes Co., Ltd.

SXL Co., Ltd.

SANYO Homes Co., Ltd.

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## Mass Customisation?!

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In 1970, the concept was anticipated by **Alvin Toffler** in *Future Shock*  
In 1987, the term was coined by **Stanley Davis** in *Future Perfect*

“**Mass** Customization is a new way of viewing business competition, one that makes the identification and fulfillment of the wants and needs of individual customers paramount without sacrificing **efficiency, effectiveness, and low costs**”

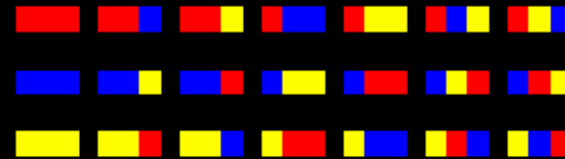
**Mass** Customisation = Achieving Mass + Customisation

# Mass Customisation

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In the broad sense:

Standardised Components



Customised Products

“Mass Production of Individually Customized Goods and Services”

(Source: Pine II 1993)

Demonstration :

How to “**Mass** Customise” a Product ?



Industrial Design Example:  
Mass Customizing a “**Book Cart**”

# User Choice : Shelves



**USER SELECTED:**  
Two sloping  
and  
Fixed Shelves



## User Choice : Handles

USER SELECTED:  
V-shaped, Vertical  
Handles



## User Choice : Wheels

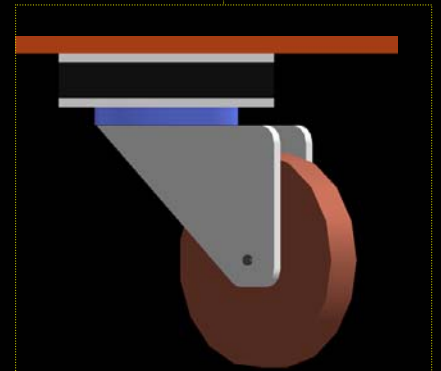
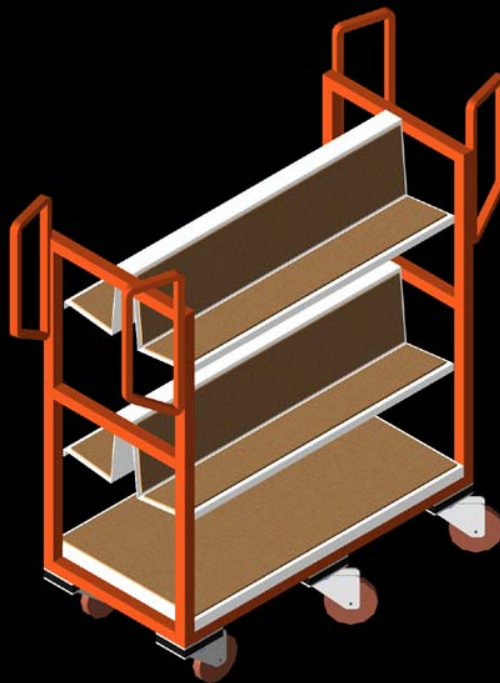
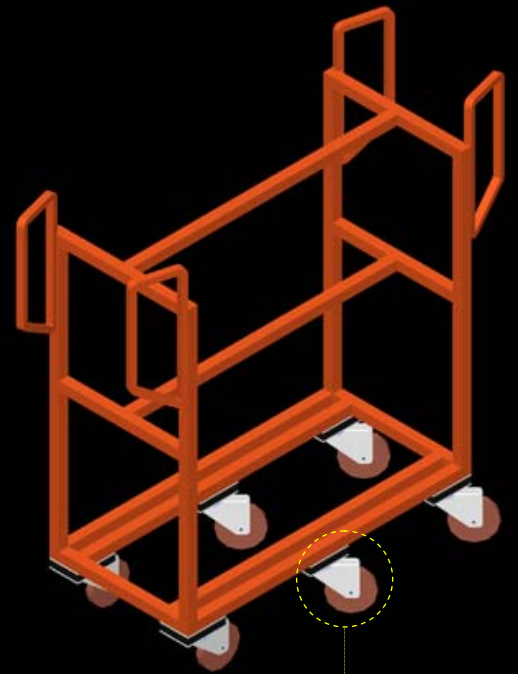
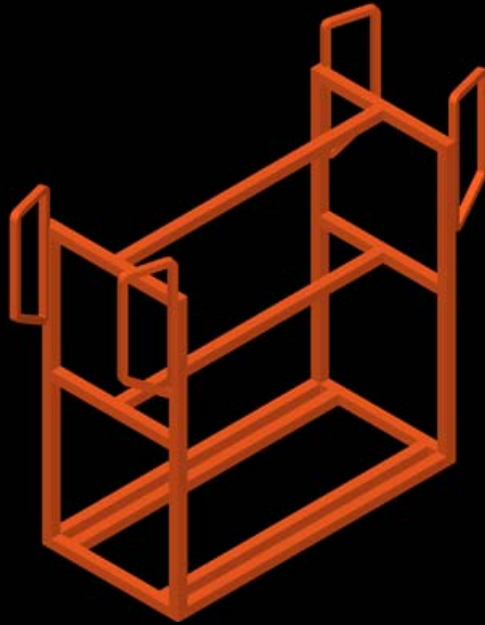
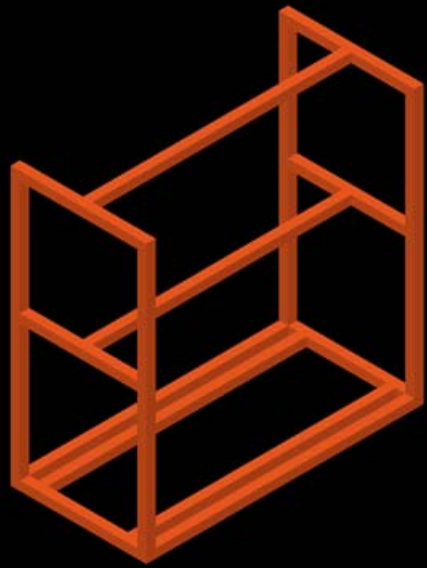


**USER SELECTED:**  
Six Wheels and Metal Plate connectors



**‘Mass Customised’**  
Book Cart

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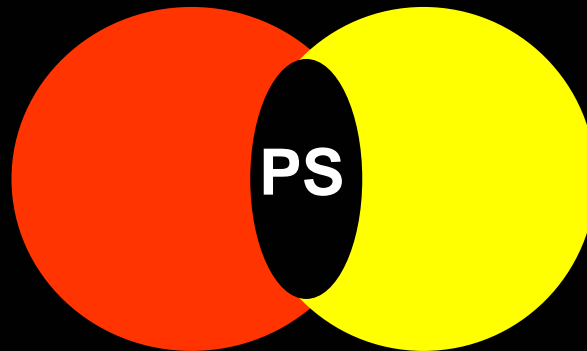


# TOTAL COORDINATION

Mass Customization (MC) model

$$MC = f(PS)$$

Product sub-system:  
Production support



Service sub-system:  
Communication support

## Mass Customization (MC) Model

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$$MC = f(PS)$$


**S**ervice sub-system

$$S = f(l, t, p)$$

l: Location

t: Tool

p: Personal

**P**roduct sub-system

$$P = f(v, e, i, o)$$

v: Volume component

e: Exterior component

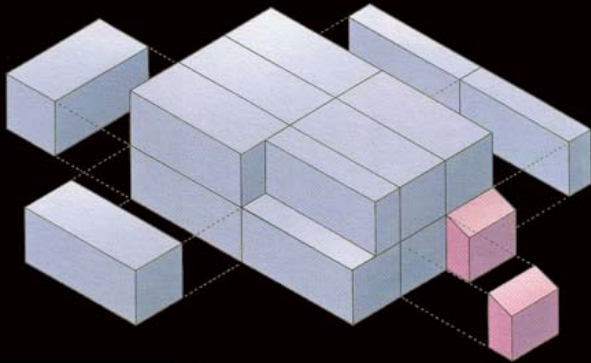
i: Interior component

o: Optional equipment

Product sub-system =  $f(v, e, l, o)$

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Volume components



TOYOTA MOTOR CO.  
modular homes



5.7 m x 2.4 m Unit



5.7 m x 1.2 m Unit



4.8 m x 2.4 m Unit



4.8 m x 1.2 m Unit



3.9 m x 2.4 m Unit



3.9 m x 1.2 m Unit



0.9 m x 1.2 m Space Up Unit

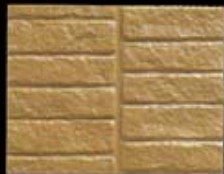
Product sub-system =  $f(v, e, l, o)$

## Exterior design components



☐ Color variations

☐ Texture



Exterior Wall



Toyota provides  
**13 types** of walls  
applicable to  
4 housing models

Product sub-system =  $f(v, e, l, o)$

Exterior design components



Balcony



▣ Baluster and Balustrade

▣ Wall Style



Product sub-system =  $f(v, e, l, o)$

Interior design components



Kitchen



20 Styles & 15 colors  
300 kitchen variations  
for Sekisui Chemical  
Two-U Home

Product sub-system =  $f(v, e, l, o)$

Interior design components



Interior Doors

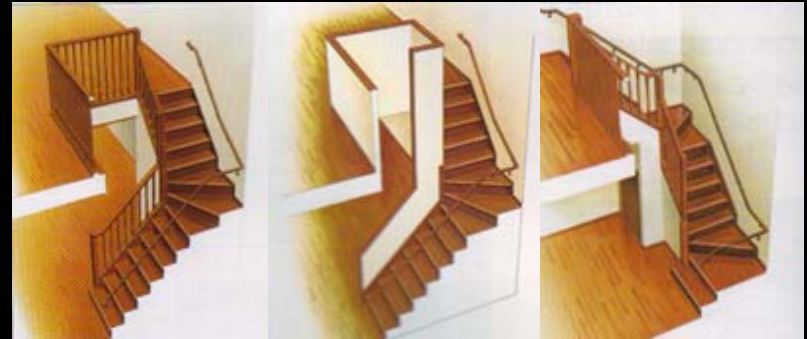
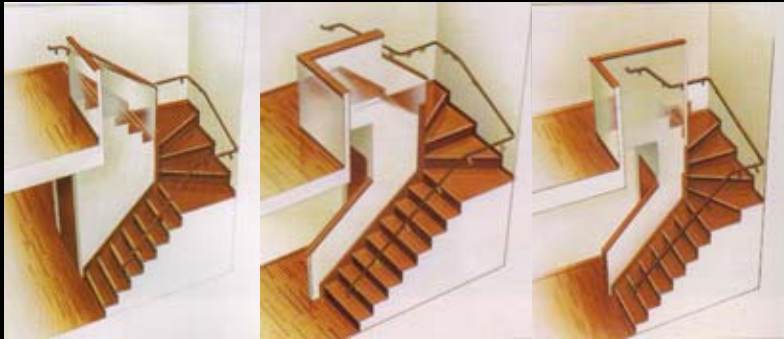
▣ 12 modules

▣ 8 more colors, textures, and styles

Sekisui offers  
**96 interior doors**  
for Two-U Home

Product sub-system =  $f(v, e, l, o)$

Interior design components

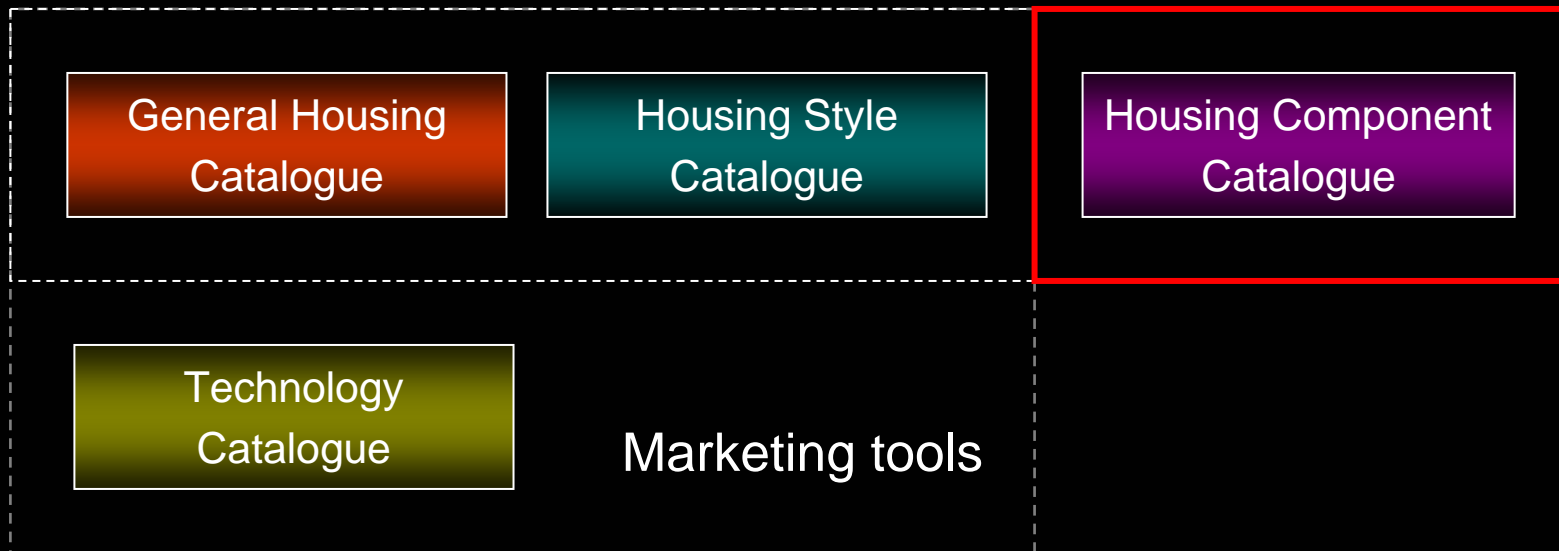


Staircase

Service sub-system =  $f(l, t, p)$

Tool factor: catalogues

Design tools



Service sub-system=  $f(l, t, p)$

Location factor

Display homes



Housing Park & Housing Information Center



# Housing Park



Sekisui Chemical  
PanaHome  
Resco

711 model homes  
380 model homes  
17 model homes

25.3 units / model home  
25.6 units / model home  
22.8 units / model home



# Housing Park in Tokyo



# Housing Park in Tokyo

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# Housing Park in Tokyo



# Housing Information Centre



Design  
Consultation



Experience

Service sub-system =  $f(l, t, p)$

Tool & Personnel factors: CAD

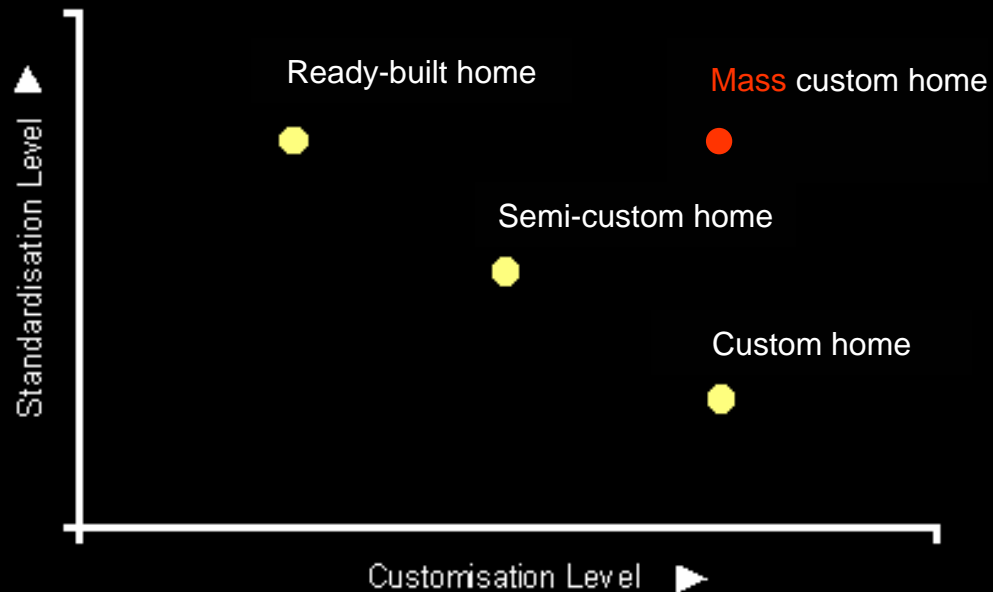


We are **happy** !



# Standardisation vs. Customisation

	STANDARDISATION LEVEL	CUSTOMISATION LEVEL
Ready-built home	High	Low
Semi-custom home	Medium	Medium
Custom home	Low	High





## Mass Custom Homes

(Source: Noguchi 2004)

## Housing Price in Japan

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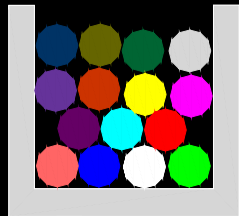
**C**onventional housing ..... 1,371 \$ /m<sup>2</sup>

**P**refabricated housing ..... 1,484 \$ /m<sup>2</sup>

**8 %** more expensive!

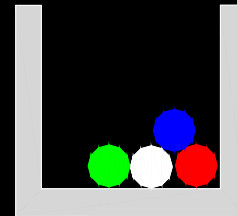
(Source: Government Housing Loan Corporation 1999; CBC 1999)

## Cost Performance



Prefabricated House

\$141,573



Conventional House

\$130,793

Average floor area of a 'mini-development' house = 95.4 m<sup>2</sup>

(Source: Mishima 2000)

# Cost Performance ?!

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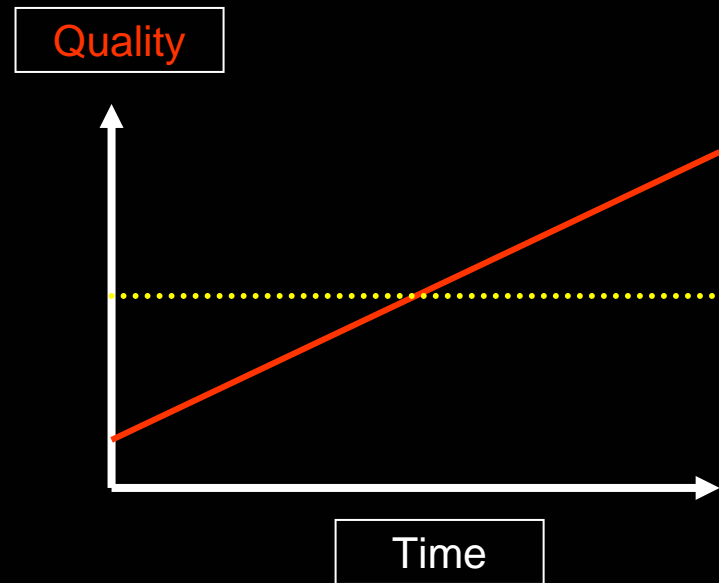
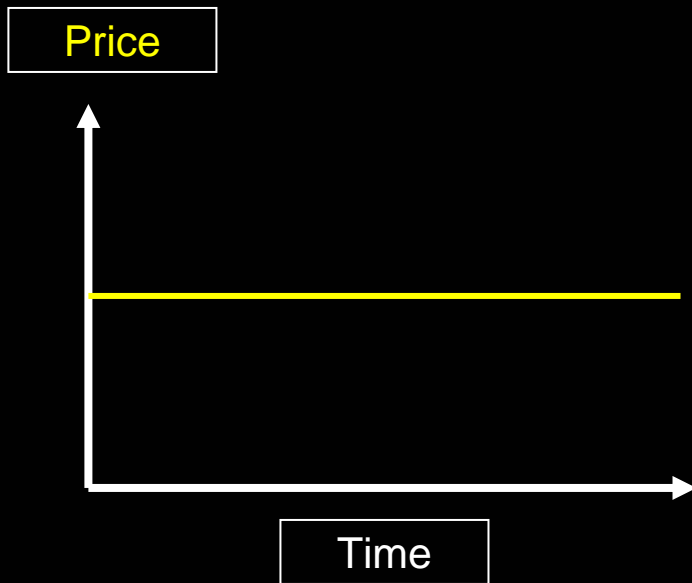
Old model



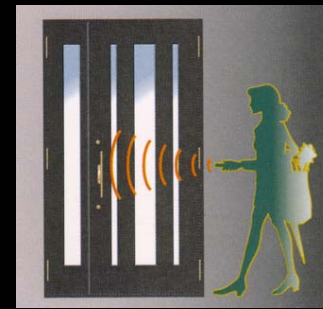
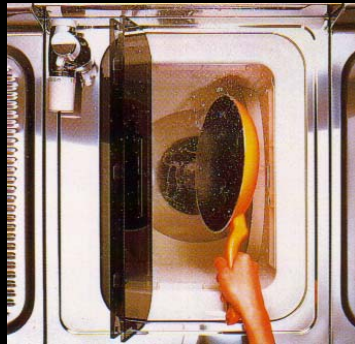
New model

# 'Cost Performance' Marketing Strategy

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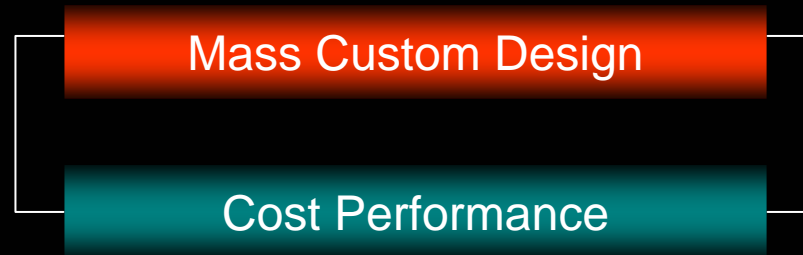
# Standard Equipment: **Se**



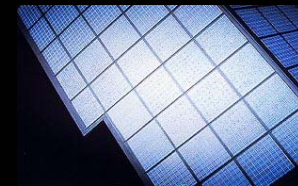
# Potential Solution: *New* Conceptual Model

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To cater to meet 'consumer' & 'societal' demands



$$\text{HIPV} = f(V, E, I, O) + PV$$



In order to cater to produce '*marketable*' PV solar homes

**Mass** Custom Home equipped with **PV**

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A B C D E F G H I J K L M N O P Q R S T U V W X Y Z



VERY THANK  
YOU MUCH



**MASS** CUSTOMISATION  
combination of standard components



All I want to say is:

**THANK YOU VERY MUCH**

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