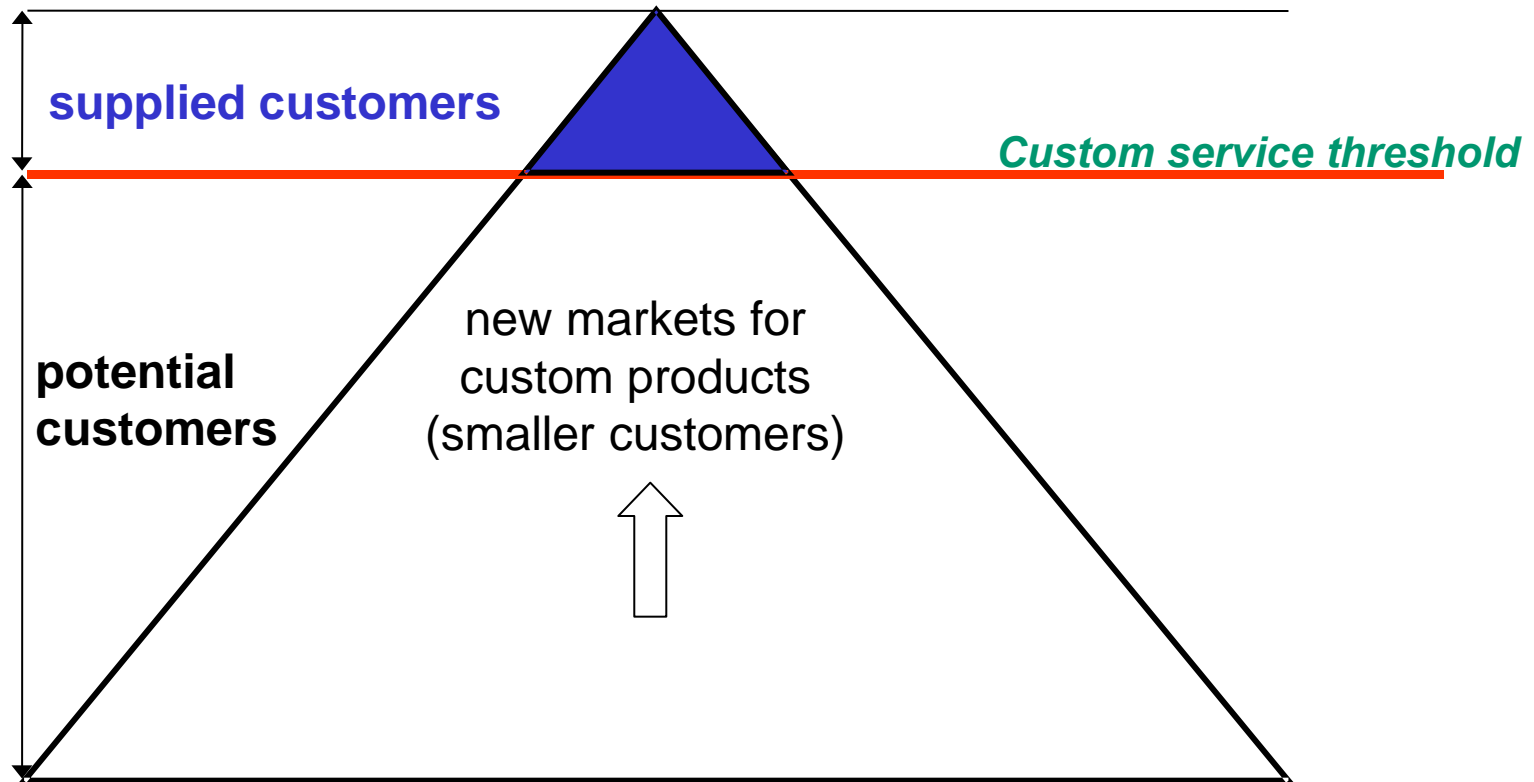# Toolkits to Support Product Development by Customers

Eric von Hippel

MIT Sloan School of Management

Firms often cannot *afford* to develop custom products for smaller customers

supplied customers

Custom service threshold

potential customers

new markets for custom products (smaller customers)

But companies can help all customers design custom products for themselves!

- Customers design chips that are produced by LSI

- User-friendly and integrated toolkit (using simulation and CAD technology)

- Traditional suppliers were reluctant to make tools available to markets (intellectual property)

- Fujitsu even refused to share its tools with US division

Design Our Gate Arrays On Your Workstation

Now you can design and verify gate arrays in-house on your own Mentor Graphics IDEA 1000,™ Daisy LOGICIAN™ or Valid Logic SCALDsystem™ engineering workstation.

Powerful New Software From LSI Logic Corporation Gives You The Freedom

Our new SOFTWARE DATA BOOK™ series of macrocell libraries gives you all the documentation, data sheets and array design rules needed to begin design of LSI Logic Corporation logic arrays. Installation is simple, straightforward and takes only minutes. Using the SOFTWARE DATA BOOK means your time can be used more productively on the workstation for *design creation* —without concern that logic models are outdated or incorrect.

Our new DESIGN VERIFIER SOFTWARE™ turns your Mentor Graphics IDEA 1000 workstation into a complete system for designing our LL5000/LL7000 series gate arrays. Used in conjunction with the SOFTWARE DATA BOOK you can enter your circuit description, then proceed to logic verification, performance simulation and output of a network description file compatible to the LDS-II™ design system at any LSI Logic Corporation Design Center. Together, the SOFTWARE DATA BOOK and DESIGN VERIFIER SOFTWARE give you the most complete in-house design and verification capability available. Call or write for complete information today.
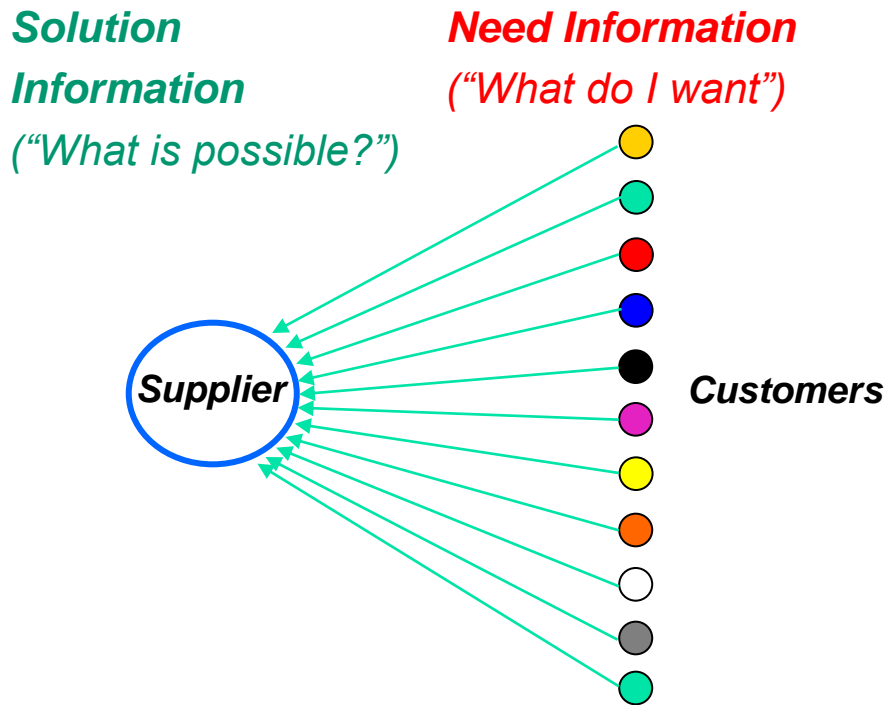
LSI LOGIC CORPORATION, 1601 McCarthy Blvd., Milpitas, CA 95035. Call (408) 263-9494 or Telex: 172-153.

*IDEA 1000, LOGICIAN and SCALDsystem are trademarks of Mentor Graphics, Daisy Corporation and Valid Logic, respectively.

No one delivers Gate Array Design Software like we do…No one.

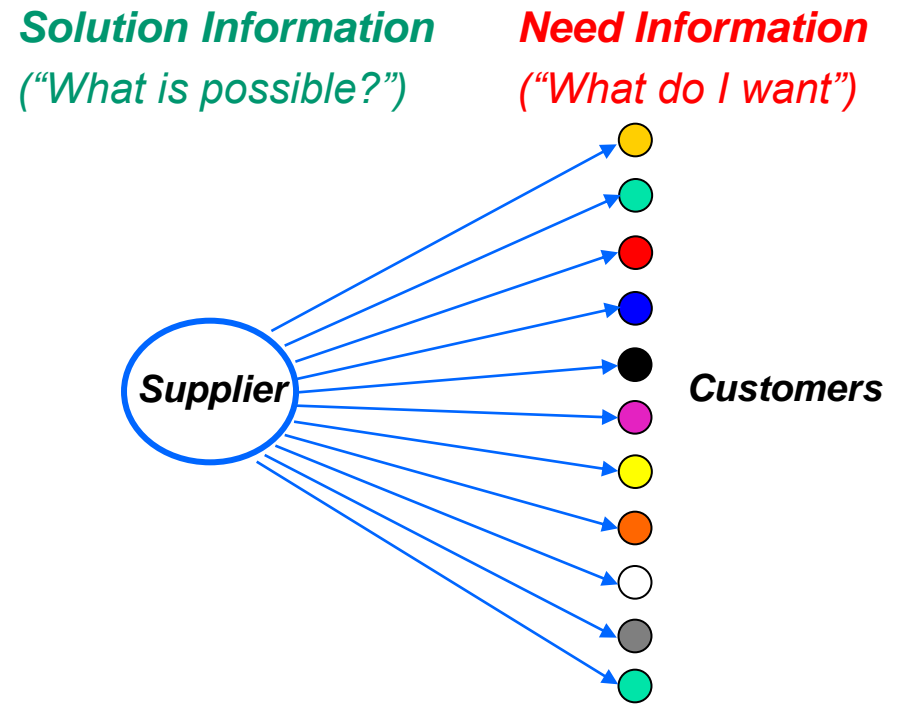**LSI LOGIC CORPORATION**

Toolkits – the basic idea

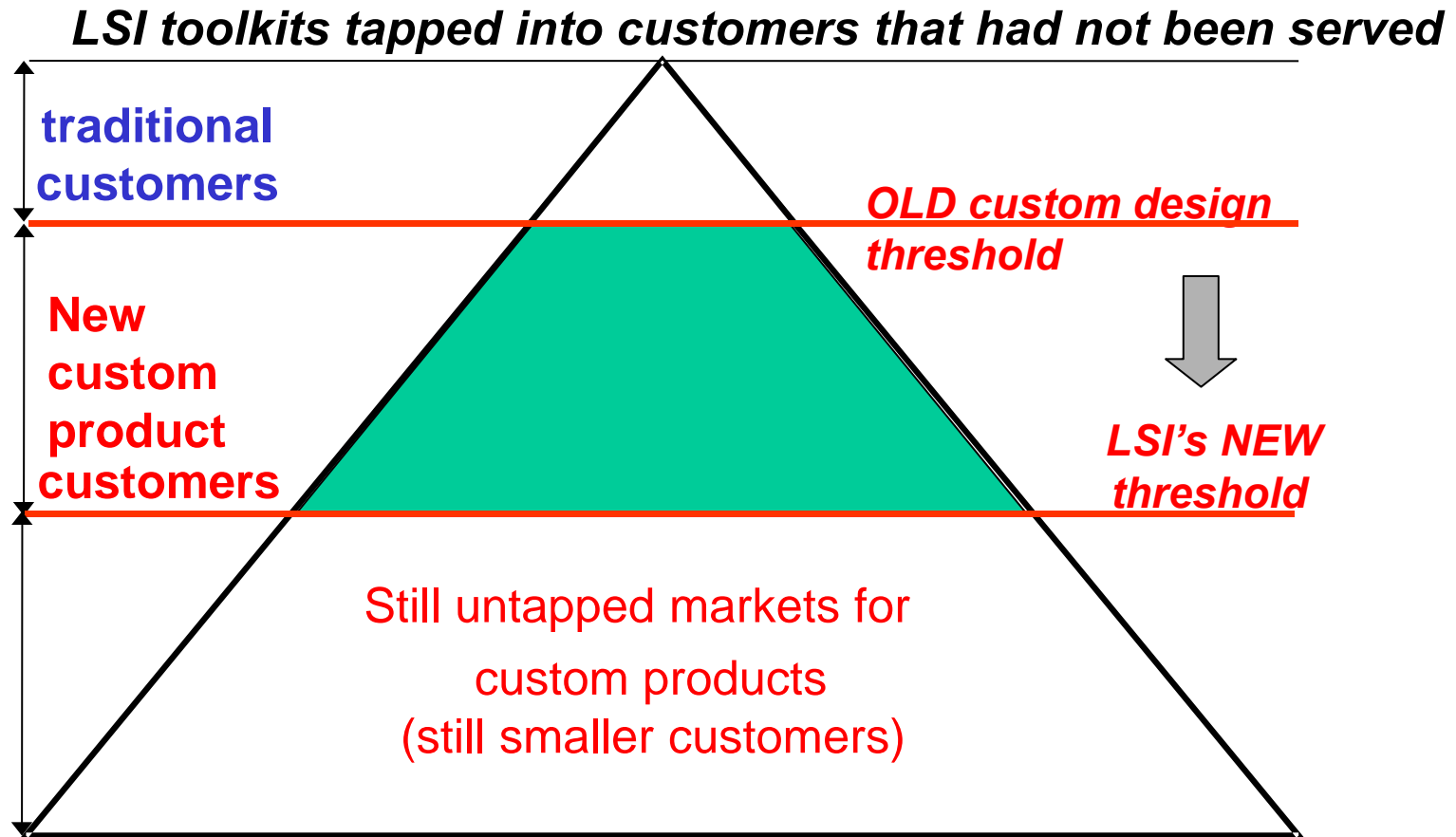The standard, "find a need and fill it" product development model

The toolkits development model

Solution Information
("What is possible?")

Need Information
("What do I want")

Solution Information
("What is possible?")

Need Information
("What do I want")

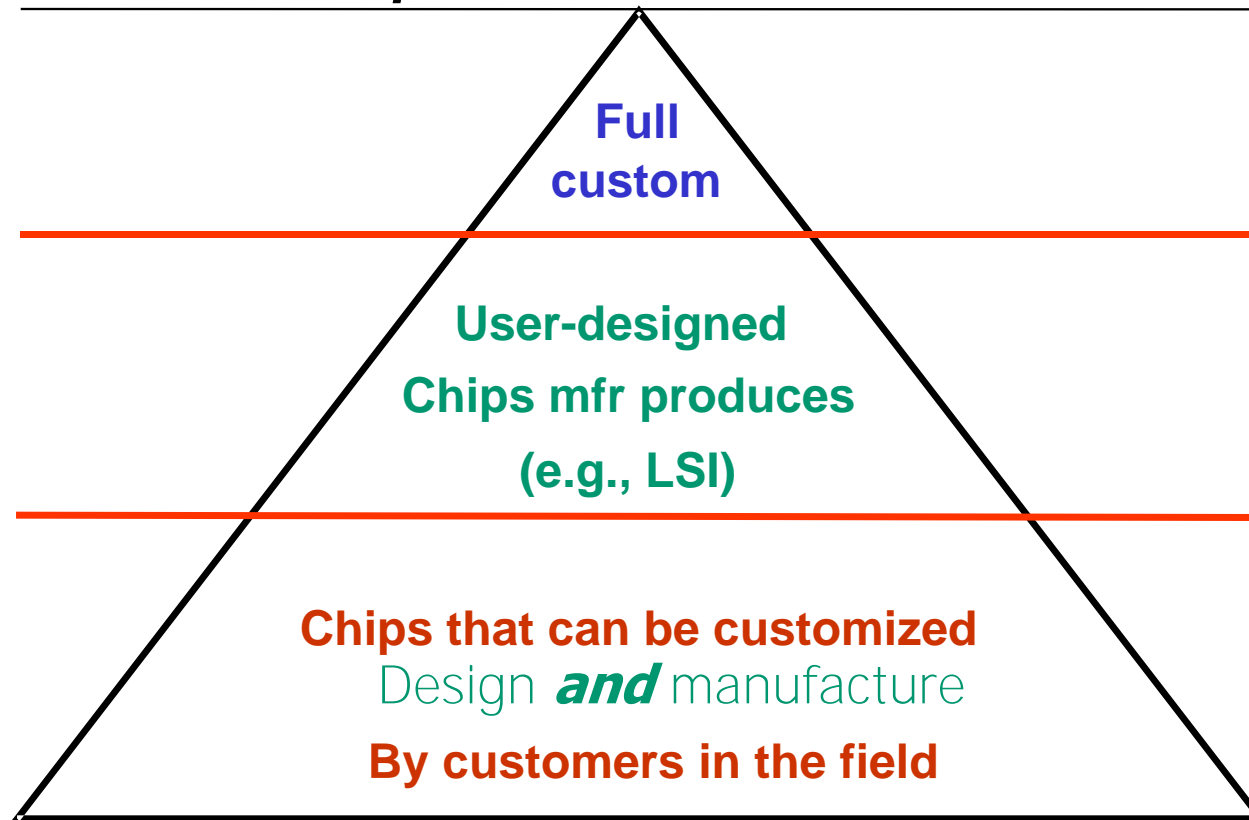*Supplier* *Customers*

Supplier *Customers*

Toolkits make sense when collecting accurate Information about each customers needs is costly

Innovation toolkits made many more custom product customers accessible to LSI

LSI toolkits tapped into customers that had not been served

traditional customers

OLD custom design threshold

New custom product customers

LSI's NEW threshold

Still untapped markets for custom products (still smaller customers)

The Pattern is Repeated: The Rise of Field Programmable Technologies

Next Steps: Where is the New Growth?

Full custom

User-designed

Chips mfr produces

(e.g., LSI)

Chips that can be customized
Design ***and*** manufacture
By customers in the field

Here is how customers can design and "build" their own custom chips in the field today.

A Verilog Introduction for Hackers
 By the Sun Feb 29th, 2004 at 09:23:14 AM EST
 <http://www.kuro5hin.org/story/2004/2/27/213254/152>

"Designing your own chips, the silicon variety. That's something
you do with millions, if not billions of dollars of equipment
and large fabrication plants under ultraclean conditions.

Well, isn't it? Actually, no. You can design your own chips
at home with a PC using no more than about $50 of equipment
and I'm going to tell you how to do it
with the absolute minimum of effort.

Why ASIC customization is cheaper with toolkits

- For custom design projects, manufacturer information is standard from project to project but user need differs

Example:

- Each ASIC design tends to require the same information from the ASIC manufacturer, but unique information from the ASIC user.
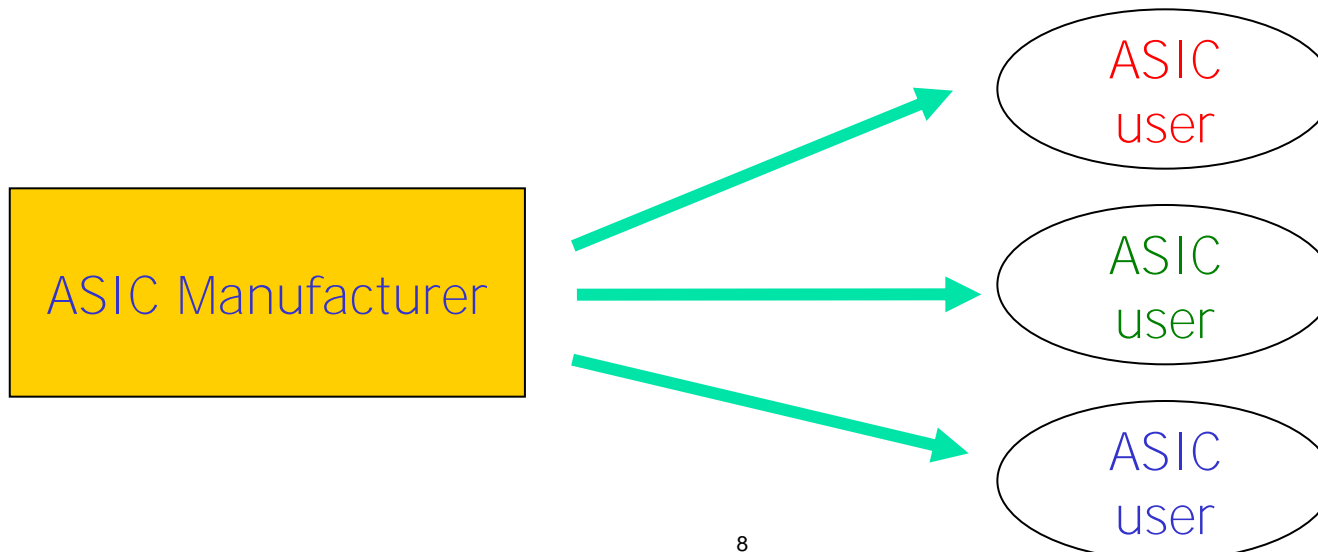
Exercise: Planning a toolkit for your company

1. **Identify a type of product your firm manufactures where user demand for customization is strong.**

2. **Think of design tools within your firm that could be used as the basis for a "toolkit for user innovation" for that product type.**

3. **How would you adapt the basic product type to separate out "need-intensive tasks" for user customization?**

4. **Describe what a "user-friendly" toolkit for user innovation might look like for this product type.**

How do you design a toolkit? There are two major tasks

A. Separate out development tasks that are custom "need-information –intensive" and assign those to users.
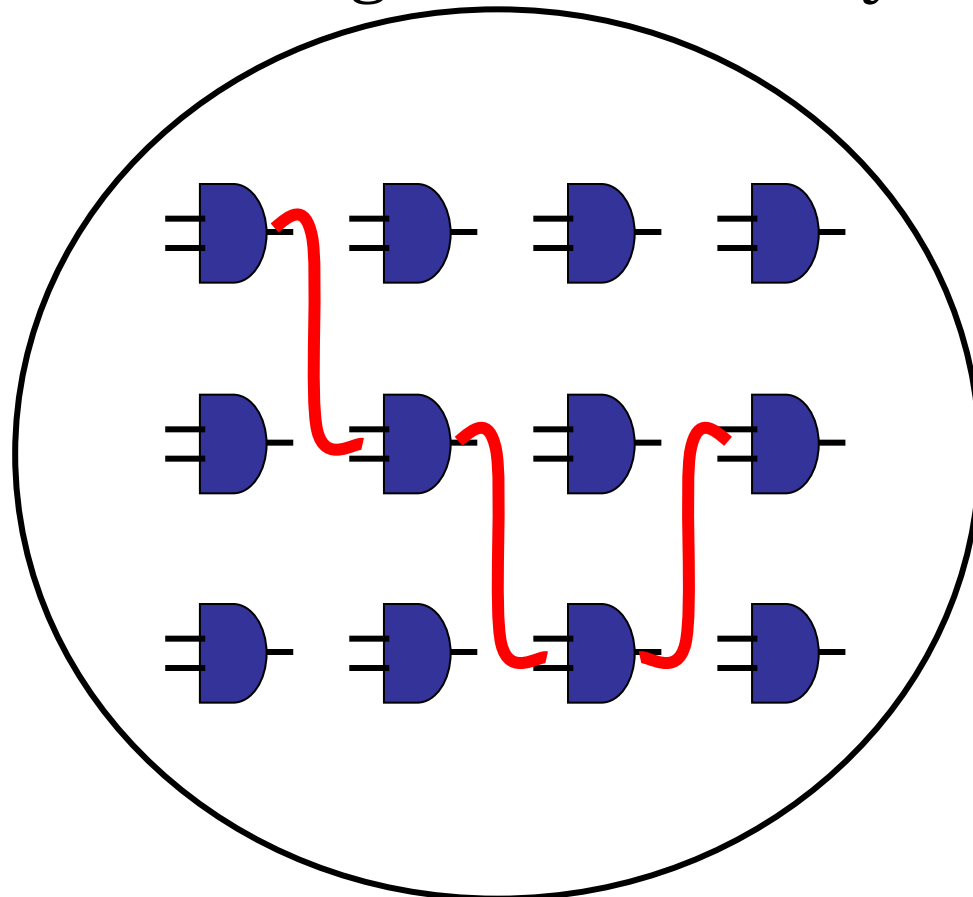
Impact on Product architecture can be major

- Custom cake vs custom pizza;
- "Full-custom" IC vs custom ASIC

B. Develop the tools users need to carry out the need-intensive tasks assigned to them.

You might have to change the basic design of your product to enable toolkits your customers can easily use
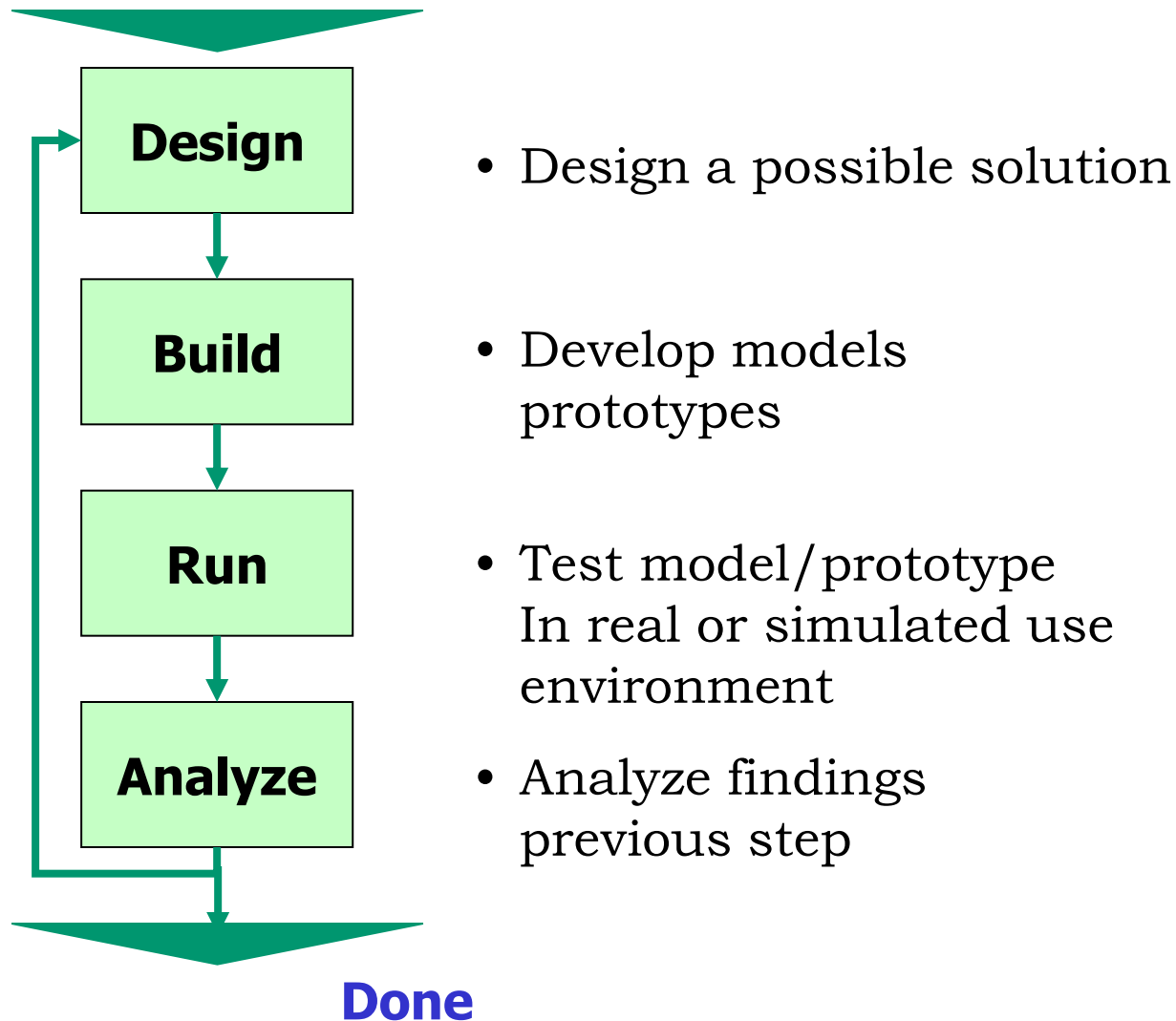
"Full-custom" IC Design vs "Gate Array IC Designs"

(B) Toolkits for users contain:

Tools to carry out trial-and-error design:

1. That are "user-friendly"
2. That offer the right "solution space"
3. That offer libraries of pre-designed modules
4. That can translate from user-language to producer language without error

Toolkits should help users to do the trial-and-error work of problem-solving in design

Design

- Design a possible solution

Build

- Develop models prototypes

Run

- Test model/prototype In real or simulated use environment

Analyze

- Analyze findings previous step

Done

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Tools to enable user to carry out design by trial-and-error

Four steps in trial-and-error-process:

	ASICs example
Design	Design custom circuit
Build	Create functioning prototype
Test	Take prototype for a "test drive"
Analyze	Compare expected and actual results. If needed, do trial-and-error cycle again. ("Iterate")

In some cases, visual images are good enough for simulation of solutions. For example, "everyone knows what a watch is and does – so a picture is OK"

(1) Offer "user-friendly" tools

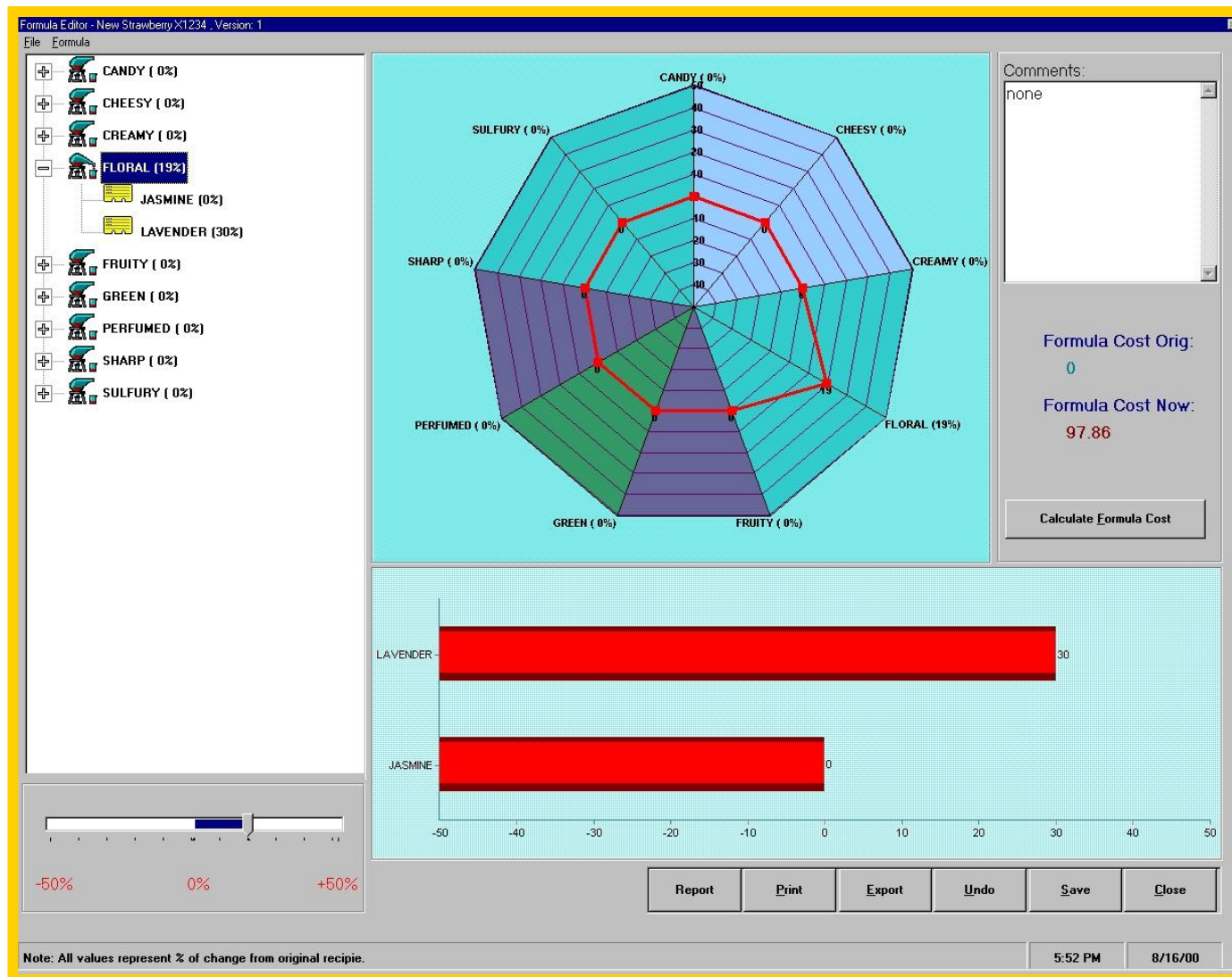**"User-friendly" means** that the user does not have to learn a new design language.

Learn what your **CUSTOMER'S** Language is; Translate your internal language into that customer language

Example: Barbie hairstyler provides users **with "user friendly" tools to create the look** they want.

User-Friendly Flavor Design Toolkit for Users

To simplify the user's design task, display only information of use to the user

- Identify the independent design dimensions that are important to the user.
- Give each design dimension a user-friendly name
- Create a translator – hidden from the user – that translates each move by a user-designer in user solution space to a move in manufacturer solution space. (Flag the user when a user move can't be done in manufacturer solution space.)

User Map: Degree of Jamminess

Low   high

Supplier Map:

Range of
Flavor
System A

Range of
Flavor
System B
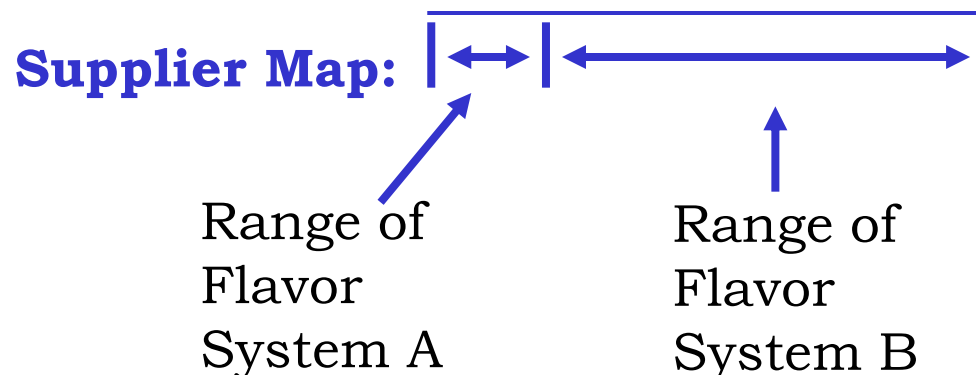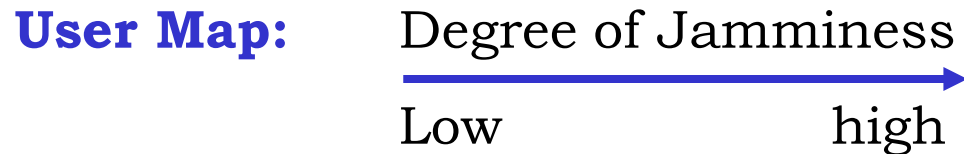
(2) Offer the right "solution space"

- Toolkits must offer users a "solution space" that contains all the design variables and tools they need to create a design.

- Example: Hairstyling toolkits:
  - Design variables offered: hair position, length, color, waviness;
  - Tools offered: virtual scissors, comb, colorants, curlers, straighteners.

(3) Offer pre-designed modules

- Custom designs are typically not totally unique. Toolkit libraries should contain pre-designed modules and modifiable "default designs" – so that users can concentrate their design work on the novel features of their designs.

- Examples:
  - "Macrocells" for custom IC designs: microprocessor
  - Modifiable "default designs" for hairstyles or for houses.

- Modules should make "design sense" to a user-designer. (e.g., not "half a roof plus front door" for house designers, or "sautéed garlic plus onions" for chefs)

(4) Toolkits must enable "first-time," error-free production of user designs

- User design language provided by toolkit must translate to production language without error:

- Sometimes this is easy:
  - Translation from circuit design language (Boolean algebra) to IC producer's digital device fabrication language.

- Sometimes this is hard:
  - Nestle Mexican Sauces toolkit

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Can you profit from toolkits?

- Users will benefit from toolkits in your industry if user needs are heterogeneous.

- If users will benefit, you must offer toolkits – or someone else will and get first mover advantage.

- Your business model may change when you offer toolkits – for better or for worse.

- Example: ASIC foundries profited from a toolkit approach for the first 15 years – and then began to lose profit to specialist toolkit suppliers.

How to start developing a toolkit

- It's OK to start with something rough as long as it offers sufficient value to entice user experimentation.

- You don't need superhuman insight to design and update toolkits – lead users will bump up against the edges of the solution space your toolkit offers and ask for more – or design toolkit improvements for themselves.

- Work with lead customers that **really** need your toolkit and so will be willing to work with you as you refine it.

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