
Unit 7

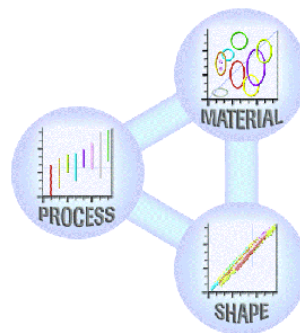
Finding the right material: a strategy for material advising



The CES 4 EduPack

UNIT 7

Finding the right material : a strategy for material advising

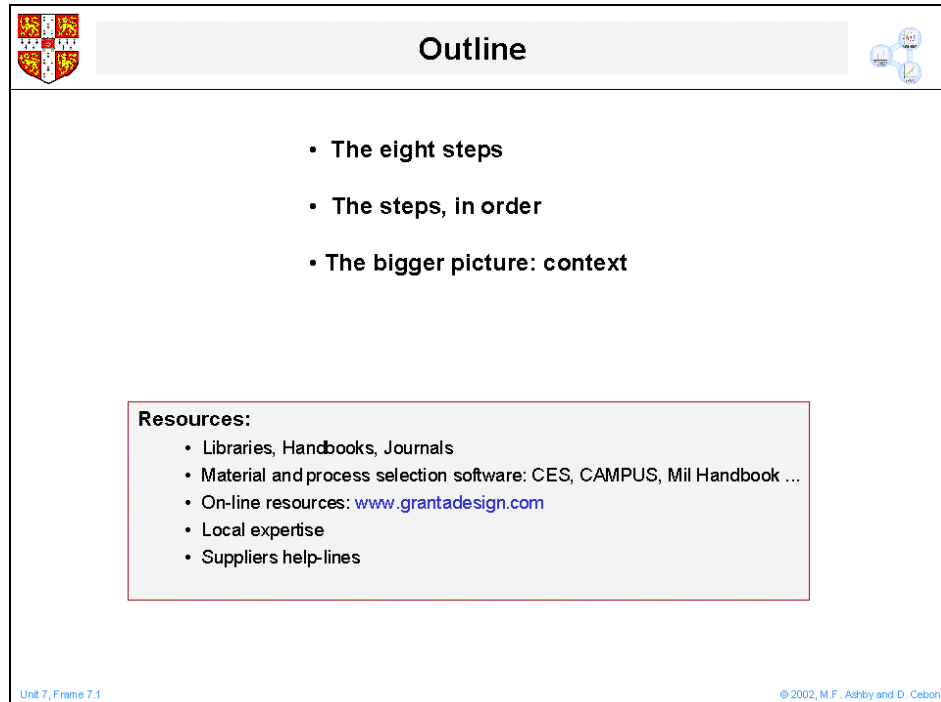


New approaches to Materials Education
- a course authored by
Mike Ashby and Dave Cebon
Cambridge, UK

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Difficulty level 2

Frame 7.1 Outline



The slide is titled "Outline" and features a crest in the top left corner and a small icon in the top right corner. The main content is a bulleted list of three items. Below the list is a box titled "Resources:" containing a bulleted list of five items. The slide footer includes "Unit 7, Frame 7.1" on the left and "© 2002, M.F. Ashby and D. Cebon" on the right.

Outline

- The eight steps
- The steps, in order
- The bigger picture: context

Resources:

- Libraries, Handbooks, Journals
- Material and process selection software: CES, CAMPUS, Mil Handbook ...
- On-line resources: www.grantadesign.com
- Local expertise
- Suppliers help-lines

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Description

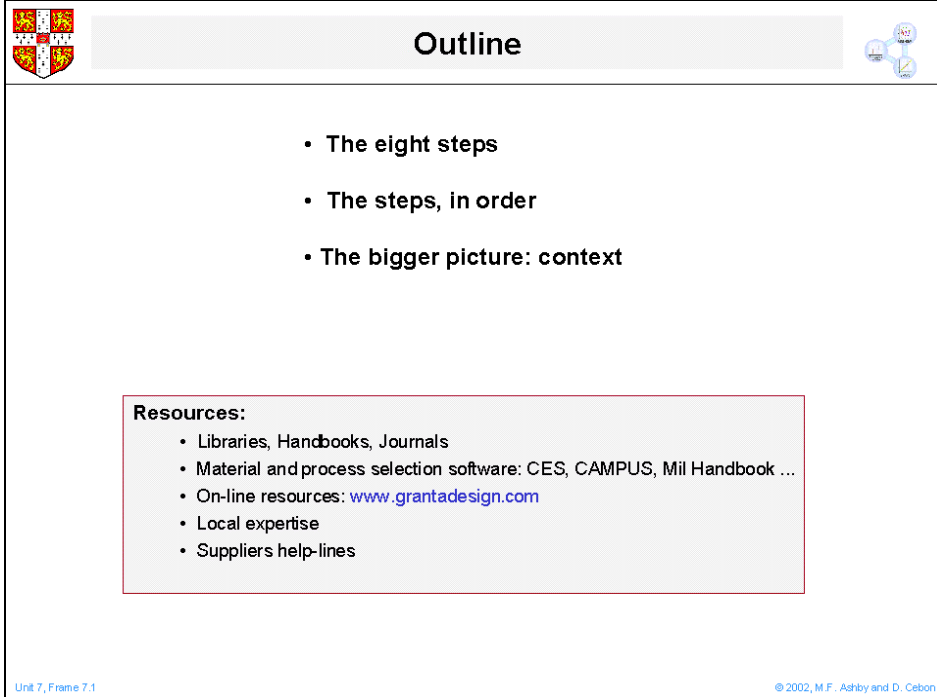
Here we cast the student in the role of a materials consultant. How would he or she go about performing this role? It provides an opportunity to pull together the threads of Units 1-6, and to give an overall structure to a common form of material consulting, answering the question: “What material should I use to make this object?”

Innovative selection of materials and processes requires a good method, good tools and good judgement. This Unit suggests a systematic approach to achieving these. It is prescriptive to the extent of suggesting a progressive series of steps, but it remains flexible in the emphasis and time allocated to each.

Further Information

These notes give background, developed in more detail in the booklet “A Strategy for Materials Advising” by M.F. Ashby, Granta Design, 2002.

Frame 7.2 The eight steps



The slide is titled "Outline" and features a crest in the top left corner and a small circular icon in the top right corner. The main content is a bulleted list of three items. Below this list is a red-bordered box containing a "Resources:" section with a bulleted list of five items. The bottom left corner contains the text "Unit 7, Frame 7.1" and the bottom right corner contains the copyright notice "© 2002, M.F. Ashby and D. Cebon".

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Unit 7, Frame 7.1

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
Description

The flow diagram shows the eight key activities involved in innovative material and process selection. It forms the basis of this Unit, which is designed to support each stage of the decision making.

Frame 7.3 Stage 1: Understand the need

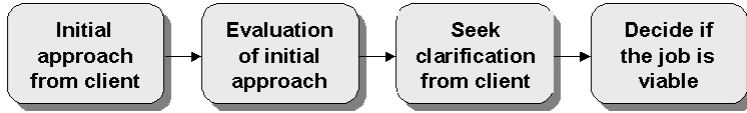


1 Understand the need



Key steps:

- What's the problem? Why is the client seeking help?
- What's the component and what does it do?
- What are the client's perceptions of the constraints and objectives?
- What are the client's preconceptions about materials, processes or solutions?
- What are the client's expectations from the consultation?



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graph LR; A[Initial approach from client] --> B[Evaluation of initial approach]; B --> C[Seek clarification from client]; C --> D[Decide if the job is viable];
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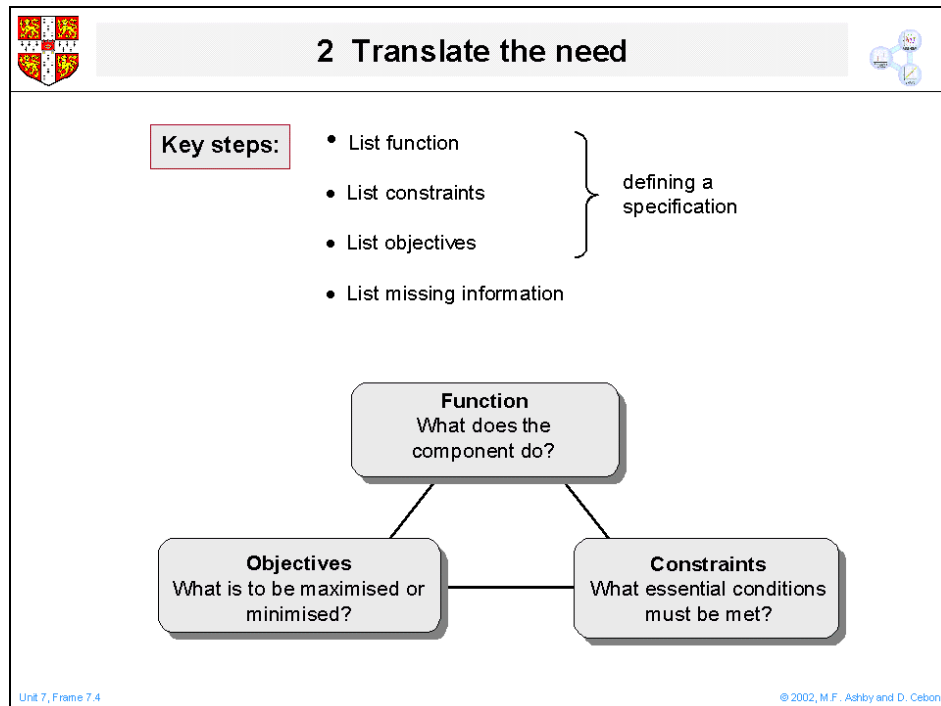
Description

It is usual for the first statement of the problem to be

- Incomplete, lacking essential information.
- Biased, reflecting the client's preconceptions about choice of material and process.

The first task is to illicit enough detail to remove any ambiguities, to define the problem as precisely as possible, and to reach a decision whether to accept or reject it.

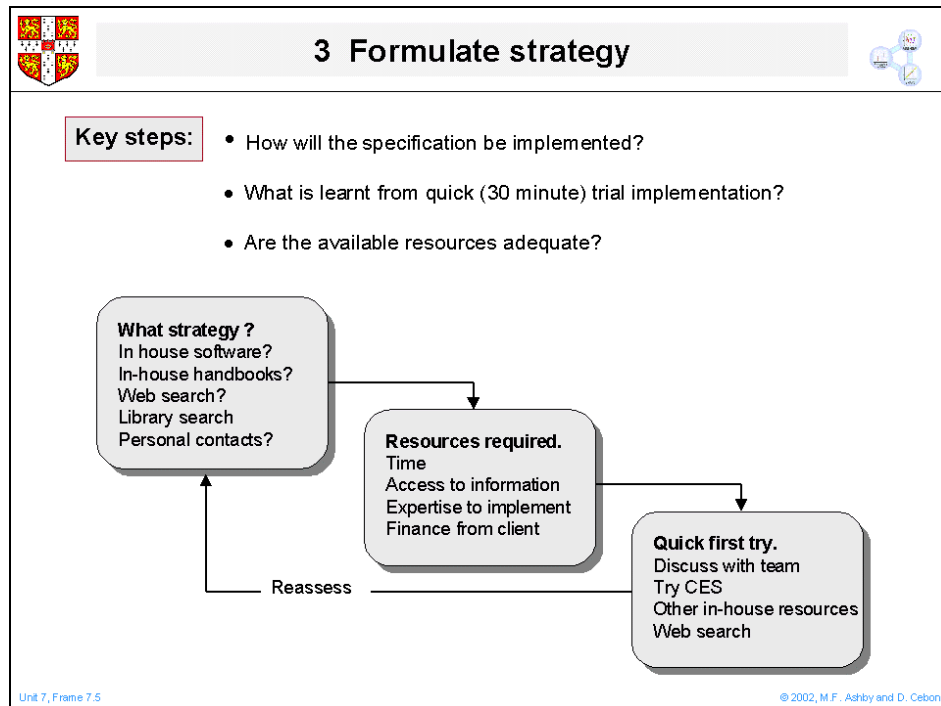
Frame 7.4 Stage 2: Translate the need



Description

Translation means the process of converting the information provided by the client into a specification for material and process selection. The precision and detail of the translation will vary greatly from case to case. At one extreme, the translation yields a full definition of the need, specifying values for all the important attributes. At the other, the translation may reveal ambiguities or a failure to specify key requirements, not even providing enough information to guess them. Then fuller information must be sought from the client. The bullet points identify the information required. It is a general procedure for translation, developing a specification – common sense must be used in the way it is applied.


Frame 7.5 Stage 3: Formulate strategy




Description

A *strategy* is the planned path to one or more solutions to a problem. Its implementation requires tools, expertise and resources. The initial strategy is imprecise: you can't be sure the tools will contain the information, or that you will have the expertise or resources to solve the problem until you try. The best approach is a first cut at a strategy, then a quick trial to see if it will work, followed by a reassessment of the strategy.

Frame 7.6 Stage 4: Implement screening

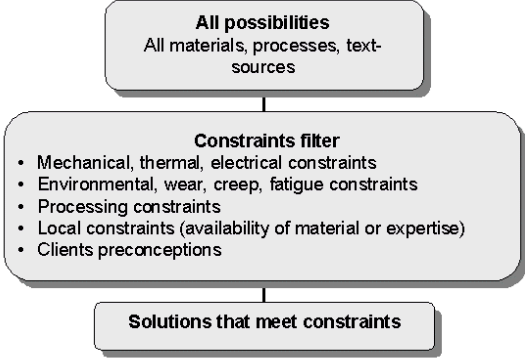


4 Screen, using constraints



Key steps:

- Screen using specified material or process name if given; if not:
- Screen using quantitative constraints
- Screen using qualitative constraints
- Screen using desired similarities



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graph TD
    A["All possibilities  
All materials, processes, text-sources"] --> B["Constraints filter  
• Mechanical, thermal, electrical constraints  
• Environmental, wear, creep, fatigue constraints  
• Processing constraints  
• Local constraints (availability of material or expertise)  
• Clients preconceptions"]
    B --> C["Solutions that meet constraints"]
  
```

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Description

When the client just wants *data* for a specific material or process, “screening” just means looking it up in one of a portfolio of data-sources (see box below). When the task is one of *selection*, “screening” means systematically eliminating materials and processes that are incapable of meeting one or more of the constraints as detailed in Units 2 and 3. It is the first of three steps in implementing a selection.


Resources:

- Handbooks and compilations: see The Text, Chapter 13, Appendix, p. 313 – 333.
- CES and its additional databases: CAMPUS, MilSpec, ChemRes etc.
- The ASM Materials Handbooks, now on-line
- The Worldwide Web Material Portal, accessed directly from CES or via grantadesigh.com.

Frame 7.7 Stage 5: Rank, using objectives

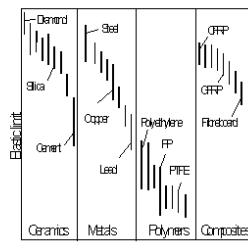


5 Rank, using objectives

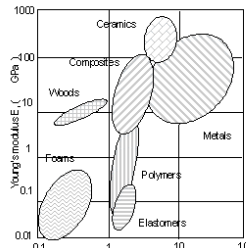


Key steps:

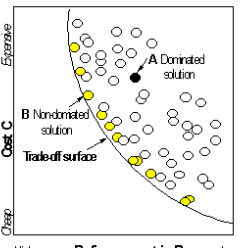
- Rank, using the most important objective.
- Compare ranking by secondary objectives.
- Create trade-off plot to balance objectives



Bar charts



Bubble charts




Trade-off plots

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Description

Sometimes applying constraints (Stage 4) is sufficient to identify promising candidates. Then Stage 5 maybe unnecessary – the investigation passes to Stage 6. More often it is the *objective* that guides the best choice. In selecting materials, it is usual that two objectives – one relating to cost, the other to some aspect of performance – are relevant. In selecting processes, the only objective is that of minimising cost.

Frame 7.8 Stage 6: Find supporting information



6 Find supporting information



Key steps:

- Identify the most promising sources for supporting information.
- Define the time allocated to the search.
- Implement the search.
- Download/copy or otherwise record useful information.
- Re-rank the candidates in the light of the supporting information.

```


graph LR
    A[CD-books  
ASM, B&H...  
Books on line] --> C[Candidates from  
screening and  
ranking stages]
    B[Handbooks,  
Trade publications  
Case studies] --> C
    D[Library  
search] --> C
    E[WWW –  
Granta Weblinks] --> C
    F[Personal  
contacts] --> C
    C --> G[Documented  
candidates  
meeting  
constraints and  
objectives]
  
```

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Description

Supporting information provides the data that cannot be adequately captured in Stages 4 and 5, usually because it is of the sort that is not contained in the structured databases required for screening and ranking. Examples are: detailed data on wear, corrosion and oxidation; case studies (“experience”) in the use of materials; failure analysis; design guide-lines and – often – details of supply and availability.

Frame 7.9 Stage 7: Consider implications

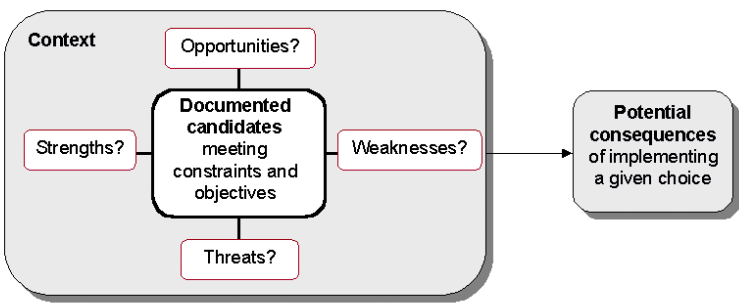


7 Consider implications



Key steps:

- Consider consequences of introducing the new material or process.
- Record potential consequences; strengths, weaknesses, opportunities and threats.



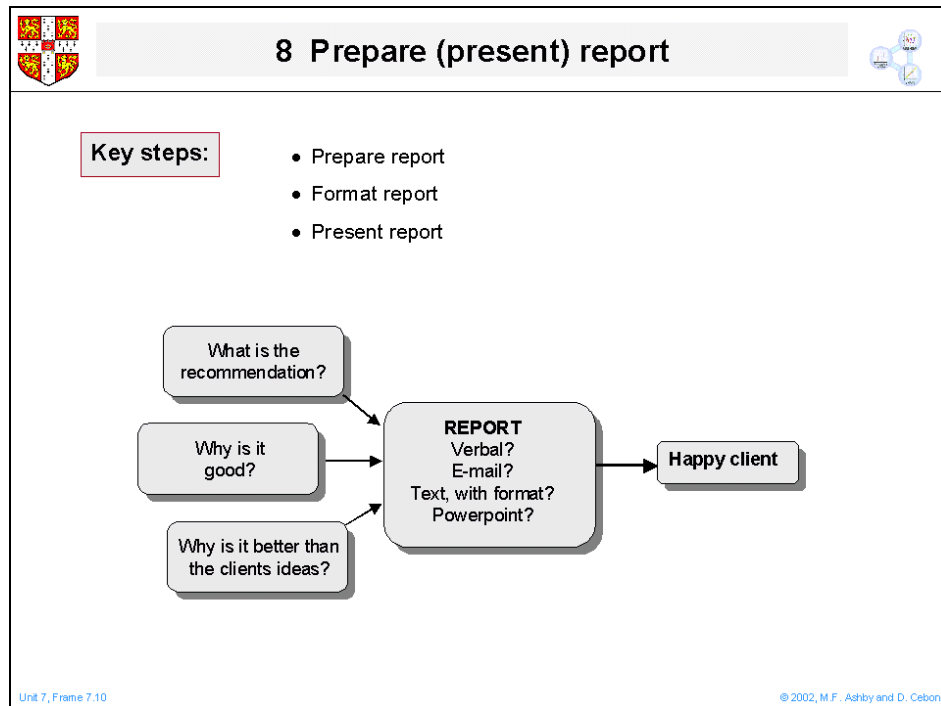
```
graph LR; Context[Context] --- Candidates[Documented candidates meeting constraints and objectives]; Opportunities[Opportunities?] --- Candidates; Strengths[Strengths?] --- Candidates; Weaknesses[Weaknesses?] --- Candidates; Threats[Threats?] --- Candidates; Candidates --> Consequences[Potential consequences of implementing a given choice]
```

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Description

Focus on the specific task of selecting a material or process can deflect attention from the bigger picture – the *context* in which the solution will be used. This is the stage to defocus and examine the consequences that might follow from adopting one or other from the final list of candidates. This is a quick task, requiring common sense rather than special skills.

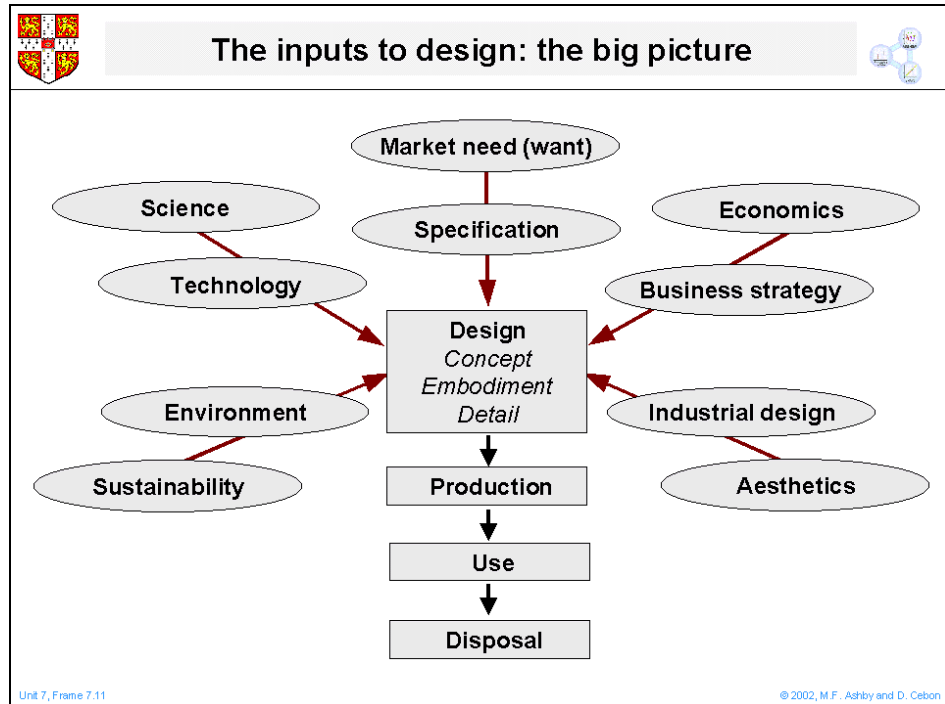
Frame 7.10 Stage 8: Prepare (present) report



Description

The report is the deliverable. Present no more than is necessary (1 page with advice, contact points and comment on alternatives and consequences may be enough), but present it in a way that is adapted to the clients needs and that demonstrates a professional approach.

Frame 7.11 The bigger picture



Description

A design seeks to meet a market need. The central column follows the path developed in Unit 1: the Design process (concept, embodiment, detail) leading to production, use and disposal. In this picture the *market need* is the driver; the degree to which the need is satisfied is the measure of success. But, in thinking through the implications of a material or process choice, other drivers should be considered too. Clockwise from the top left:

- New developments in science and technology can make the “standard” solution to a problem obsolete. It is important to be aware of innovations that bear on the clients problem.
- The economic climate and attitude to risk within a company condition the way it will react to suggestions for change. It is well to be sensitive to these.
- Industrial design and aesthetics play an important role in creating market demand. The potential for a material or process choice to enhance these is may influence the final decision.
- There is an increasing awareness of the impact of manufacturing on the environment, and growing pressure to avoid the used of certain materials and processes because of their contribution to this. The use of eco-benign materials and processes, and the ability to recycle or reuse exert a growing influence on choice.