

# Scale-Up of Chemical Engineering Process

## Chapter 2: R & D and Commercialization

by  
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## Current Malaysian R & D

- **Commercialization success rate:**  
**8-10% [Malaysian companies]**  
**15% [Developed Countries]**

(Source : Bernama Aug 14, 2014)



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# Scale Up Considerations

- Economical
- Raw materials
- Production vulnerability
- Logistics
- Social
- Mechanical and technical restrictions
- Start-up, management, maintenance
- Safety



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# Major Issues in Scale-up

- Unexpected problems in a commercial manufacturing operation (laboratory scale was fine)
  - examples : impurities not encountered during pilot scale; flow stability; materials; flow pattern; determination of explosive limits; waste disposal; storage of unstable materials; logistics of raw materials; utilities requirement
- Mode of operation : batch vs continuous vs semi-continuous



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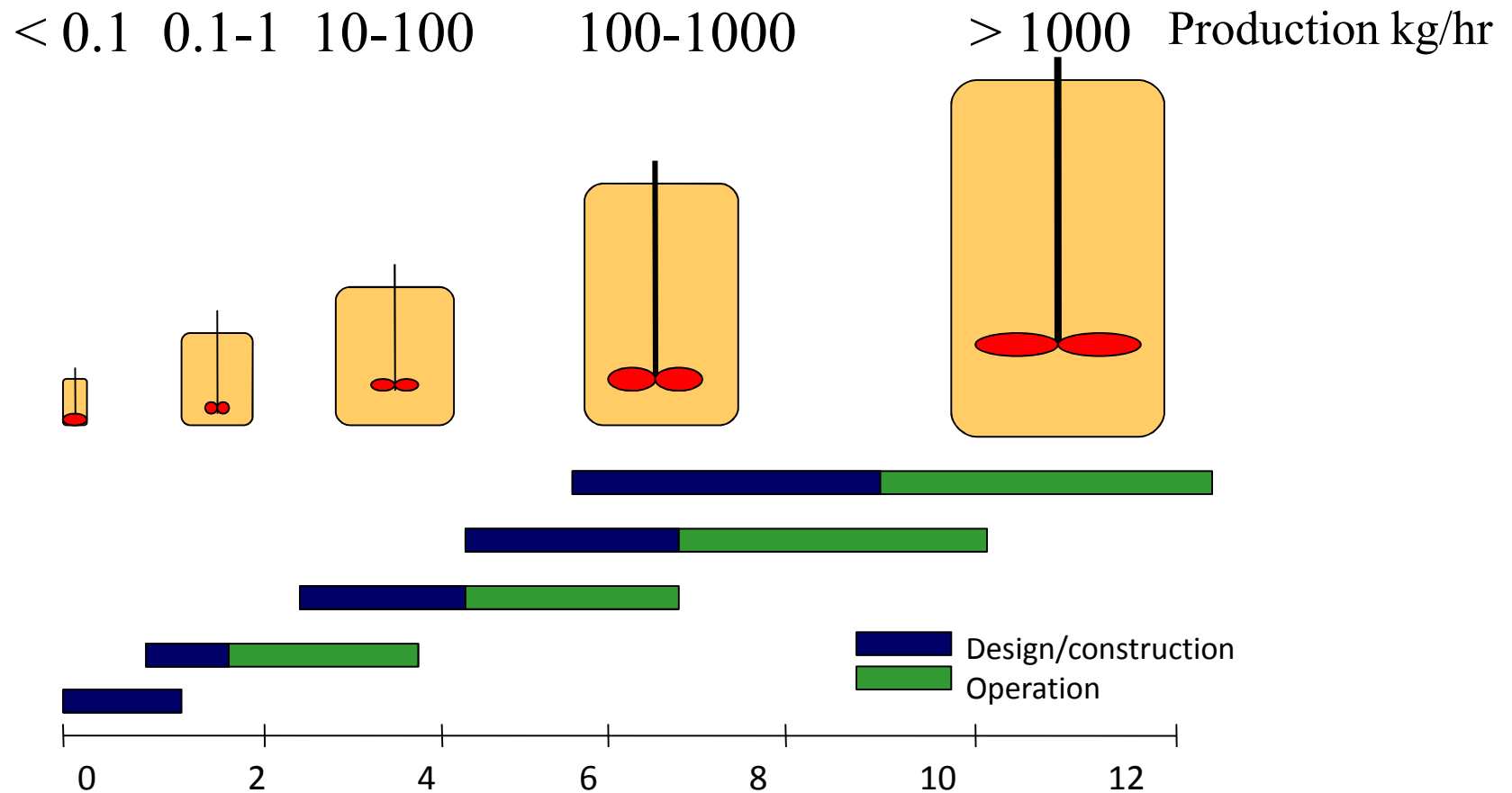
# Approaches to Scale-up

- Full scale test (existing plant)
- Modular scaleup (limited scaleup)
- Known scaleup correlations (available from previous studies)
- Fundamental approach (proper modeling)
- Empirical approach (sequential)



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# Timeline Vs Scale



(Source : Chemical Process Technology by Moulijn et. al. 2001)



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# Commercialization Stages

- **Development of an idea**
- **Market survey**
- **Champions of the idea**
- **Budget allocation**
- **Stage gate process**
- **Small scale / pilot plant**
- **Semi work**
- **Economic models**
- **Samples to customers**
- **Customers commitment**
- **Contracts signed**
- **Approved for expenditure**



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# Factors Affecting Scale-up

- Overall process understanding
- Physico-chemical phenomena
- Similitude – geometric vs dynamic
- Business plan (customer requirement; timeline including when to sell; pricing)
- Local and international regulations (osha; epa)
- Product quality
- Availability of raw materials



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# Success Factors of Scale-up

- **Multidisciplinary**
- **Strong R & D back-up**
- **Sufficient budget**
- **Details**
- **Customers relationship**
- **Thorough market survey**
- **Solid organization**
- **Raw materials availability**
- **Infrastructure**
- **Competent manpower**



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# Author Information

**Credit to the author:**

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