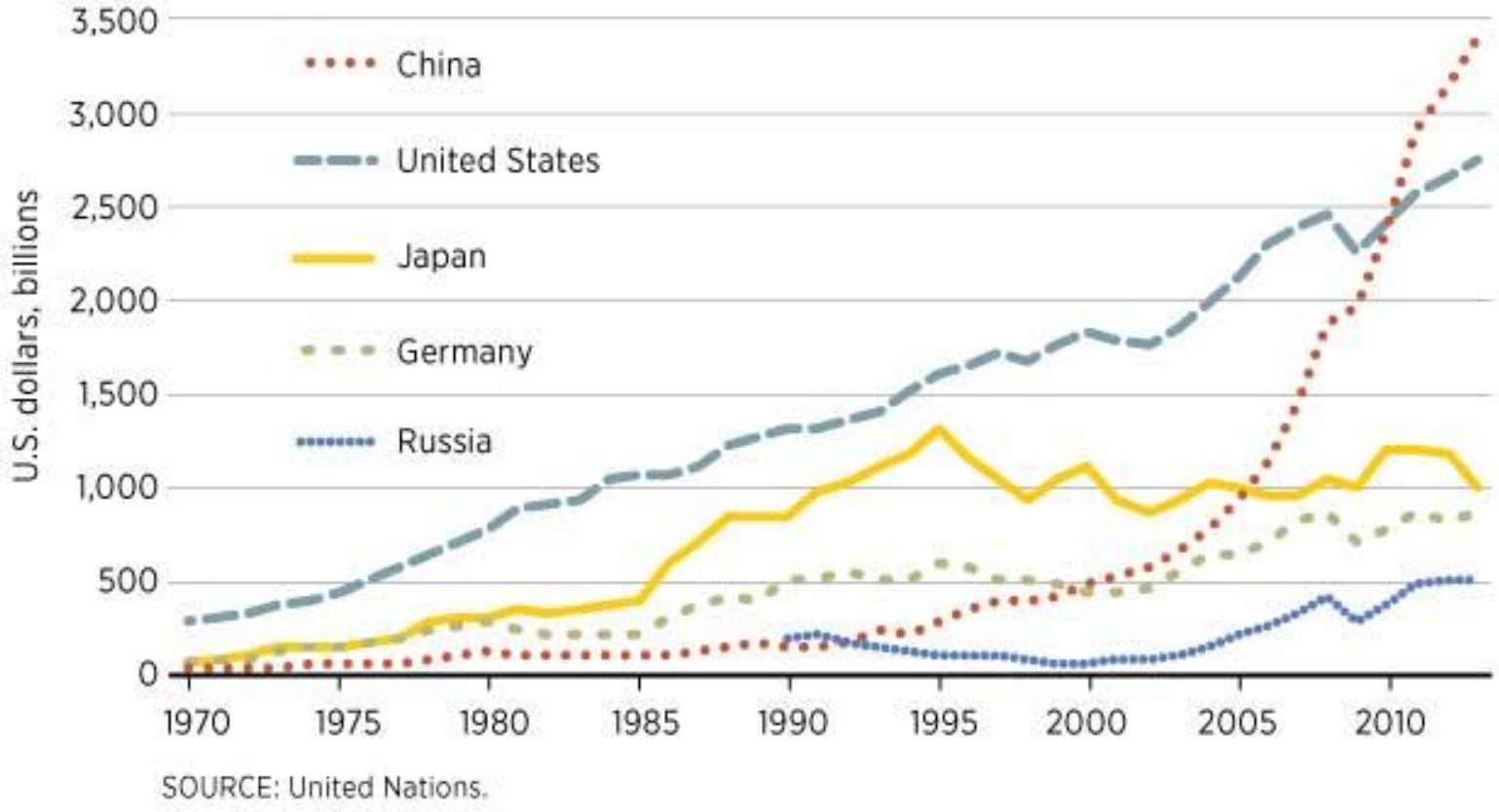
Manufacturing Technology II

LESSON 1 INTRODUCTION

COURSE OUTLINE

- **Overview of machining processes**: Traditional and non traditional machining processes.
- **Mechanics** of single and multi-tooth cutting processes.
- **Modeling, analysis and control of machining processes**. Measurement of cutting forces and chip thickness. Dynamics of cutting processes; chatter vibration. Cutting tool materials, performance and cost.
- **Planning for machining**.
- **Lasers in Manufacturing**: Classes of lasers, types and components of lasers, general application of lasers, laser beam machining, welding with lasers, engraving and cladding, laser micromachining.
- **Product/mold design and small batch production**: Rapid prototyping; Stereolithography, Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS), Laser Engineering Net Shaping (LENS), Fused Deposition Modelling (FDM). Recent developments in manufacturing processes and manufacturing systems.

Manufacturing Output for Top Five Countries in 2013



FEDERAL RESERVE BANK OF ST. LOUIS

Why is China leading in Manufacturing today?

DISCUSSION

- **Reasons for China's rapid advance**:
  - Manufacturing of new products → **custom tooling**
  - Mass production of parts
  - Close tolerance of precision engineering in the micro/nano scale
    - Example: Economies of tooling: 3D CAD design drawings and technical information is supplied to the manufacturer to produce tooling for the parts

- **Snap back to Kenya**: *Jua Kali* sector – Are we doing well? If not, how do we improve?

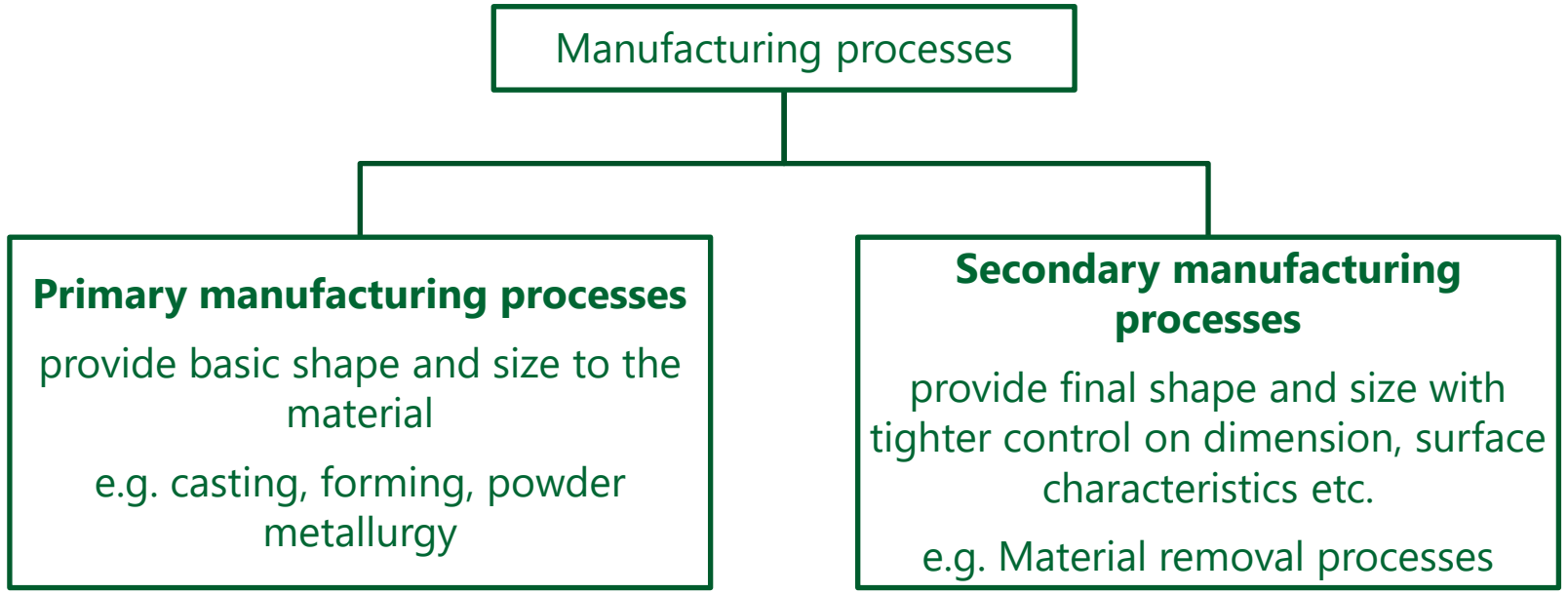
WHAT IS MANUFACTURING?

- **Manufacturing**: **value addition processes** by which raw materials of **low utility** and value (due to its inadequate material properties and poor or irregular size, shape and finish) are **converted into high utility** and valued products with definite dimensions, forms and finish to perform a specific function.

DEFINITIONS

Manufacturing processes: science and technology of manufacturing products effectively, efficiently, economically and in an environmental-friendly manner through:

- Proper selection of input materials, tools, machines and environments.
- Improvement of the existing materials and processes
- Development of new materials, systems, processes and techniques



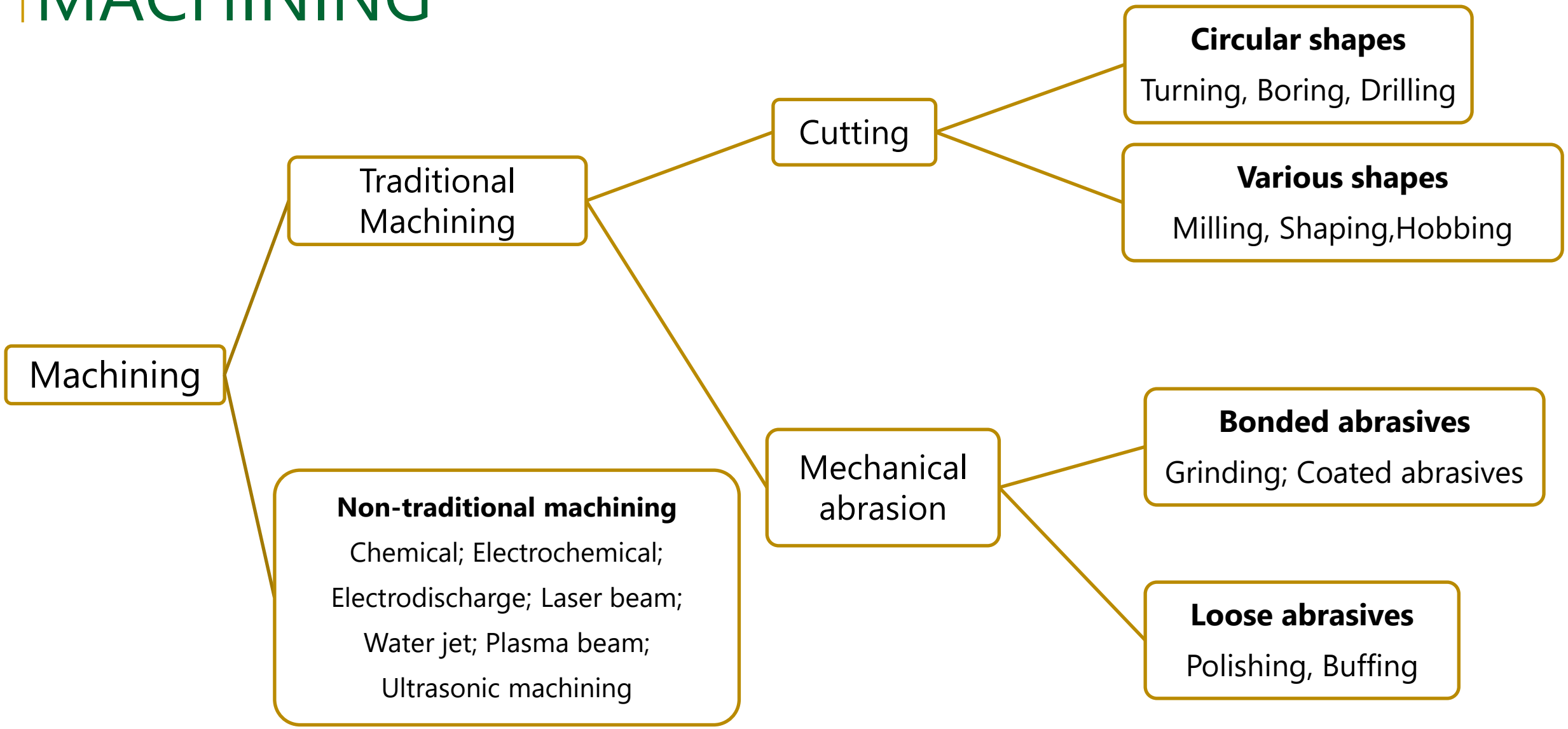
MACHINING

- Removal of material from the workpiece (machining allowance) in order to produce a specific geometry at a definite degree of accuracy and surface quality.
- Machining is classified into two:
  - Traditional machining
  - Non-traditional machining

TRADITIONAL MACHINING

- A tool harder than the workpiece to be machined is penetrated in the workpiece to a certain depth.
- Relative motion between the tool and workpiece is responsible for generating the required shape.
- Classified into:
  - **Machining by cutting**: tool is penetrated in the work material to the depth of cut.
  - **Machining by abrasion**: Material is removed by a multitude of hard, angular abrasive particles or grains (also called grits), which may or may not be bonded to form a tool of definite geometry.
    - Individual cutting edges are randomly oriented and the depth of engagement is small and not equal for all abrasive grains that are simultaneously in contact with the workpiece.

MACHINING


Machining
Traditional Machining
Cutting
Circular shapes
Turning, Boring, Drilling
Various shapes
Milling, Shaping,Hobbing
Mechanical abrasion
Bonded abrasives
Grinding; Coated abrasives
Loose abrasives
Polishing, Buffing
Non-traditional machining
Chemical; Electrochemical;
Electrodischarge; Laser beam;
Water jet; Plasma beam;
Ultrasonic machining

LIMITATIONS OF TRADITIONAL MACHINING

- Traditional Machining is limited by:
  - The need for more complex shapes
  - Tight tolerance in micro- and nano- components
  - Higher surface quality requirements
  - Harder to machine engineering materials with improved thermal, chemical, and mechanical properties
  - Low-rigidity structures

NON-TRADITIONAL MACHINING

- Absence of tool-workpiece contact or relative motion.

Mechanical	Thermal	Chemical
Machining medium: ▪ Solid grains suspended in abrasive slurry (ultrasonic machining) ▪ Fluid jet (Water jet machining)	Material is removed by melting or vaporizing the workpiece. – Electrodischarge machining – Electron beam machining – Laser beam machining – Ion beam machining – Plasma beam machining	Material is removed through chemical dissolution – Chemical machining – Electrochemical machining

- Additive manufacturing: Rapid prototyping, LENS, Near net shaping etc.

TRADITIONAL VS. NON-TRADITIONAL MACHINING

Traditional machining	Non-traditional machining
Cutting tool and work piece are always in physical contact with relative motion with each other	No physical contact between the tool and the workpiece.
Material removal rate depends on mechanical properties of work material	Can machine, difficult to cut materials such as titanium, ceramics.
Difficult to produce 3D surfaces. Relative motion between the tool and work is rotary or reciprocating.	Capable of producing complex 3D shapes and cavities
Difficult to machine small cavities, slits, blind holes	Can machine small cavities, slits and production of non-circular, micro-sized, large aspect ratios
Use relative simple and inexpensive machinery & readily available cutting tools.	Requires expensive equipment, skilled labour, which increase the production cost significantly
Low capital and maintenance cost	High capital and maintenance cost
Mostly use mechanical energy	Use energy in direct form
Surface finish and tolerances are limited by machining inaccuracies	High surface finish (0.1 m) and tolerances (25 m) can be achieved
High metal removal rate	Low material removal rate

GROUP EXERCISE

Identify the manufacturing processes that are carried out in Kenya in the following industries:

Group 1: Energy sector

Group 2: Food processing

Group 3: Aerospace

Group 4: Textiles/Packaging