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Libyan Manufacturing for Desalination Plants

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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Outline

- Libyan manufacturing capacity
- Desalination schedule
- Membrane components
- Machining techniques
- Manufacturing improvement
- Recommendations

Mindset Importance

R&D Environment	versus	Manufacturing Environment
Derives processes as experimenters do research on the process		Has preset detailed instructions/drawings that communicate pre-engineered process
Make changes to their processes real time		Formal change approval process
Use lab book for documentation as experiment matures		Use inflexible structure of written instructions and approvals
Experimental process is flexible as research and experimentation unfolds		Objectives are clearly defined by end specifications, and not very flexible
Objective is find best, most accurate way		Goal is to produce perfect product on time
Time can be taken to get it right		There is flexibility, but within controlled schedule

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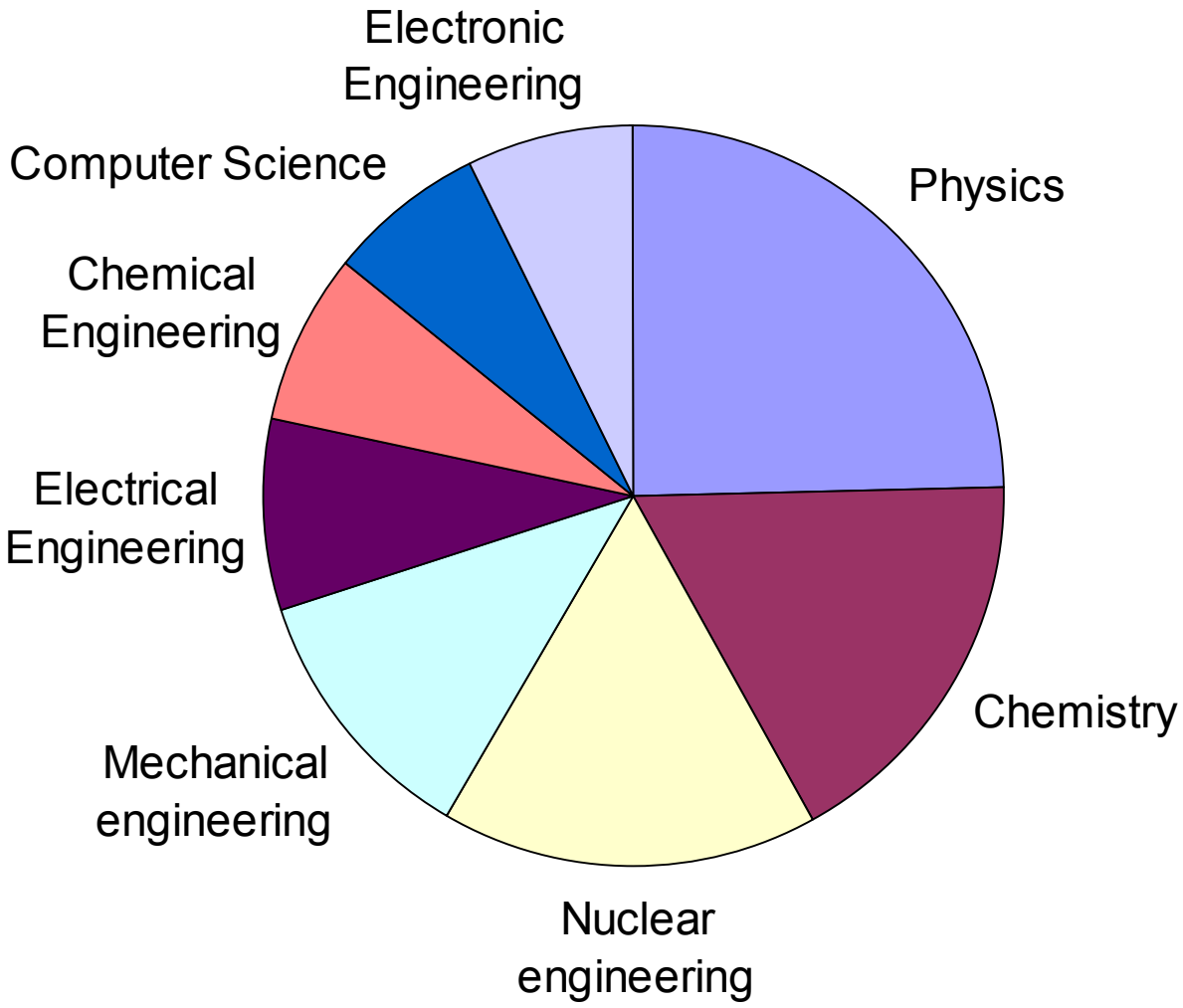
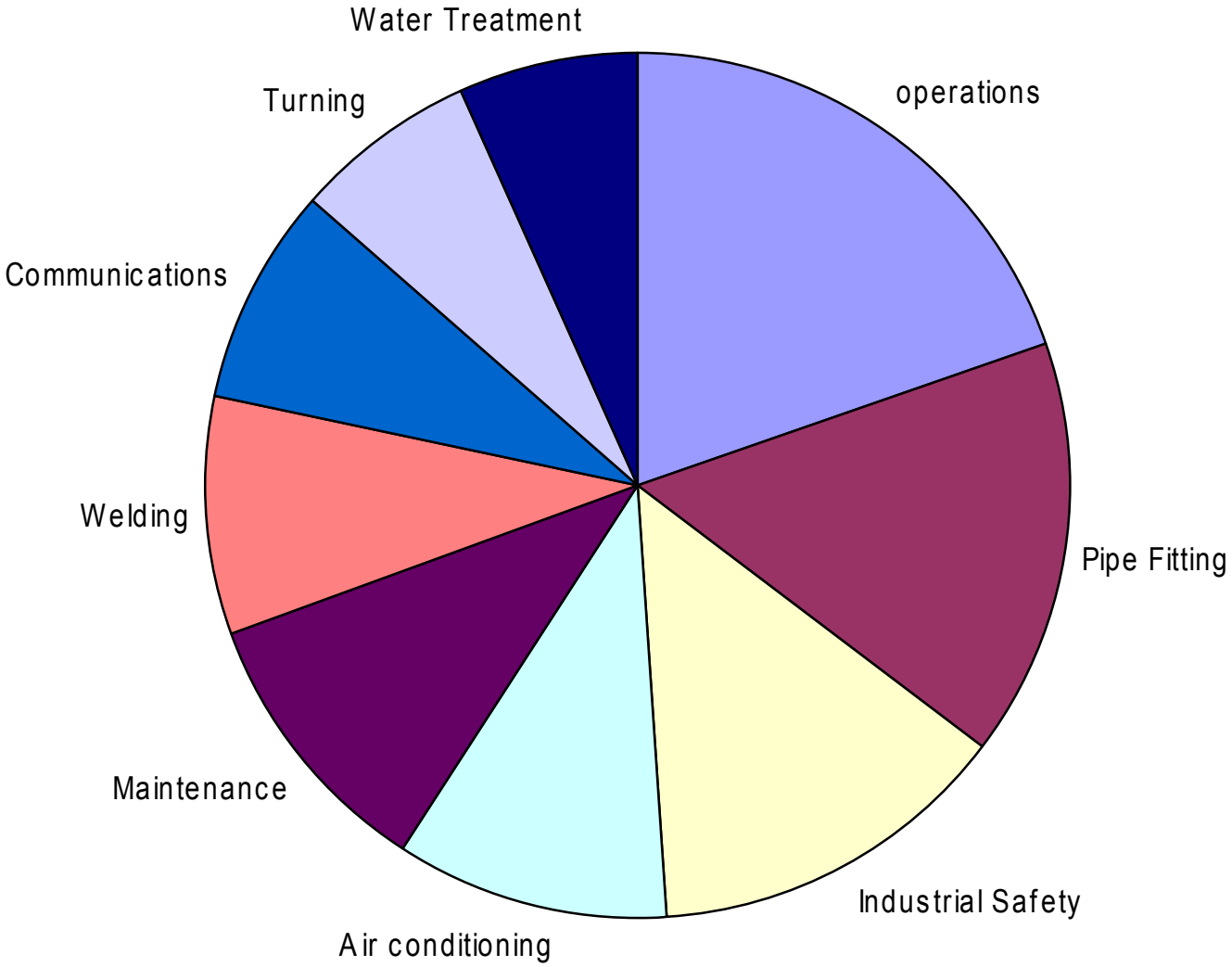
Degreed Staff at Tajoura (~300 people)



Technicians (150)



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Desalination Training Workshop

- 6000 ft^2
- 4 components: Design, Build, Construct, Move

Drilling Tube Supports

- **Needs:**
  - **Design for manufacturability**
  - **Vocational training curriculum**
  - **Instructor training**
  - **Component focus**

MSF Equipment for Training

MED Test Product

- Condenser in foreground was built in workshop

Libyan Water Desalination Processes

Share %			
2000	1990	1980	
62	**77**	**84**	**MSF**
18	**12**	**4**	**RO**
9	**10**	**12**	**ED**
11	**1**	**0**	**ME+VC**

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Libyan Desalination Schedule

- 100,000 m^3/day at present
- 1,000,000 m^3/day in 10 years.
- Average size = 40,000 m^3/day
- ~ 20 plants to be built
- Membrane vs. Thermal vs. Hybrid??
- ~$1 billion for capital costs
- Needs: vessels, pipes, pumps

Membrane Element Construction

The center tube - Also called permeate collection tube, is the center of the element around which membrane leaves, permeate carrier and spacer material is wound. Materials typically include:

ABS

- typically are used in low pressure, ambient temperature environments with few chemical compatibility problems.

PVC

- selected when an inexpensive material is needed for high-pressure, seawater applications.

Polysulfone

- used under conditions of wider temperature and pH ranges, and is resistant to many chemicals.

Aluminum

- used in extremely high-pressure environments.

Stainless steel

- used in extremely high-pressure environments when chemical resistance is also required.

Membrane Components

Anti-telescoping device - fill the space between elements in a pressure vessel, center the element within the housing and facilitate flow from one element to the next.

The inter-connector - connects the center tubes of neighboring elements and directs flow of the permeate to one or both ends of a pressure vessel.

The product end adapter and dead-end plug - open-end adapter or closed dead-end plug is used, depending on whether permeate will flow from both ends or one end of the element.

The permeate carrier - a sheet of material inserted between the backsides of the membranes, forming a membrane envelope to promote the permeate flow towards center tube for discharge at the ends.

The feed spacer - inserted between neighboring membrane surfaces to create the best membrane flow conditions:

Diamond pattern - This spacer is the most popular.

Parallel pattern - This configuration prevents suspended solids fouling with turbulence.

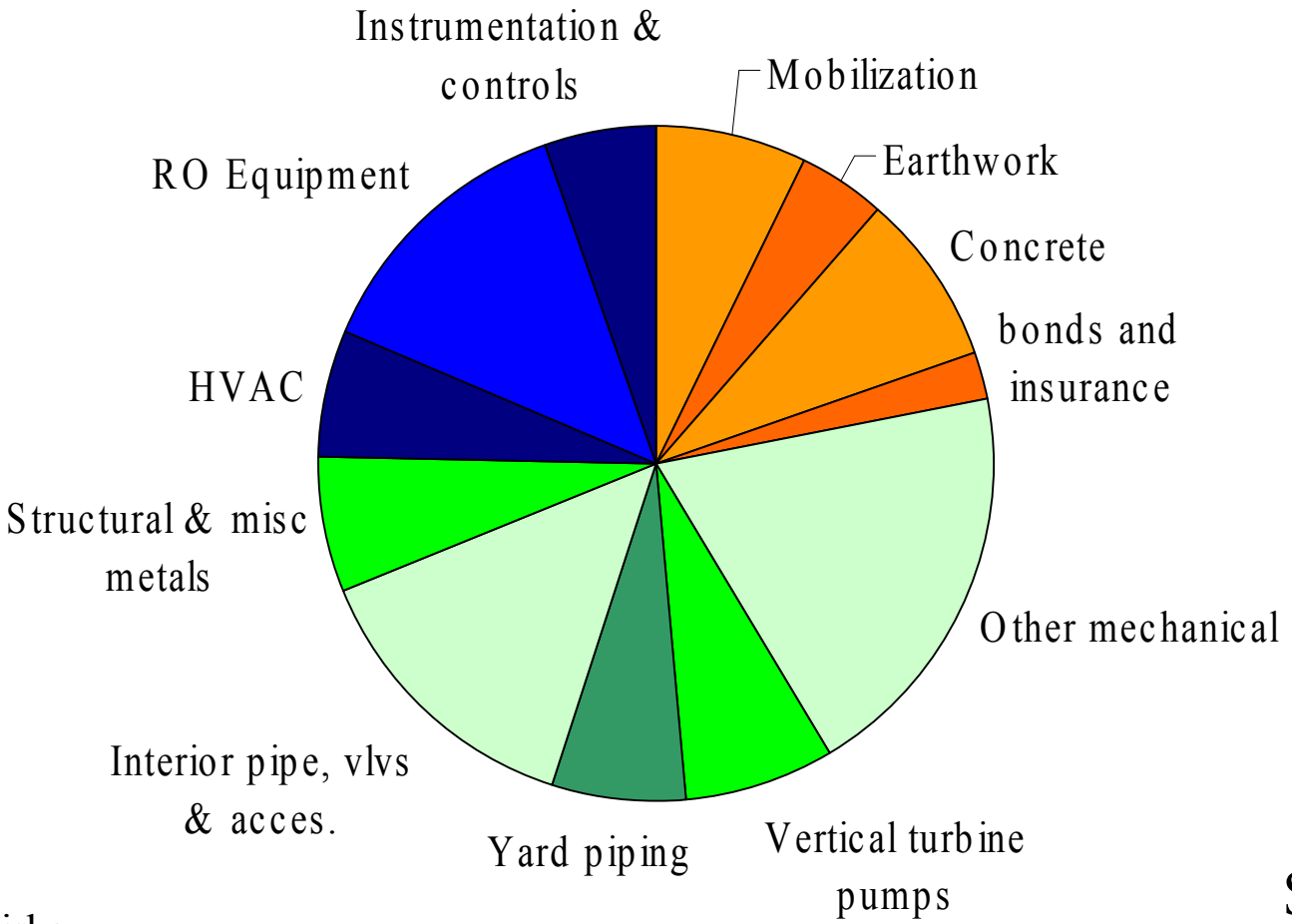
Corrugated - forms discrete flow channels over the membrane surface.

The outer wrap - The tape-wrapped option is used for light duty cases, such as low pressure water purification. A fiberglass wrap will support the element under higher pressure applications.

Adhesive sealant - Standard types of adhesive sealant typically are used to form membrane envelopes of high mechanical integrity.

Costs of 67,000 m^3/day RO Plant

El Paso, Texas, USA



Joseph D. Chwirka, P.E., CDM

$20M USD Total Capital

Membranes to Machining

- Membrane modules and components will be difficult but not impossible to manufacture
- Low cost, marginal quality membranes may provide cost-effective strategy
- 50% (~$500M) can be affected by metal manufacturing locally
- Manufacturing capacity is going to benefit Libya.
- Efficiency in manufacturing, energy, operations are all costs that need to weighed together

Machining Types

Heavy Machining

Machines capacity of 25,000 kg and 2 meters long

Project Machining

Machining services and project management

Rapid Turnaround

Rapid response to manufacturing needs

Miniature Machining

Microscopic machining

Composite Machining, Grinding & Polishing

Machining of non-metals

Explosive Processes

Explosives machining by remotely operated equipment

Sandia Machining Activities

Manufacturing Liaison

The electronic and mechanical liaison group works with onsite shops and outside suppliers.

Welding, Fabrication & Assembly

Onsite or remote welding, assembly and repair

Precision Metal Forming

Aircraft quality sheet metal fabrication

Heat Treatment

Hardening, normalizing, annealing

Machine Repair

Preventative maintenance and repair of machine shop equipment

Abrasives

Grinding and lapping of materials

Mechanical Measurements

In-process and final dimensional measurements of components

Calibration

Length, mass, force, and dimensional reference standards

Vulnerabilities

- Operator certification expired
- Tools/equipment out of calibration
- Expired shelf life materials
- Nonconforming and conforming hardware mixed
- Not following procedures
- Using procedures improperly Red-Lined or changed
- Unauthorized use of material

Training Objectives

Knowledge Applied on the Job	Skills Affecting Costs
The ultimate value of training is how it is applied on the shop floor. Goals should include: • *Reduced scrap and rework. • *Decreased tooling costs. • *Shorter setup times. • *Avoid machine damage • *Safety	Training ultimately improves cost performance. Want to deliver results that: *Reduce the overall cost of training. *Enhance workplace productivity and performance. *Reduce operational costs. *Enhance the employee work environment.

Lean Manufacturing Terms

Agile Manufacturing
Computer-Aided Design
Computer-Aided Manufacturing
Computer-Integrated Manufacturing
Computerized Process Simulation
Concurrent Engineering
Continuous Improvement
Cross-Functional Teams
Customer Reject Rate
Defects Per Unit
Design for Manufacturing & Assembly
Empowered Natural Work Teams
Failure Modes and Effects Analysis
Finite Element Analysis
First-Pass Yield
Flexible Assembly Systems
Flexible Machining Centers
Flexible Manufacturing Systems
Flow - Focused Factory Production
Forecast/Demand Management
Just-in-Time (JIT)
Level Scheduling
Life Cycle Costing
Machine Availability Rate
Manufacturing Cycle Time
Natural Work Team
Pass-Through Yield
Predictive Maintenance
Problem-Solving Methodologies
Processing Time
Product Data Management
Productivity Increase
Queue Time
Rapid Prototyping
Real-Time Feedback
Self-Directed Natural Work Teams
Shop-Floor Data Collection
Single Minute Exchange of Dies
Statistical Process Control
Total Cost of Quality
Work-in-Process Inventory
Yield Improvement

The 6 S's

Sort
Clearly identify items needed for current work. Remove anything not needed.

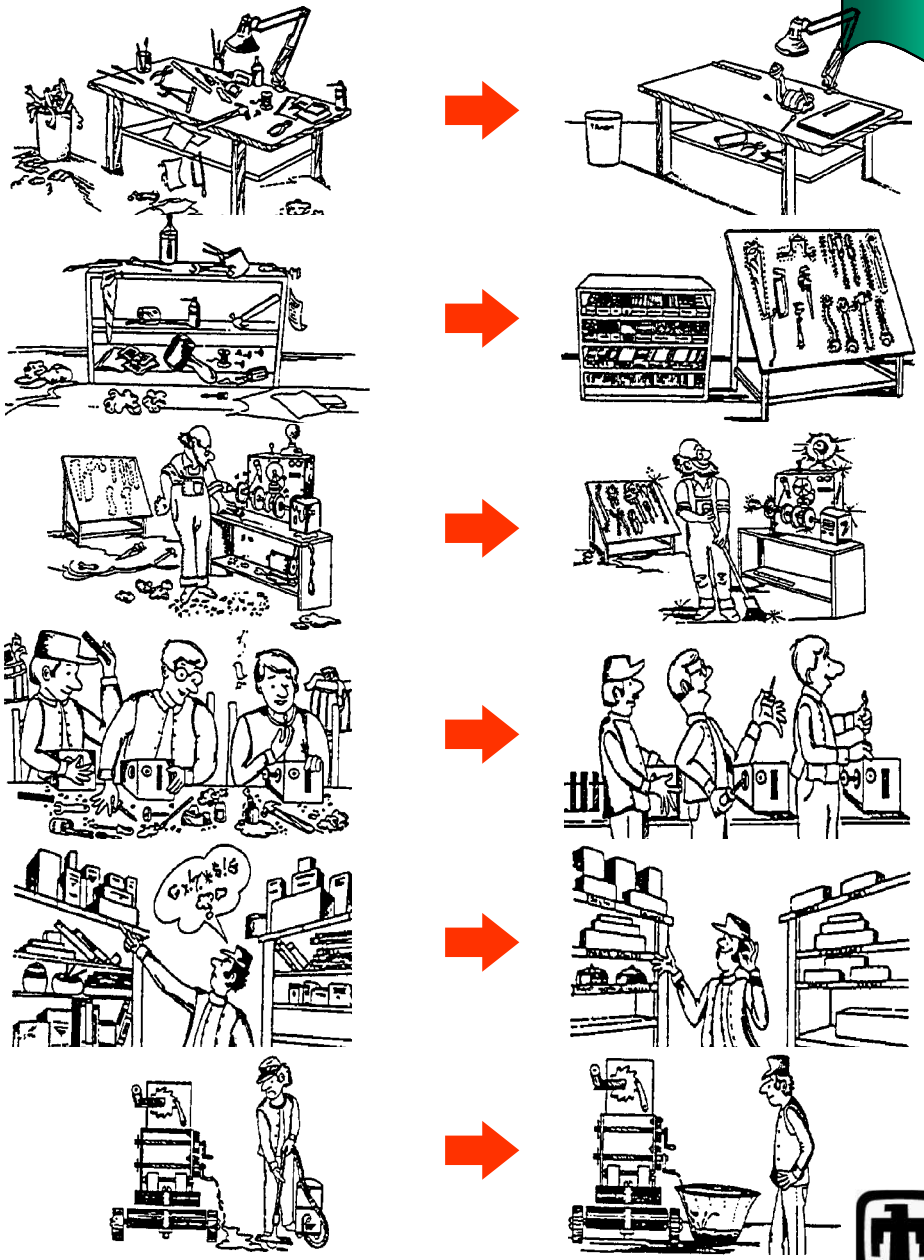
Straighten
Place for everything, and everything in its place. Label to ensure everything is available.

Shine
Keep the workplace neat and clean so that problems are easy to identify.

Standardize
Develop methods, policies, and checklists to support the first four steps.

Sustain
Make a habit of maintaining and improving all of the established standards.

Safety
Identify and reduce or eliminate potential hazards and dangers. "Make it SAFE!"



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6S Benefits

- Reduce walking, reaching, storing, waiting, downtime, inventory, waste/errors
- Lower span times and learning curve
- No wondering, wandering, searching, asking, clutter
- Improved safety, employee morale, cleanliness
- Shop status is evident to all
- Increase floor space

6S Improvements at Sandia





Before (top) and after (bottom) pictures show the 6S difference at three levels. Left, the overall workspace is spacious, organized and uncluttered. Center, new workstations are functional and ergonomic. Right, hand tools are organized and easy to find.

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Other Manufacturing Opportunities

- Petroleum industry
- Heating/Cooling
- Automobile
- Water reuse
- Construction
- Machinery

Recommendations

- Advisory team help with direction
- Work with suppliers and customers
- Build manufacturing facility according to lean manufacturing principles
- Consider alternative products and applications
- Continue staff training and development
- Look to export product (Algeria)

Why Sandia?

- Water-energy-food vision
- Department of Energy's manufacturing lab
- Neutral 3rd party or independent evaluator
- Cooperative Monitoring Center at Amman
- Assisted Russian labs in manufacturing

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Questions?