GMS401 – Midterm #2

GMS401 – Chapter 7: Design of Work Systems

Introduction and Job Design

- Work system design involves:
  - *Job design* (content and method)
  - Determination of working conditions
  - *Work measurement* (i.e. establishment of standard times)
  - *Compensation*
- Current practice in job in job design contains elements of 2 basic schools of thought:
  - The efficiency school – emphasizes a systematic, logical approach to labour cost reduction
  - The behavioural school – emphasizes satisfaction of wants and needs of workers as motivator for increased productivity

Efficiency approach

- Includes:
  - Specialization – focuses jobs to narrow scope
  - Methods analysis
  - Time standards
- The seriousness of the problems with assembly-line specialization caused job designers to seek the behavioural approach

Behavioural approach

- Job enlargement – giving a worker a larger portion of the total task
  - Horizontal loading – additional work is on the same level of skill and responsibility
  - Sequence of activities instead of only one for a manufacturing worker
- Job rotation – workers periodically exchange jobs
  - Broadens learning experience, allows workers to fill in for absent workers, avoids injuries caused by repetitive physical work
- Job enrichment – increasing responsibility for planning and coordination
  - Vertical loading
- Self-directed teams – groups who perform the same function and are empowered to make certain decisions and changes in their work
  - Sometimes referred to as an autonomous team
  - Better suited than management to make decisions since they are close to their work
  - Fewer managers necessary, higher quality, productivity, and worker satisfaction

Methods analysis

- Methods analysis – breaks down the job into a sequence of tasks and elements and improves it
- Basic procedure –
  - Identify the job to be studied and gather all pertinent facts about its operations, machines, equipment, materials, and so on
  - Discuss the job with the operator and supervisor
  - Analyze and document the present method of performing the job
  - Question the present method and propose a new method
- Analyzing and improving methods is facilitated by use of:
  - Process charts – chart used to examine the overall sequence of an operation by focusing on movements of the operator or flow of material
  - Worker-machine chart – used to determine portions of a work cycle during which an operator and equipment are busy or idle

Motion study

- Motion study – systematic study of the human motions used to perform an operations or task
  - Purpose is to eliminate unnecessary motions and to identify the best sequence of motions for max. efficiency
- There are a number of different techniques or tools that motion analysts can use to develop efficient procedures:
  - <u>Motion economy principles</u> – guidelines for designing motion-efficient work procedures
    - Divided into 3 categories – use of arms and body, arrangement of workplace, and design of tools and equipment
  - <u>Analysis of elementary motions</u>
  - <u>Micro-motion (show-motion video) study</u> – use of motion pictures and slow motion to study motions that otherwise would be too rapid to analyze
  - <u>Simultaneous hands motion chart</u> – also known as Simo chart
    - Simo chart – a chart that shows the elementary motions performed by each hand, side-by-side, over time

Working Conditions

- Temperature and humidity
- Ventilation
- Illumination
- Noise and vibrations
- Work breaks
- Safety
- Ergonomic – fitting the job to the worker's capability and size

Work Measurement

- Work measurement – determining how long it should take to do a job
- Standard time – the amount of time it should take a qualified worker to complete a specified task, working at a sustainable rate, and using given methods, tools and equipment, raw materials, and workplace arrangement
- Organizations develop standard times in a number of ways:

Stopwatch time study

- Development of a standard time based on observations of one worker taken over a number of cycles:
    - Define the job to be studied, and inform the worker who will be studied
    - Determine the number of cycles to observe
    - Time the job, and rate the worker's performance
    - Calculate the standard time, allowing for rest periods
- The number of cycles that must be timed is a function of three things:
    - The variability of observed times
    - The desired accuracy
    - The desired level of confidence for the estimated job time
    - Refer page 234 for examples
- Development of standard time actually involves calculation of three times:
    - Observed time – average of recorded times
    - Normal time – observed time adjusted for the worker's performance
    - Standard time – normal time multiplied by allowance factors such as taking a washroom break, machines adjustments, and talking to a supervisor

Predetermined element times

- Published data based on extensive research on element times
    - Times of the basic elements are measured in Time Measurement Unit (TMU)
    - One TMU equals .036 second

Work sampling

- Technique for estimating the proportion of time that a worker spends on each activity or is idle
- Primary use is for analysis of non-repetitive jobs
- Overall procedure consists of the following steps:
    - Clearly identify the worker(s) to be studied
    - Notify the worker(s) of the purpose of the study to avoid arousing suspicion

- Calculate an initial estimate of sample size using a preliminary estimate of *p,* if available. Otherwise, use *p hat* = .50
- Develop a random observation schedule
- Begin taking observations. Recalculate the required sample size several times during the study
- Determine the estimated proportion of time spent on the specified activity

Compensation

- Time-based pay – also known as hourly pay
- Output-based pay – also known as piece rate pay
  - In order to obtain max. benefit from piece rate pay, it should be:
    - Accurate
    - Easy to apply
    - Consistent
    - Easy to understand
    - Fair
- Group bonus plans
- Skill/knowledge bonus plans
  - Horizontal skills – reflect a variety of tasks the worker is capable of performing
  - Vertical skills – reflect managerial tasks the worker is capable of
  - Depth skills – reflect quality and productivity results

GMS401 - Chapter 7S: Learning Curves

The Concept of Learning Curves

- The time required to perform a task decreases with increasing repetitions
- If the task if short and somewhat routine, only a modest amount of improvement will occur, and it generally occurs during the first few repetitions
- If the task is fairly complex and has a longer duration, improvements will occur over a larger number of repetitions
- Learning curves have little relevance for planning or scheduling routine short activities
- Time per unit decreases as the number of units increases
- Improvements may create a scallop effect in the learning curve
  - Improvements may temporarily increase time as workers adjust to the improvement
- Every doubling of units produced results in a constant percentage decrease in time per unit
- By convention, learning curves are referred to in terms of the complements of their decrease rates
  - For example: an 80% learning curve denotes a 20% decrease in unit time with each doubling of units produced
  - The 80% learning percentage is referred to as “slope” of the learning curve

  - A 100% curve would imply no decrease in unit time at all – no learning

Determining Unit Times

- Can be found using a formula or a table of values
- Refer to page 7 for table

Applications of learning curves

- Useful application in a number of management activities:
  - Labour planning and scheduling
  - Negotiated selling/purchasing
  - Assessing labour training needs and performance
- Can be used to determine the length of training for new workers doing complex-long-cycle jobs
- Can be used to determine the minimum number of repetitions to achieve a given standard

Cautions and Criticisms

- Learning percentage may differ from organization to organization and by type of work
- Projections based on learning curves should be regarded as *approximations* of actual times and treated accordingly
- If time estimates are based on the time for the first unit, considerable care should be taken to ensure that this time is valid
- Learning curves do *not* apply to mass production because the decrease in time per unit is imperceptible
- Users of learning curves sometimes fail to include carryover effects; previous experience with similar activities can reduce unit times

GMS401 – Chapter 9: Management of Quality

Introduction

- Quality – ability of a good or service to consistently meet or exceed customer expectations

Evolution of quality management

- Prior to Industrial Revolution, skilled craftsmen performed all stages if production
- Pride of workmanship provided motivation
- Industrial revolution brought division of labour, pride of workmanship became less meaningful
- Product specification became more important; need for inter changeable parts
- Quality control – monitoring, testing, and correcting quality problems after they occur
- During the 1950s, the quality movement evolved into quality assurance; more proactive

- Quality assurance – providing confidence that a product's quality will be good by preventing defects before they occur
- 1970s – NASA and Pillsbury created a quality management system to assure and control food safety
- Later, International Organization of Standards created ISO 9000
- 1980s – Total Quality Management; continuous improvement: never-ending

Dimensions of quality

- Quality of goods:
  - Performance
  - Aesthetics
  - Special features
  - Safety
  - Reliability
  - Durability
  - Perceived quality
  - Service after sale
  - Latent quality: assumed quality
- Service quality:
  - Tangibles
  - Convenience
  - Reliability
  - Responsiveness
  - Time
  - Assurance
  - Courtesy

Determinants of quality

1. Product design
2. Process design
3. Production

- Conformance to design specifications during production – the degree to which produced goods or services conform to the specifications of the designers

Costs of quality

- Internal failure costs – caused by defective parts or products discovered during production
- External failure costs – caused by defective parts or products discovered after delivery to customer
- Appraisal (detection) costs – costs of inspection and testing

- Prevention costs – costs of preventing defects from occurring

Quality gurus

W. Edwards Deming:

- Compiled a list of 14 points he believed were the prescription needed to achieve quality in an organization
- Believed that it was up to management to motivate workers
- Need to reduce variation – special causes and common causes of variation
- Foundation of statistical process control (SPC)
- Promoted plan-do-study-act (PDSA)

Joseph M. Juran

- His handbook – Quality Control Handbook
- Described quality management in terms of a trilogy consisting of:
    - Quality planning
    - Quality control
    - Quality improvement
- One of the first to measure cost of quality
- 10 steps for continuous improvement

Armand Feigenbaum

- Recognized that quality was not only a collection of tools and techniques, but also a "total field"
- Quality at the source – every employee is responsible for inspecting his own work
    - Example: worker can stop the assembly line if there is a defect

Philip B. Crosby

- "do it right the first time"
- Zero defects – philosophy that any level of defects is too high
- Quality-is-free: costs of quality are so great that quality efforts must not be viewed as costs but rather a way of reducing costs

ISO 9001

- ISO 9001 – The international standard for a quality management system, critical to international business
- Three types of documents:
    - Quality manual
    - Procedures manual
        - For each process there is a description of how it is to be done and what to do if there is a problem
    - Detailed work instructions

- Elements:
  - Quality management system
  - Management responsibility
  - Resource management
  - Product realization
  - Measurement, analysis, and improvement

Hazard analysis critical control point (HACCP)

- HACCP – a quality management system designed for food processors
- HACCP steps:
  - Perform hazard analysis
  - Determine the Critical Control Points (CCPs)
  - Establish the HACCP plan

Canada awards for excellence (CAE) and total quality management (TQM)

- Criteria for CAE:
  - Leadership and governance
  - People focus and healthy workplace
  - Planning and environmental sustainability
  - Process management
  - Customer/citizen/client focus
  - Supplier/partner focus
- Implementation has been divided up into stages:
  - Foundation
  - Transformation
  - Role model
  - World class

Total quality management (TQM)

- An approach to quality management that involves everyone in an organization in quality management and continual effort to improve quality and customer satisfaction
- Key factors:
  - Continuous improvement
  - Involvement of everyone
  - Customer satisfaction
- TQM approach:
  - Find out what customers want
  - Design a product that will meet or exceed what customers want
  - Design processes that facilitate doing the job right the first time (quality at source)

        - Poka-yoke or fail-safing: incorportating process design elements that prevent mistakes
    - Keep track of results (TWM is data driven) and use them to guide improvement
    - Extend these concepts to suppliers/partners

Problem solving and continuous improvement

Plan-do-study-act cycle

- Also known as the Deming cycle
- The problem solving and quality improvement methodology used in the continuous improvement
- Basic steps in problem solving and quality tools used:
    - Define the problem
    - Collect data
    - Analyze the problem
    - Generate potential solutions
    - Choose a solution and implement it
    - Monitor the solution to see if it accomplishes the goal

Six sigma

- A more sophisticated statistical approach to problem solving and quality improvement than used in the PDSA cycle of the continuous improvement
- Has five steps (DMAIC):
    - Define
    - Measure
    - Analyze
    - Improve
    - Control

Basic quality tools

Seven basic quality tools:

- Process flow diagram
- Check sheet
- Histogram
- Pareto chart – a chart that arranges categories from highest to lowest frequency of occurrence
- Scatter diagram
- Control chart – a line plot of time-ordered values of a sample statistic with control limits
- Cause-and-effect diagram

Another useful tool is the Run Chart – a time plot that can be used to track the values of a variable over time

Methods for generating ideas and reaching consensus

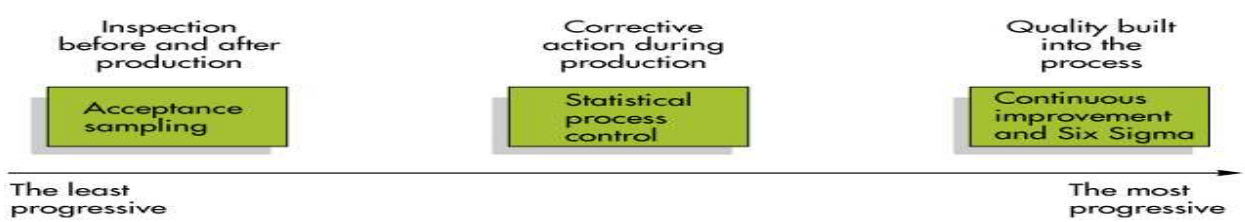
- Brainstorming
- Quality circle – a group of workers who meet to discuss ways of improving the products or processes
- Interviewing
- Benchmarking – process of measuring an organization's performance against the best in the same or another industry
- 5W2H approach – who, what, when, where, why, how, how much
- Reaching consensus
    - List reduction
    - Balance sheet
    - Paired comparisons

GMS401 – Chapter 10: Statistical Quality Control

Introduction

- The best companies emphasize designing quality into the process, thereby reducing the need for inspection/tests
- Statistical quality control – use of statistical techniques and sampling in monitoring and testing of quality of goods and services
- The part of SQC that relies on inspection of previously produced items is referred to as acceptance sampling
- The part of SQC that occur during production is referred to as statistical process control
- Inspection – appraisal of a good or service against a standard

Statistical Process Control Planning Process



1. Define the quality characteristics important to customers, and how each is measured
2. For each characteristic,
    a. Determine a quality control point

i. Typical points are: at the beginning of the process, at the end of the process, at the operation where a characteristic of interest to customers is first determined

b. Plan how inspection is to be done, how much to inspect, and whether centralized or on-site
c. Plan the corrective action

Statistical process control

- Statistical evaluation of the product in the production process
- Random variation (common variability, in Deming's terms) – natural variation in the output of the process, created by countless minor factors
- Assignable variation (special variation, in Deming's terms) – non-random variability in process output, a variation whose cause can be identified

Control charts

- Control chart – a time-ordered plot of a sample statistic with limits
- Control limits – the dividing lines for the value of sample statistic between concluding no process shift and a process shift, hence random and assignable variations
- A sample statistic that falls between the UCL and LCL suggests random variations (i.e. no process shift)
- A sample statistic that falls on and outside of the UCL and LCL suggests assignable variation
- Type I error – concluding that a process has shifted (i.e. an assignable variation is present) when it has not (i.e. only random variation is present)
- Type II error – concluding that a process has not shifted (i.e. only random variation is present) when it has (i.e. an assignable variation is present)

Sample mean and range control charts

- Sample mean control chart - The control chart for sample mean, used to monitor process mean
- Two ways to calculate control limits (refer page 329)
    - Formula approach
    - Table approach
- It is okay if individual values fall out of the UCL and LCL, we are concerned with the sample means
- Sample range control chart – the control chart for sample range, used to monitor process dispersion or spread

Individual unit and moving range control charts

- Individual unit (X) control chart – control chart for individual unit, used to monitor single observations (n=1)
- Moving range (MR) control chart – control chart for moving range, i.e. the difference between consecutive observations, used to monitor the dispersion or spread when n=1

Control charts for attributes

- Control charts for attributes are used when the process characteristics is <u>counted</u> rather than <u>measured</u>
- P chart – attribute control chart for the fraction of defective items in a sample
- C chart – attribute control chart for the number of defects per unit
- For both p charts and c charts, when the lower control limit is negative, it must be set to zero

Using control charts

Examples of non-random patterns in control chart plots:
- Trend – sustained upward or downward movement
- Cycles – wave pattern
- Bias – too many observations on one side of the centre line
- Level shift – a shift in the level
- Too much dispersion – the values are too spread out

Process capability

- Design specification – a range of acceptable values established by engineering design or customer requirements
- Process variability – actual variability in a process for a product
- Process capability – the ability of a process to meet the design specification
- Control limits and process variability are directly related: control limits are based on sampling distribution variability, and sampling distribution variability is a function of process variability
- The output of a process may or may not conform to design specification even though the process is statistically in control – this is where process capability comes in

Capability analysis

- Capability analysis determines whether the process output falls within the design specifications
- Process capability ratio, C_p = design specification width/process width
    - Upper design specification – lower design specification/6sigma
- For a process to be capable, it must have a capability ratio of at least 1.00

- The greater the capability ratio, the greater the probability that the output of a machine or process will fall within the design specifications
- If the process is not centred between design specification limits, or if there is no design specification limit on one side, C_{pk} is used
- C_{pk} is the smaller of the two ratios:
    - upper design specification – process mean/3sigma
    - process mean – lower design specification/3sigma

Six Sigma Quality

- Six sigma quality – a more advanced version of problem solving/continuous improvement. It also refers to the goal of achieving process variability so small that the half-width of design specification equals six standard deviations of the process
- Six sigma improvement methodology (DMAIC):
    - Define
    - Measure
    - Analyze
    - Improve
    - Control

Design of experiments

- Design of experiments – experiments by changing levels of factors to measure their influence on output and identifying best levels for each factor