PREDETERMINED TIME SYSTEMS (MTM-2)
(Read Ch. 13, pp. 491-500, 514-520)

Predetermined Times System - technique for obtaining a standard time (time study, work sampling) via:
1) analyzing and subdividing a task into elemental motions
2) assigns pre-set standard times for motions
3) summates these to obtain a standard time for the whole task (no direct timing)

History - 1) based on Gilbreth's therbligs
      2) with time added for each therblig
      3) Work Factor in 1930's, now >200

Methods Time Measurement (MTM)
1) by Maynard, et al. 1940's
2) jobs from Westinghouse, broken down into elements, rated, timed,
3)Time Measurement Unit (TMU) = .00001 hr = .0006 min = .036 sec or 1 hr = 100,000 TMU
4) many variations (1,2,3): trade-off between speed and accuracy - MTM-2 best compromise
5) also MTM-C for clerical work, MTM-V for machine shops, MTM-M for magnified work

MTM-2 can be used if:
1) cycle time > 1600 TMU (1 min, with ± 5% accuracy)
2) cycle is not highly repetitive
3) no complex finger motions involved
4) Ex. Dealing cards: i) .5 min - NO, ii) very repetitive - NO, iii) complex finger motions - NO

9 basic categories of motions:

1) **GET (G)** - *reach* for an object, *grasp* it, eventually *release* the object, purpose = to gain control of object
2) **PUT (P)** - move and *position* object while under control, purpose = to move object to new location
Both GETs and PUTs affected by three variables:
   a) cases (Fig. 13-3, Fig. 13-4): type of grasping or correcting motion, actually two types of PUTs:
     i) *insertion*: one object into another
     ii) *surface* alignment
   b) distance reached: measure knuckle to knuckle (MTM-1) or approximate using classification levels of motion (MTM-2)

Range (in)	Code	Classification
0-2	2	1-finger
2-6	6	2 - wrist
6-12	12	3 - forearm
12-18	18	4 - arm
18-32*	32	5 - torso

* beyond 32 in. include *step*

 c) weight of object or resistance - if significant weight is moved, additional time added to G or P, over and above basic value, to compensate for additional muscle recruitment
GET WEIGHT (GW) - add 1 TMU for each 2 lbs, up to 40 lbs
PUT WEIGHT (PW) - add 1 TMU for each 10 lbs, above 4 lbs, up to 40 lbs

Note: 1) These values are per hand, if 20 lbs in both hands, then a PW10=1 TMU extra
2) GW greater than PW because greater muscle recruitment to overcome inertia
3) Quantify resistance using net effective force (equivalent to friction with μ=.4)
$F_{friction} = \mu N$ W=F/#hands
4) Gs and Ps require two additional identifiers: case and distance, e.g. PA2

3) **APPLY PRESSURE (A)** = 14 TMU, exert muscular force on object without moving it (over a short time period, but longer than for a GET or PUT), e.g. Push a button

4) **REGRASP (R)** = 6 TMU
1) changing position of object without relinquishing control, e.g. reorient tool,
2) as soon as the hand relinquishes control, use a GET

5) **EYE ACTION (E)** = 7 TMU
1) to recognize an object, no mental time other than simple perception,
2) shift line of vision to new area, normal area of vision is 4" circle at 16"
3) don't overdue, GETs and PUTs have E already included!

6) **CRANK (C)** = 15 TMUs/rev
1) hand/fingers move object in circular path > ½ rev
2) if < ½ rev, use G and P
3) may also need GW, to overcome initial stiction, and PW for sticky crank
4) note difference between a continuous crank and intermittent crank

7) **STEPS (S)** = 18 TMU/step
1) leg motion with purpose of moving the body
2) distance > 12"

8) **FOOT MOTION (F)** = 9 TMU
1) short foot motion, < 12"
2) activate a pedal, not to move body

9) **BEND & ARISE (B)** = 61 TMU
1) vertical displacement of the body
2) bend, stoop, kneel on one knee
3) kneeling on both knees = 2B

Applications:
1) use <u>MTM Methods Analysis Chart</u>
2) summarize motions
3) add TMUs (ratings are included)
4) add allowances
5) consider special cases (<u>Fig. 13-8</u>):
1) Principle of simultaneous motion - simultaneous *difficult* [C] motions can not be done as quickly as with one hand only, add a penalty, see <u>Fig. 13-7</u> (X = no penalty)
2) Principle of limiting motion - for two different times for each hand, use longer one
3) Principle of combined motion - for two combined motions in one hand, use longer time
4) R as part of GC or PC is not counted

The final summary: **MTM-2 Data Card** (<u>Table 13-3</u>)

Sources of error:
1) Discreteness - tabular data, average out over long cycles
2) Synthesis assumes flawless performance - real performance varies
3) Practice - MTM assume a well-practiced operator

4) Incorrect application - if basic assumptions are violated, errors will result

Comparison of different methods for determining a standard time (Fig. 16-2)