Technical Applications of Computers with Matlab, FreeMat, and other free and open software
APPENDIX***

Jerry V McMichael

***Part I

DEDICATION

This book of TECHNICAL APPLICATIONS of Computers, along with the book ONCE A NATURAL SCOUT, FOREVER AN ADVENTURER, Chronicles of Jerry McMichael, are both dedicated to my great grandsons {really a a second sweep of grandsons as "great" is too much for them and me}. Since I can not be there for their graduation out into the world, if this world even makes it that long before the Second Coming and END; however in case I want them to have a leg up on the challenges of the future.

Flow Control with FOR in FreeMat.

1-1: FOR loop in FreeMat.

NOTE: For loops are seldom needed. They increase the run time of a program; however there are a few times they are needed.

The following is an excert from the Freemat online manual on the FOR loop:

The for loop executes a set of statements with an index variable looping through each element in a vector. The syntax of a for loop is one of the following:

```
for (variable=expression)
    statements
end
```

Alternately, the parenthesis can be eliminated

```
for variable=expression
    statements
end
```

or alternately, the index variable can be pre-initialized with the vector of values it is going to take:

```
 for variable
    statements
  end
```

The third form is essentially equivalent to for variable=variable, where variable is both the index variable and the set of values over which the for loop executes. See the examples section for an example of this form of the for loop.

Examples

Here we write for loops to add all the integers from 1 to 100. We will use all three forms of the for statement.

1. First example. (You should run the code in Freemat[1] or Matlab.)

```
--> accum = 0;
--> for (i=1:100); accum = accum + i; end
--> accum
ans =
 5050
```

2. The second form is functionally the same, without the extra parenthesis

```
--> accum = 0;
--> for i=1:100; accum = accum + i; end
--> accum
ans =
 5050
```

3. The two examples above in Freemat code.[2]

```
%For Loops in Freemat examples
clc
accum1 = 0;
for (i=1:100);
    accum1 = accum1 + i;
end
```

---

1. If you have not downloaded your free copy of freemat 4.2beta then do so at

2. Freemat is admitted a matlab clone, and if you have used matlab, you will notice little difference.

```
accum1      %to view result of final loop only, that is outside the loop after
end above
% should show an ans of accum, ans = 5050
%semicolons, ;, are removed to view statements in command window for
debugging
%in order to see results simply remove the symbols % in front of 4 state-
ments below
%accum = 0
%for (i=1:100)
%    accum = accum + i
%end
%another run without the parenthesis
accum2 = 0;
for i=1:100;
    accum2 = accum2 + i;
end
accum2
```

1-2: Comparison between FIND in a routine to calculate distance greater than 30 feet and less than 30 feet of a cable car, from Delores M. Etter in INTRODUCTION TO MATLAB FOR ENGINEERS FOR ENGINEERS AND SCIENTISTS {We will use Freemat.}

1. Solution of the problem of the cable car where (a) within 30 feet of the tower, the velocity equals $0.425 + 0.000175*d^2$, where d is for distance, and (b) distance from tower greater than 30 feet where the velocity equals $0.625+0.12d-0.00025*d^2$.

    a. The routine in Freemat.

```
%comparison for using FIND and a FOR loop
%first using FIND
clc
d=25:35
lower = find(d<30)
velocity(lower) = .425 + .000175*d(lower).^2;
upper = find(d>= 30)
velocity(upper) = .625 + .12*d(upper) - .00025*d(upper).^2;
```

b. Display in command window.

```
d =
 25 26 27 28 29 30 31 32 33 34 35
lower =
 1 2 3 4 5
upper =
  6  7  8  9 10 11
```

2. To the above routine is added TIC to start the timer of the routine and TOC to stop the timer and record the output. By this means we can compare the same time of problem solution between FIND and FOR.

   a. Code in Freemat.

```
%comparison for using FIND and a FOR loop
%first using FIND
tic
clc
d=25:35
lower = find(d<30)
velocity(lower) = .425 + .000175*d(lower).^2;
upper = find(d>= 30)
velocity(upper) = .625 + .12*d(upper) - .00025*d(upper).^2;
toc
```

   b. Command window display.

```
d =
 25 26 27 28 29 30 31 32 33 34 35
lower =
 1 2 3 4 5
upper =
  6  7  8  9 10 11
ans =
    0.0020
```

2. Somewhat parenthetical but befor using FOR on the velocity and distance problem, we will briefly look at FIND from the Freemat 4.0 manual.

   a. Starting off simple to find from an array, a, to find elements of the array that are equal to 2.

```
a = [1,2,5,2,4];
find(a==2)
```

   b. Code in Freemat.

```
%using FIND in freemat
clc                    %clears the console window
a = [1,2,5,2,4]
find(a==2)
%NOTE that in every case the answer for find is in terms of position
```

   c. Display for the above routine.

```
%using FIND in freemat
clc                    %clears the console window
a = [1,2,5,2,4]
find(a==2)
%NOTE that in every case the answer for find is in terms of position
```

      d. Something a little more challenging. This starts with a larger array, A, which with FIND replaces the elements in the array that are zero with the number 5.

```
--> A = [1,0,3;0,2,1;3,0,0]
A =
1 0 3
0 2 1
3 0 0
--> n = find(A==0)
n =
2
4
6
9
--> A(n) = 5
```

3. The simple and the challenging routins in one script, and with more notations, %, for your learning experience. This is also a good drill on the management of arrays, vectors, matrices, or determinants--whatever you wish to call them.

   a. The freemat routine.

```
%using FIND in freemat
clc                    %clears the console window
a = [1,2,5,2,4]
find(a==2)
%NOTE that in every case the answer for find is in terms of position
%second example from Freemat Manual that starts with a larger array,A,
%then finds and replaces all the zero elements in the array with 5.
A = [1,0,3;0,2,1;3,0,0]  %notice that the 2 rows are separated with ;
%the appearance of the array, actually a matrix is inserted
%A =
%1 0 3
%0 2 1
%3 0 0
n = find(A==0)  %now the find statement for those absolutely equal to zero
%the n lists the location in A in the sequence of element numbering, from
1 to 9
%n =
%2
%4
%6
%9
%NOTE: you realize that this is also good drill on arrays, matrices, and
determinats, also
%sometimes called vectors for you who have had a course in Vector Analy-
sis
%then replace the n positions of 2,4,6, and 9 with the number 5.
A(n) = 5
A
```

b. The display.

```
a =
 1 2 5 2 4
ans =
 2 4
A =
 1 0 3
 0 2 1
 3 0 0
n =
```

```
 2
 4
 6
 9
A =
 1 5 3
 5 2 1
 3 5 5
ans =
 1 5 3
 5 2 1
 3 5 5
```

4. Now we should calculate the distances greater than and less than 30 feet for the cable velocity routine, this time using FOR, and with TIC and TOC timing of the FOR routine.

   a. Code.

```
%comparison for using FIND and a FOR loop
%first using FIND
tic
clc
d=25:35
lower = find(d<30)
velocity(lower) = .425 + .000175*d(lower).^2;
upper = find(d>= 30)
velocity(upper) = .625 + .12*d(upper) - .00025*d(upper).^2;
toc
%now to calculate lower and upper using a FOR loop and compare the run
time.
d2=25:35
for k = 1:length(d2)
    if d2(k) < 30
       velocity(k) = .425 + .000175*d2(lower).^2;
    else
       velocity(k) = .625 + .12*d2(upper) - .00025*d2(upper).^2;
    end
end
toc
```

b. Display.

```
d =
 25 26 27 28 29 30 31 32 33 34 35
lower =
 1 2 3 4 5
upper =
  6  7  8  9 10 11
ans =
    0.0010
d2 =
 25 26 27 28 29 30 31 32 33 34 35
ans =
    0.0020
```

NOTE: The time for both the FIND and FOR routines run together, exactly .0020, or 2 milli-seconds, and exactly twice the 1 millisecond of the first FIND routines, so that either is just as efficient in time.

1-3: FOR looping in Matlab routines run in FreeMat.

It should be obvious by now that any kind of loop, FOR or WHILE, is a structure to repeat a calculation several of times. The FOR loop is used as the number of passes is known ahead of time {before the beginning of the loop}; and the WHILE loop as the specified conditions within the loop determines the number of loop pases.

1. Three FOR loop examples in one Freemat routine.

    a. The code.

```
%some for loops from Matlab runs in Freemat
cla
clc
for k = 5:10:35     %k, the index, obvious runs from 5 to 35 in increments
of 10
    k
    x = k^2
```

```
end
%example two, a for loop may be written as a single statement
for x2 = 0:2:10, y2 = sqrt(x2), end
%example three, nested loops
clc
m = 0;
%the outer loop increments q by 3s.
for q = 0:3:6
    m = m+1;
    n= 0;
    %next the nested inner loop, increments of r by 5
    for r = 0:5:15
        n = n +1;
        A(m,n) = r + q;
    end                       %the inner loop ends
end                           %end of outer loop
A                 %display the completed A matrix
%example four,implied loop
clear 'all'      %gets rid of workspace variables(called current environment in
FreeMat)
x3 = [1:.1:10];
y3 = cos(x3)
plot(x3,y3), grid
clc
who                   %runs remaining list of variables
```

b. Remaining variables in workspace {environment in FreeMat}, after the "clear all" and the last "clc". Just as in Matlab, the FreeMat command of "who" lists all the variables currently in the workspace or environment.

-->	Variable Name		Type	Flags	Size
	ans	double			[0x0]
	x3	double			[1x91]
	y3	double			[1x91]

Appendix of *Selective Researh Notes.*

Like any Appendix of a Technical book, this one of TAC is a hodge podge of supportive technical information. The only manner to find your way through it apart from thumbing, is to use this short TOC below. The major difference here is that this Appendix is essential to understanding of TAC and the learning process. Some technical matters in the main book presentation are saved for here in order for the reader to come up to par, and others are included for a positive reinforcement in the integrated learning process. You should enjoy it, and with frequent references back and forth, from main text to Appendix and vice versa.

A-1: Flight Test Engineering.

February of 2011, interesting and challenging technical jobs for Contract Engineering picked up. Typical of those are the four listed below. Especially interesting considering the subject matter of TECHNICAL APPLICATIONS OF COMPUTERS before this Appendix is one on "Flight Dynamics: Stability and Control". You will find a common element of "flight test" and hence the title of this Appendix as "Flight Test Engineering". Of course this must be integrated with those sections that were delayed until you had a total integrated perspective of the technical applications of computers with MATLAB.

A-1-1: Four Job Descriptions for Analysis.

1. Job Title: Flight Dynamics/S&C Engineer

Description: Works on engineering projects containing critical problems, the solution of which requires major technological advances and extensive related development.

Principal Duties and Responsibilities:

1. Responsible for an entire engineering project of major complexity within established scope.

2. Makes technical decisions and recommendations that are recognized as

authoritative and have an important impact on extensive engineering activities

3. Applies advanced technical principles, theories and concepts based on broad

expertise or unique specialized knowledge

4. Leads the development of innovative principles and ideas

5. Acts independently to determine improved methods and/or procedures to

optimize technical product, cost and schedule requirements

6. Works under consultative direction; uses independent judgment to accomplish objectives

7. Develops standards and guides for diverse engineering activities

8. Conceives and plans investigation of broad areas of importance for which engineering precedents are lacking in areas critical to the program.

Required Skills/Experience:

•   Bachelors degree in engineering, a related curriculum, or equivalent

combination of appropriate education and experience sufficient to successfully

perform the essential functions of the job.

•   Thirteen (13) years in the specific technical discipline or fifteen (15)

years broad engineering experience in several technical disciplines with a

Bachelors degree, or eleven (11) years in the specific technical discipline

with PhD.

•   Experience in augmented air vehicle control system design and analysis using state of the art techniques that include LOES, optimal control theory,

model-based design, and aeroservoelasticity analysis.

•   Application of traditional handling qualities criteria to control system

design.

•   Familiarity of PIO and handling qualities rating methods.

•   Experience with 14 CFR Part 25 Certification, especially of an airplane with a fly-by-wire control system.

•   MATLAB & Simulink fluency required

Location: Savannah, GA

Duration: Long-term contract

Max Rate: $78/HR

Note - Package may include standard per diem of $110 per week and Per Diem

split of $26.78/HR both non-taxable(for one year) and report to work travel of

.375 per mile if driving or one-way coach if flying and 6 paid holidays annually.

Job Number: #640

Input Date: 02/14/2011

Rate: $78/HR

Location: Savannah, GA

Per Diem: Possible

Start Date: ASAP

Duration: Long-term

Firm Name: INCONEN CORPORATION

Attention: Leslie Major

Address: 6133 BRISTOL PKWY STE 232

City, State: CULVER CITY, CA 90230

Local Phone: 310/410-1931

800 Phone: 888/208-8064

Fax Phone: 310/410-1751

Email: leslie@inconen.com

Website: http://www.inconen.com

Immediately it is obvious that this is a Systems Engineering job as "work on related projects" is used instead of systems; of course those in Aviation would immediate recognize that these Projects are either Airplanes, since this is obviouslsy Gulfstream, a division of General Dynamics, at Savannah; or the project are sub-systems of Gulfstream aircraft {in all probability some of the newer G models although Windstream models {from the Israeli company recently purchased}. The job knowledge, experience, and skills mentioned are: (1) air vehicle control systems design; (2) control system analysis; (3) the state-of-the-art technique of LOES; (4) optimal control theory; (5) model based design; (6) aero-servoelasticity analysis; (7) application of handling qualities to control design; (8) PIO and handling qualities rating methods; (9) FBW; (10) 14 CFR Part 25 FAA certification; (11) MATLAB and Simulink.

Then you will see a lot of similarity to the same job skills, knowledge, and experience in the job description below of a Flight Test job on the F-35 at Paxtuxent River Maryland Naval Air Station.

2. Job Title: 2- Flight Controls

Description: Security Level: Secret

Provide onsite Flying Qualities/S&C engineering support for F-35/JSF at PAX

River. Duties include Mission Control Room support for ground & flight test,

mission planning, supporting analysis and issue resolution, and coordination

across variants and sites to resolve issues and maximize flight test sortie

rate. Bachelors or Masters degree from an accredited college in a related

discipline with 5 years of professional experience in Flying Qualities and

Stability and Control in support of flight test.

Skills/Experience: BS or MS Degree in AE, ME, with a minimum 20 years

experience in design & installation of mechanical systems, including primary and secondary flight controls, landing gear & retraction mechanisms, hydraulic systems, Primary and secondary structures. Computer skills involving 6-DOF simulation tools, MATLAB and C++ required.

Job Number: 01057

Input Date: 02/14/2011

Rate: $50 (9+ years)

Location: Ft. Worth- Pax River, TX

Per Diem: Possible

Overtime: Possible

Start Date: 03/09/2011

Duration: 03/09/2012

Firm Name: CCI STAFFING

Attention: Janie Bracero/Debra Olson

Address: 805 FOREST RIDGE DR STE 100

City, State: BEDFORD, TX 76022-6542

Email: jbracero@cci-staffing.com; dolson@cci-staffing.com

Website: http://www.contractconsult.com

NOTE: Notice the mention of S&C for Stability and Control for the F-35 like for Gulfstream General Aviation, models, and Pax River adds "Flying Qualities to the S&C.

"Handling Qualities" is another phrase for "Flying Qualities"; and Stevens and Lewis in AIRCRAFT CONTROL AND SIMULATION, present[1] the standard forms of these quality analysis with first the pilot rating system of 1-10 {and we thought the Thai sellers of goods invented the 1-10 system} and then the more precise specs of "Military Specifications for the Flying Qualities of Piloted Aircraft" of MIL-F-8785C, 1980[2]. These include quantitative numbers for the Phugoid mode, the short-period, roll mode, spiral mode, and dutch roll mode. Additional requirments {specifications made into requirements as part of the System Design Process} exist for stability augmentation of the high performance aircraft such as FBW, the F-35 as the forerunner of the F-16 and F-22 and the Gulstream G models being typical examples.

"Flight Controls" especially after you throw in Flying Qualities/S&C is a short form of "Flight Dynamics/S&C, and both together should leave the impression in your mind that STABILITY AND CONTROL (S&C) loom large in Flight Test. You would be reminded of previous chapters in the main body of the text which dealt with the subject, and complete books like the fine one by a professor at Notre Dame have been written on the subject FLIGHT DYNAMICS: Stability and Control. Other job knowledge, experience, and skills include: (1) Control room; (2) flight tests; (3) ground tests; (4) mission planning; (5) data analysis; (6) issue {problem} resolution; (7) 6 DOF simulation; (8) MATLAB and Simulink.

So confusing to many are the concept of "System" and in particular "Systems Engineering", that it took 3 separate job descriptions to describe a particular job at Boeing. Two of them are shown below, and the third is found on the Boeing website.

3. Systems Engineering Engineer {Boeing runs it onsite a little differently}[3]

Company: Boeing

Position: Systems Engineering Engineer

Openings: 12

Location: Wichita, KS

---

1.   Page 280, 288-291.
  2.   Superseded by MIL 1797.
3.   System Engineer 3 and 4 B-52 radar modification.

Duration: 3 Months (+)

Hourly Pay Rate: (DOE)

JOB DUTIES:

Applies an interdisciplinary, collaborative approach to plan, design, develop and verify a lifecycle balanced system of systems and system solutions. Evaluates customer and /operational needs to define and coordinate system performance requirements, integrate technical parameters and assure compatibility of all physical, functional and program interfaces. Performs various analyses to optimize total system of systems and/or system architecture. Performs analyses for affordability, safety, reliability, maintainability, testability, human systems integration, survivability, vulnerability, susceptibility, system security, regulatory, certification, product assurance and other specialties quality factors into a preferred configuration to ensure mission success. Develops the planning, organization, implementation and monitoring of requirements management processes, tools, risk, issues, opportunity management and technology readiness assessment processes. Resolves cross-functional technical issues.

ADDITIONAL DETAILS FROM DEANA –

*****Broad ability to evaluate complex vehicles and systems from a multitude of perspectives. Includes the ability to apply figures of merit and integrated optimization tools. Ability to perform multi-disciplinary trade studies to evaluate configuration alternatives for functional and spatial integration. Skill and ability to: collect, organize, synthesize, and analyze data; summarize findings; develop conclusions and recommendations from appropriate data sources at the department level. Complete knowledge of engineering discipline(s) (e.g., electrical, mechanical, software engineering) applied to product related systems (e.g., aircraft, avionics, propulsion, spacecraft, information/ communication systems) throughout the product development life cycle, from concept development to deployment. Complete knowledge of engineering analysis (e.g. mechanical, electrical, avionics, design, circuit, systems, stress, structural, durability). Complete knowledge of design, improvement, and installation of integrated systems of people, materials, equipment, and methods. Apply complete knowledge of modeling techniques (e.g., mathematical modeling, simulation, design of experiments, operations research) to analyze a system. Complete knowledge of product lifecycle, including manufacturing, deployment, modification, aging and continued service, and disposal. Broad knowledge of detection and estimation

techniques (e.g., maximum likelihood, maximum a posteriori [MAP], non-parametric, constant false alarm rate [CFAR], amplitude/frequency/phase). Broad knowledge of classification techniques (e.g., pattern recognition, feature extraction, correlation, demodulation, multiple hypothesis tracking, template techniques, neural networks, support vector machines). Broad working knowledge of the methodology and processes associated with risk management, and conducting trade studies, including cost as an independent variable (CAIV) trades. Ability to: identify and quantity potential risks areas within specific (depth), understand design constraints (technical, cost & schedule), identify and trade alternatives (i.e., trade studies), select/recommend the best plan for mitigating risks, implement/execute plans for mitigating risk, establish appropriate performance tracking metrics to track risk burndown over time. Ability to effectively utilize risk management tools (iso-risk charts/plots, waterfall, etc) to support program/project execution.*****

This same job on the Boeing website is called Systems Engineer 3/4. It makes it clear that hopefully they would hire former B-52 navigators with engineering degrees, but that sounds like the optism of HR. Reading all 3 descriptions together, a person would think that Boeing has some charge money right now for B-52 radar modifications into the SR2 radar, and with such concepts as "system of systems" is looking forward to the possiblility of the Contract Employee fitting into the Future Combat System, where the more general job descriptions would come in.

4.Systems Engineer 3\4

Requisition Number10-1021281

Location Wichita, KS

Security Clearance Required? Current Secret - US Citizenship Required

Position Description:

The B52 Strategic Radar Replacement (SR2) program has a need for a Systems Engineer with B52 Radar Navigator experience. The primary responsibilities of this position are to serve as systems engineering support for the development

and integration of a new Radar on the B52. The SR2 program will replace the current B52 Strategic Radar system. This position requires extensive coordination and communication with the B52 Mission Systems and Systems Engineering IPTs and customer. In this position you will help ensure that the system design meets the desired mission capabilities and customer requirements including interface definition, software and hardware requirements development (e.g., aircrew display formats and functionality), integration test support, flight test support, and systems engineering associated with this effort.

Of course, Boeing is the second largest airplane manufacturer in the world, and as such has the right to define its own job requirements. Where obviously the requirments overlap on job skills, knowledge, and experience with companies like Lockheed Martin, the largest thanks to the purchase of General Dynamic FW, are at the top level of system design where customer requirments {specifications} are turned into design requirments, quite often in many interface documents. System also in that it includes both hardware and software; systems in that many sub-systems on the aircraft are involved like the displays; and systems in that it must go through the process of integration, test, and flight test.

A-2: Last Chance.

As we look at those sections mentioned previous in the main body of the book, but skipped over temporarily for integration in this Appendix on "Flight Test Engineering", this is LAST CHANCE for learning only in the sense of the first reading and study of this book. It is somewhat like the famous last chance at the end of the runway where final checks are made on the F-16 for flight worthiness as to security of arms, structure, lack of leaks, and removal of pin on the emergency power hydrazine system. For it is hoped that far beyond the immediate learning of many of the technical applications of computers, you have both seen the integrated nature of physics, electronics, engineering technology, math, and computers for more ease of learning, and also developed certain system techniques to allow you in the future to rapidly "come-up" on new systems. In other words the first reading of this book is not your last chance at learning as continuing education, especially on the technical applications of computers, must be a life time pursuit. A couple of decades ago, the half-life of the average college degree was 8 years, which means that half of everything that you learned in 4 or 5 years of college was obsolete; and it would be embarassing to think what it is in 2011 and beyond in this age of information and technological explosion. An explosion that we called the "Digital Atomic

Age" at the beginning of the book. Problem solving based on seeing the integration of technical subjects, and the learning of such, is what you must have and develop beyond the immediate knowledge, skills, and experience; and that can further be solved as Problem Solving on Systems.-13

Below is the list of those sections skipped, which fitted into the flow, but required a little more background of the total text before being covered here in the Appendix. You might call this round two with the addition of the perspective of Flight Test Engineering.

1. **The Process in CMMI (Sect 5-13) and in Embedded Systems Architecture** (Sect 5-14). You can not get any more systems level than this unless you go all the way to the system of sytems of the 17 vehicles of the Future Combat System.

2. **Some of the NASA reports** mentioned but not discussed from Section 5-15 in the chapter on "The Process".

  (1). Stability and Control Derivative and Dynamic Characteristics. {Sounds like the job description for Gulfstream of "Flight Dynamics/S& C".} In our respect for NASA Edwards and the flight test engineering work of the past, we must give due respect to this early {1966} look at efforts to get the S&C derivatives from flight test data in AGARD-AR-549, part 1.

  (2). A FORTRAN program for S&C derivatives that derives those derivatives from flight test data, NASA TND-7831, 1975.

NOTE: There is the well-known saying in flight test engineering that "we do not want to re-invent the wheel". While we may not want to, quite often we do and often although frustrating you must appreciate the trend of Naval Aviation, like in Flight Test at Pax River, to stick with the traditional.

  (3). A New Method, in 1976, for Test and Analysis of Dynamic S&C, AFFTC-TD-75-4. This publication out of Edwards AFB makes a significant contribution to the history, if not the technical advance, of flight test engineering at Edwards.

  (4). Sometimes Systems ID and parameter estimation have been confusing, so that any paper like AGARD-CP-172, paper 16 of May 1975 that clarifies the "Practical Aspects of Using a Maximum Likelihood Estimator" will be welcome.

NOTE: Did you notice some of those computer and data analysis methods required on the Systems Engineering for the B-52 radar replacement such as:

Broad knowledge of detection and estimation techniques (e.g., maximum likelihood, maximum a posteriori [MAP], non-parametric, constant false alarm rate [CFAR], amplitude/frequency/phase). Broad knowledge of classification techniques (e.g., pattern recognition, feature extraction, correlation, demodulation, multiple hypothesis tracking, template techniques, neural networks, support vector machines)

Of course these parametric methods are the most common for radar, but you see how the estimation technique of maximum likehood gets into the systems and data analysis with computer numerical methods.

3. **Cost Function (Sect 6-8)** in Model Methology of Operations Research[1].

4. **"Fminsearch"** (Sect 6-9) of MATLAB, the Nelder and Mead Simplex algorithm.

5. Place of **the cost function, J,** in parametric estimation (Sect 6-10).

6. **MATLAB program for Aircraft Trim plus more.**

7. **(Sect 7-7) Coefficients from Flight Test** versus Mach and Altitude.

8. Working with **the Pendulum System in MATLAB, Sect 7-12**, sometimes the simplest of systems can be the model for much more complex systems. For example some of the parameters in the MIL specs for flight test, were originally derived from simple models like the pendulum. We will us the pendulum in MATLAB to explore the flight test requirments for manuvers like the Dutch roll and Phugoid method.

9. **Files/Directories, the computer handling of data, and interfacing with external programs (Sect 8-3 on drill).** It is very approriate in this Last Chance that our drill with MATLAB also become integrated in Flight Test Engineering. After all, most of us do it for more than fun!

---

1.   Did you notice the mention of the methods of Operations Research in the Systems Engineering job for Boeing? This was previously the more popular title for numerical methods in computers.

10. **The Fourier Transform (Sect 8-4).**

11. **Plotting Polynomials (Sect 8-5)** with the "polyval" of MATLAB with some typical polynomials of flight test engineering.

12. **Matrices of Data and Plotting (Sect 8-6).**

13. **Programming Input and Output in MATLAB (Sect 8-11).**

14. Engineers are not programmers, but must be able to program. Why not use the language of Engineers, that of **MATLAB, for programming.** More programming with (a) looping in MATLAB (Sect 8-13), (b) control flow statements (Sect 8-14), (c) "IF" statements, necessay in all programming languages (Sect 8-15), (d) loops for the programming of missiles (8-16) for we dare not neglect the flight test of missiles, (e) a useful program routine to do the Air Data computer functions, used as a function in MATLAB programming {[Mach,Qbar] = ADC(VT,H)}.

15. A peak in our programming (8-18) with MATLAB skills as we calculate the **state derivatives for the Transport Aircraft.**

NOTE: You see the wisdom of Round 2 in learning of Technical Applications of the Computer with MATLAB. At chapter 8, this task was right there in the flow to be introduced, but if you were still learning MATLAB the skill level was still too high at chapter 8. Besides now, you have more motivation to get a job, or a better job!

16. Optimization in the Excel Data Analysis ToolPak (9-4).

17. Optimization in MINITAB (9-5).

18. Modeling, Parameter Estimation, and System ID (10-7).

19. Statistics Toolbox of MATLAB versus Data Analysis ToolPak (10-8).

20. Back to a simple system again to integrate with the electronics of the LCR circut (Sect 12-2) using the simple model of the spring mass system.

21. Then advance into other electronic circuits which provide a basis for the understanding of the 3 types of controllers for automatic control--PID, PD, and PI. You will remember these controllers of digital control computers as Propor-

tional and Integrating, Proportional and Integrating and Differential, and PD (Sect 12-3).

22. And on to the unique circuits called filters (Sect 12-4), and from circuits into the mathematical and computer methods of LaPlace and the TF (transfer function).

23. Drill with the very important tool of the Transfer Function on well known circuits of electronics technology (12-6).

NOTE: Did you see model-based design in the job description for Flight Dynamics at Gulfstream. Of course, while they mean the more modern methologies of like modeling in Simulink, models are helpful at all levels. You might consider that they are analogies and ways to visualize a circuit or system. You might also recall that for every physical system there is an analogous electronic model, and vice versa.

A-3: Basic Manuvers of Flight Test.

There are 2 factors that every aircraft of every generation have in common, even as they must pitch, roll, and yaw they must also be capable of interfacing with a pilot in order to pitch, roll, and yaw {the UAV crews on the ground at home base are no exception, and indications are that the stress on this crews is harder than manned aircraft}. And even as the roll, pitch, and yaw get more fancy as aircraft and pilot interface in more complex manuvers of the co-ordinated same 3 motions in manuvers lke chandells, lazy-8s, pivots about the pylons, and these -basic requirments for pilot and aircraft testing never change, so the unique manuvers of flight test as specified in MIL-specs and FAA CFR's seldom change. In other words, it is almost impossible to outdate either even as it is almost impossible to outdate the interface of pilot and aircraft of any type and generation. They must be able to go up and down, roll, and yaw; and there must be both Stability for the aircraft and Controlability for the pilot.

1. Zeta, Omega, and the 5 standard and specified manuvers {generally called modes from the perspective of aerodynamics, analysis, and flight test} of flight test are: Phugoid, short period, dutch roll, spiral, and roll.