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Introduction.

One of the major problems in the construction, check-out and maintenance of a large program is that of adequate documentation of the code. Aids to documentation, and means of enforcing the required disciplines on programmers, have been developed over the years. Among these are the adoption of symbolic programming languages, macro-languages, high level languages, etc. Unfortunately the use of the higher level languages has led to a decrease in efficiency in object programs, and even more seriously, to an expansion in their size. This report makes an initial attempt to investigate alternative methods of documenting the same program, and examine the penalties involved in each technique. The program segment chosen as an example was taken from real life, but cannot necessarily be regarded as typical, since it involves mathematical computations.

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The investigation is not complete, but is published partly as an illustration of the method of quantitative and factual analysis which should be applied by those engaged in research into machine and software design.

Summary.

Appendix 1 shows a flowchart for the program. Note that the boxes contain only "comments" explaining what needs doing and why. They do not contain any indication of how the tasks are to be performed.

Appendix 2 shows the same flowchart using begins, ends and indentations instead of arrows and boxes. If a "flowchart" is to be input into the computer, this is the form it should take. It may be found that the indented form is just as clear as the pictorial form, and might replace it as a standard documentation technique.

Appendix 3 shows how that data for a program might be fully annotated. For each variable name we indicate the purpose for which it is used, and list all the comments which refer primarily to it. To the right of the line, we give the actual declaration of the quantity, and the actual symbolic coding corresponding to each comment. It might be helpful also to have a cross-reference listing of all the places where the variable is used or has its value changed by assignment.

Appendix 4 shows the program written in "pure" ALGOL. All the comments have been inserted, using the PL/I comment convention /*.......*/. A program like this could be produced automatically from the material of the previous two appendices, using the comments as macro-names and the coding as macro bodies. However, this would be a difficult operation on a small computer, since it is an essential prerequisite of good documentation that the comments should be written out in full. Furthermore, the resulting code would be very diffuse, since it makes no attempt to "bind" the code together by storage of temporary results, use of registers, etc. Finally, a systematic use of program generation in this way is likely to lead to frequent failures to set variables properly before their use.

Appendix 5 shows the same program (unannotated) written in ALGOL, but using the letters A and B to stand for the accumulator and the B-register. This is very useful in the production of efficient object code. However, the values of A and B are frequently changed as a side effect of other instructions which do not mention them, and the programmer runs a constant risk of forgetting this.

Appendix 6. shows a form of infix notation which mirrors exactly the structure of the machine code. Its advantages over machine code are:-

1. Bracketed and indented techniques can be used (although in this example they are not).

2. More than one related instruction can be placed on a single line.

3. Infix notations are more familiar and pleasant in general than prefix notations of machine code.

This code was the first attempt to understand the original machine code. It may be worth while to do more work on this form of low-level notation.

The actual SIR coding for this program is also available for inspection.

As an additional study of the code, the following figures were obtained:

Of 253 instructions, there were

32 b-register loads

59 b-lined instructions

50 jumps.

112 other instructions.

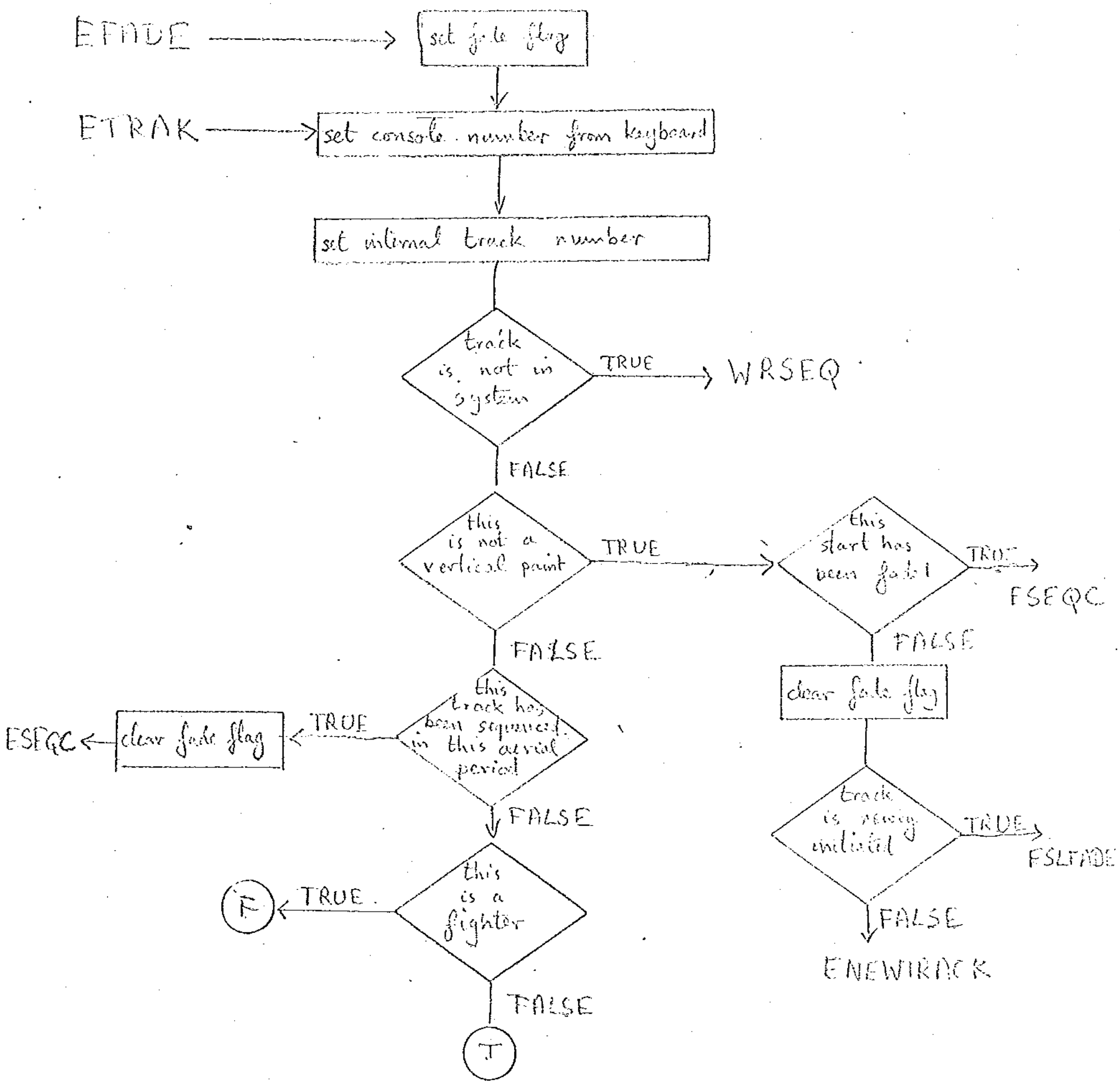
If a second B-register had been available 15 instructions would have been saved; if yet a third b-register had been available, a further 5 instructions would be saved. If the B-register were wholly volatile, (i.e. always had to be reloaded before use), an additional 25 instructions would be required.

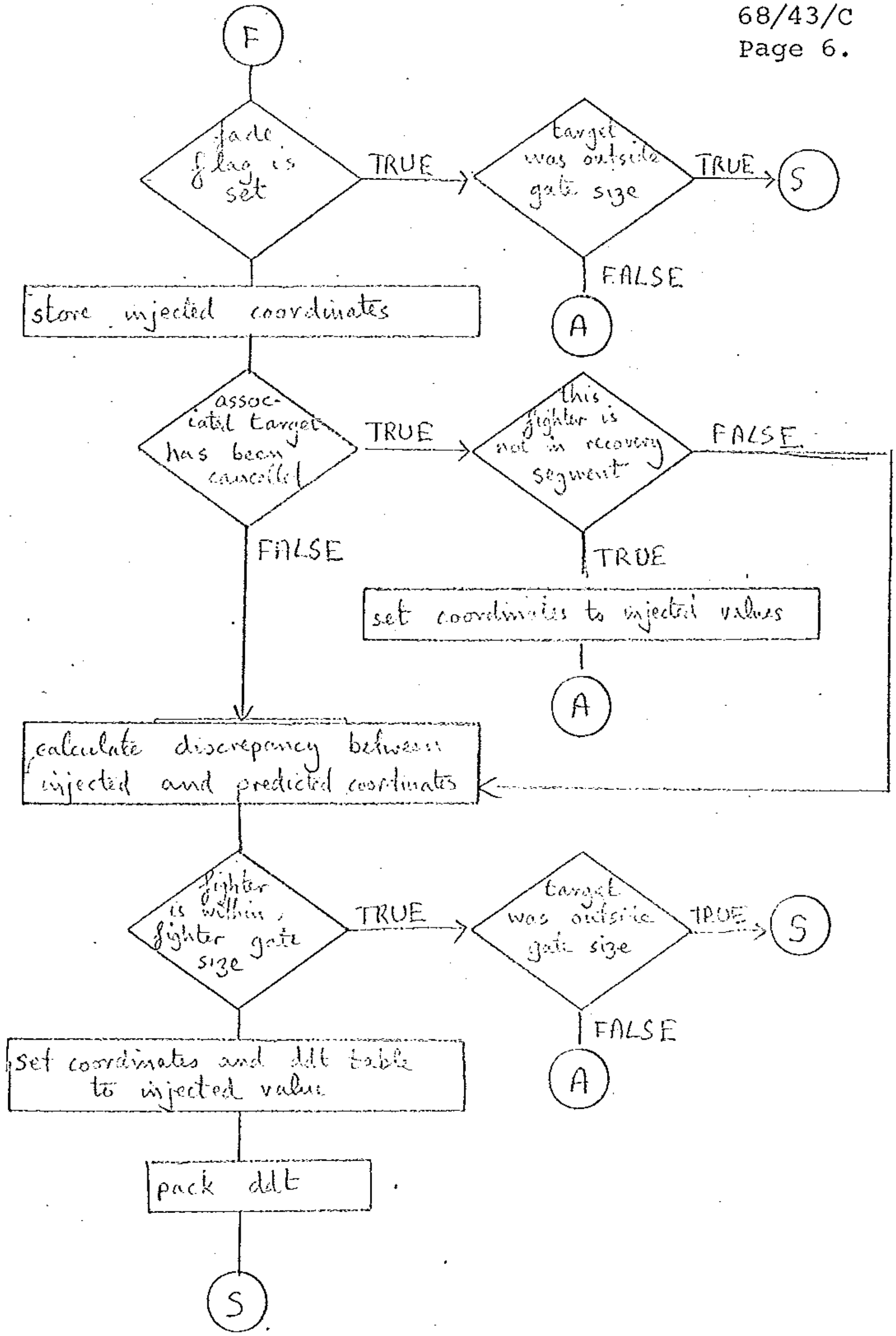
Conclusion.

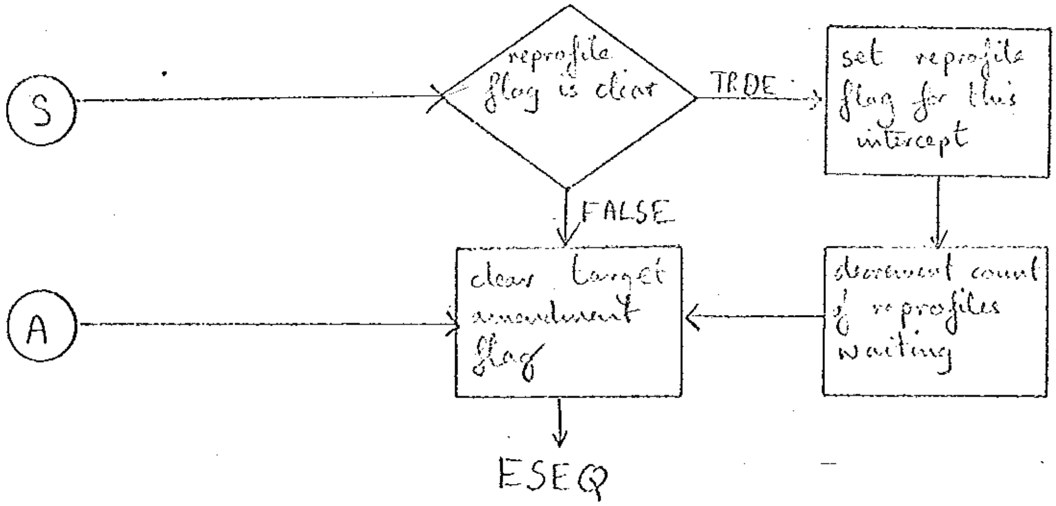
No firm conclusions are available at the present stage. Numeric estimates should be made of the penalties of using each of the proposed notations. The example program should be used to test the characteristics of proposed future machine designs, and software designs.

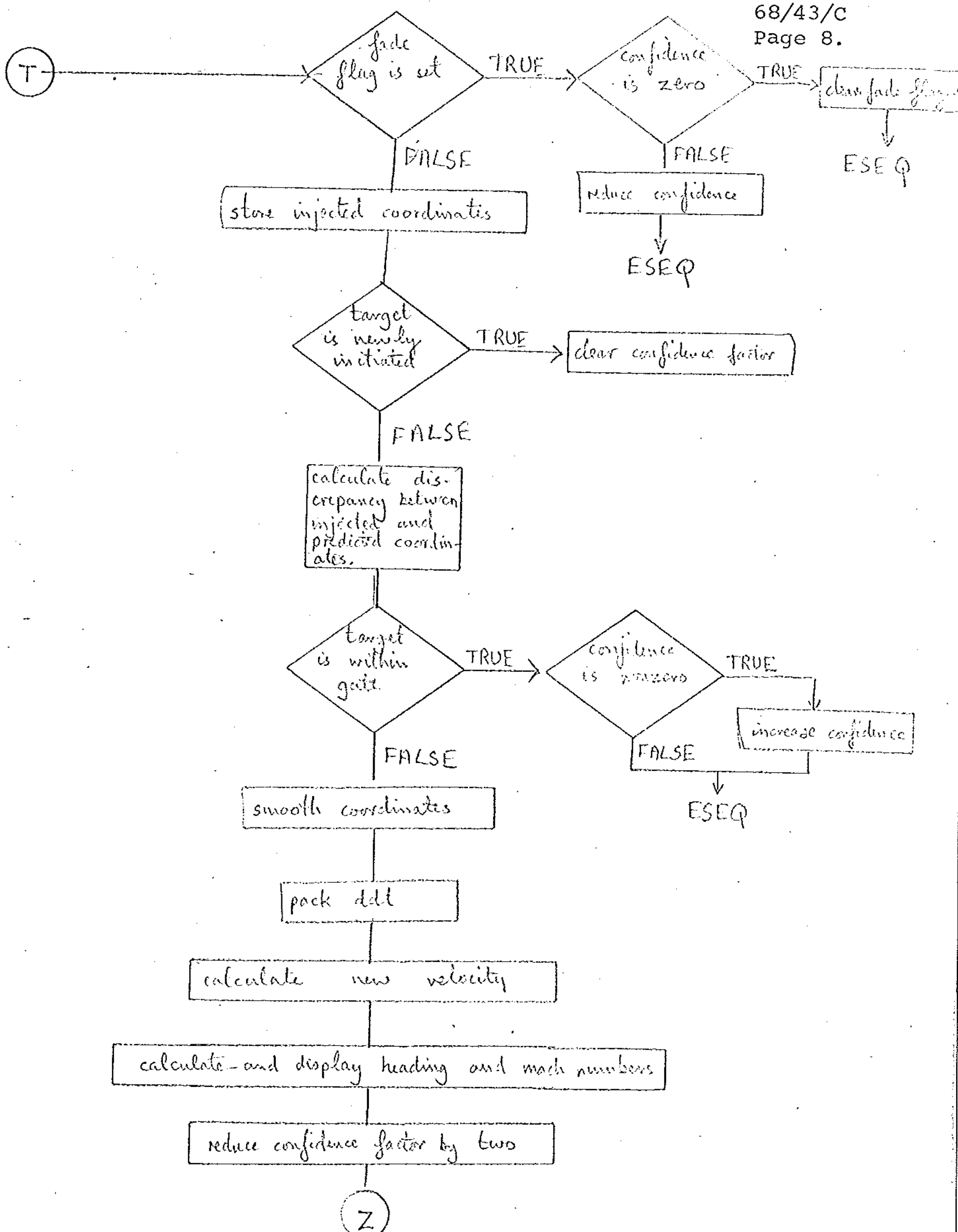
One possibility arises from the study of optimisation, that perhaps the hardware should have one entirely volatile accumulator and one entirely volatile B-register. These would be used exclusively by the translater of a high-level language. Any other registers available may be put under the control of the programmer by providing standard identifiers, as in Appendix 5.

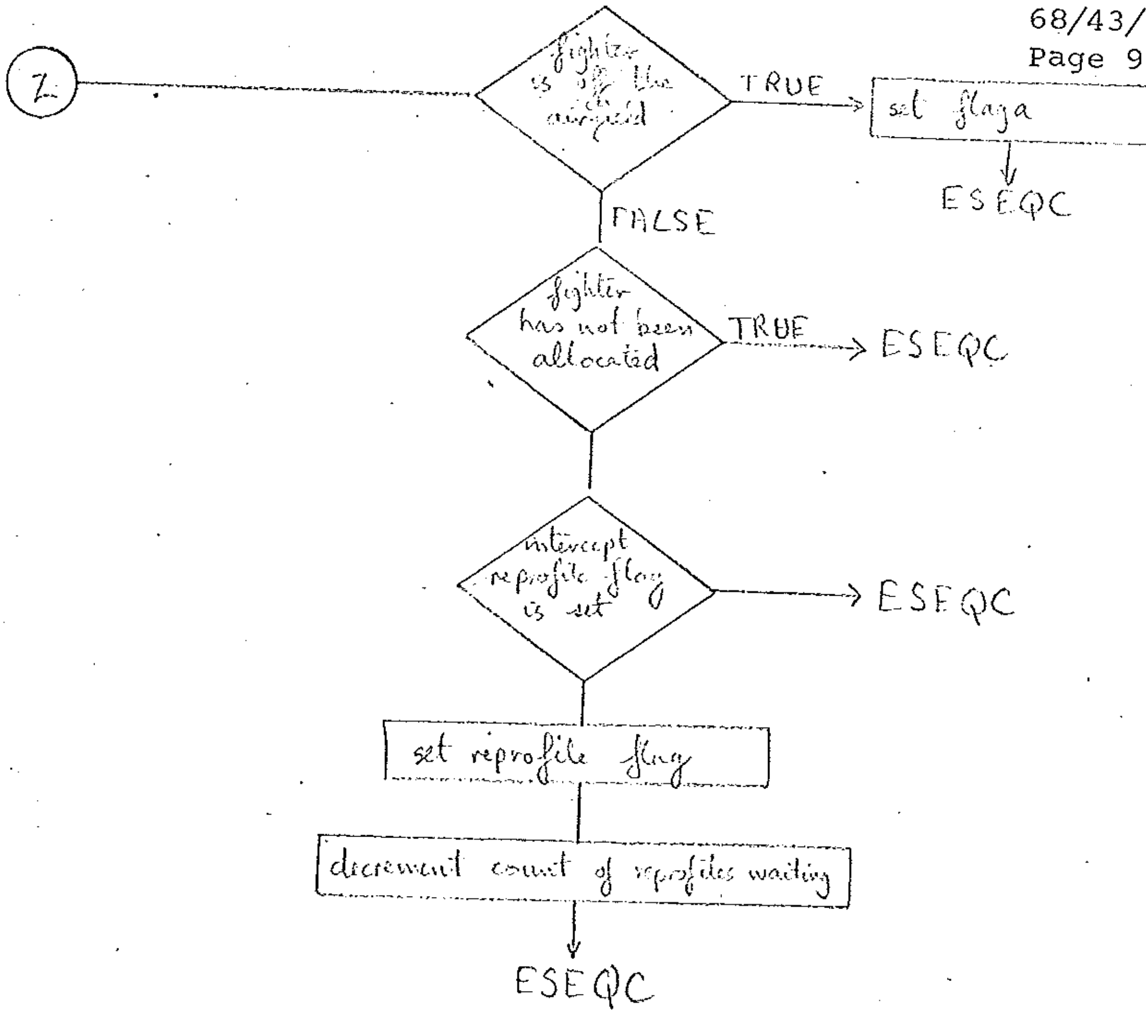
Appendix 1. TRACKING PROGRAM: FIGHTER MODULE.
Flow chart in conventional notation.




F
fade flag is set
TRUE
target was outside gate size
TRUE
S
FALSE
A
store injected coordinates
associated target has been cancelled
TRUE
this fighter is not in recovery segment
FALSE
TRUE
set coordinates to injected values
A
FALSE
calculate discrepancy between injected and predicted coordinates
fighter is within fighter gate size
TRUE
target was outside gate size
TRUE
S
FALSE
A
set coordinates and ddt table to injected value
pack ddt
S


S
reprofile flag is clear
TRUE
set reprofile flag for this intercept
FALSE
A
clear target amendment flag
decrement count of reprofiles waiting
ESEQ


T
fade flag is set
TRUE
confidence is zero
TRUE
ESEQ
FALSE
FALSE
store injected coordinates
reduce confidence
ESEQ
target is newly initiated
TRUE
clear confidence factor
FALSE
calculate discrepancy between injected and predicted coordinates.
target is within gate
TRUE
confidence
TRUE
increase confidence
FALSE
ESEQ
FALSE
smooth coordinates
pack
calculate new velocity
calculate and display heading and mach numbers
reduce confidence factor by two
Z


Z
fighter is off the airfield
TRUE
set flag a
ESEQC
FALSE
fighter has not been allocated
TRUE
ESEQC
intercept reprofile flag is set
ESEQC
set reprofile flag
decrement count of reprofiles waiting
ESEQC

Appendix 2. TRACKING PROGRAM: FIGHTER MODULE
Flow chart in ALGOL notation.

```
EFADE:   set fade flag;

ETRAK:   set console from keyboard;
         set internal track number;
         if track is not in system then go to WRSEQ
         if this is not a vertical point then
            begin if this start has been faded then go to ESEQC;
               clear fade flag;
                  if track is newly initiated then go to ELSFADE;
                                                   else to to ENEWTRAK
            end;

         if this track has been sequenced in this aerial period
         then
            begin clear fade flag;
               go to ESEQC
            end;
```

```
if this is a fighter then
   begin if fade flag is set then
      begin if target was outside gate size
                      then go to SETFREPRO
                      else go to ACLEAR

      end;

 store injected coordinates;
if associated target has been cancelled then
   begin if this fighter is not in recovery segment then
      begin set coordinates to injected values;
        go to ACLEAR

      end;
   end;
calculate discrepancy between injected and prodicted
coordinates;
if  fighter is within fighter gate size then
   begin if target was outside gate size
                      then go to SETFREPRO
                      else go to ACLEAR

   end;

set coordinates and ddt table to injected value;
pack ddt;

SETFREPRO: if reprofile flag is clear then
              begin set reprofile flag for this intercept;
                 decrement count of reprofiles waiting

              end;

ACLEAR;     clear flaga;
            clear fade flag;
            go  to ESEQC

    end fighter
```

```
else
begin comment this is a target;
    if fade flag is set then
       begin if confidence is zero then clear fade flag;
                                        else reduce confidence;
             go to  ESEQC.

       end;

store injected coordinates;
if this target is newly initiated then clear confidence factor
    else begin calculate  descrepancy between injected and
                                             predicted coordinates;
       if target is within gate then
           begin if confidence is non zero then increase
                                             confidence;
              go to ESEQC

           end;

         end;

smooth coordinates;
pack ddt;
calculate new velocity;
calculate and display heading and mach numbers;
reduce confidence factor by two;
if fighter is off the airfield then
           begin set flag a;
              go to ESEQC

           end;

if fighter has not been allocated then go to ESEQC;
if intercept reprofile flag is set then go to ESEQC;
set reprofile flag;
decrement count of reprofiles waiting;
go to ESEQC

end;
```

Appendix 3. Correlation of Comments and Code.

flaga	table of flags for each console, indicating that target was outside gate size.	flaga [0:2]= (0,0,0)
.1	target was outside gate size	flaga [v console] <0
.2	clear flaga	flaga [v console]:=0

tgate	table of gate size for confidence factor. tgate [-1] is gate size for fighter.	tgate [-1:7] = (+1/-5, +2/-5, +1.25/-5, +.9/-5, +.75/-5, + .6/-5, +.45/-5. +.35/-5, +.24/-5)
.1	fighter is within fighter gate size.	discrepancy $\leq$ tgate [-1]
.2	target is within gate.	discrepancy $\leq$ tgate [vcon[vtrack no]]

injected x, injected y,	temporary storage for injected coordinates.	<u>integer</u> injected x, injected y;
.1	store injected coordinates.	injected x : = v rollx [v console] injected y : = v rolly [v console]

fade	flag indicates that the point is to be faded.	<u>integer</u> fade
.1	set fade flag.	fade: = -1
.2	clear fade flag.	fade: = 0
.3	fade flag is set.	fade < 0

v console	number of console which has injected the current trace.	<u>integer</u> v console.
.1	set console from keyboard	v console: = ckbno -1

vtrackno	number of current track	integer vtrackno.
.1	set internal track number	vtrackno: = tabtrak [ptrak [vconsole]]
.2	track is not in system.	vtrackno $<$ 0
.3	this is a fighter.	vtrackno $\geq$ 11

t seqc	table of times of last sequencing for each track.	tseqc [O:23]
.1	track has been sequenced in this aerial period.	tseqc [vtrackno]=tud time [vtrackno]

tx, ty.	tables of x and y coordinates for each track.	tx [0:23], ty [0.23]
.1	set coordinates to injected values.	tx [vtrackno]:= injected x; ty [vtrackno]:= injected y;
.2	set coordinates and ddt table to injected value.	tx [vtrackno]:= bddt3[2]:= injected x; ty [vtrackno]:= bddt3[3]:= injected y;
.3	smooth coordinates.	

```
begin integer smoothing factor, B;
      B:= vtrackno; smoothing factor:= tpos [vcon[B]];
      bddt3 [2]:= tx [B]: = ((.5 - smoothing factor) *injected x
                             + smoothing factor *tx [B]) left 1;
      bddt3 [3]:= ty [B]: = ((.5 - smoothing factor) * injected y
                             + smoothing factor *ty [B]) left 1;
end.
```

bddt [0:3] ? .1 pack ddt.	 bddt 3[1]: = vtrackno <u>left</u> 7 <u>and</u> 130944 +5; PERIPH (4206)

vkon	table of confidence factors for non fighter targets. values range up to 7.	vkon [0:11]
.1	this target is newly initiated.	vkon [vtrackno] ⟨0
.2	clear confidence factor.	vkon [vtrackno]: = 0
.3	confidence is non zero.	vkon [vtrackno] ≠ 0
.4	confidence is zero.	vkon [vtrackno] = 0
.5	reduce confidence.	vkon [vtrackno]:= vkon [vtrackno] -1;
.6	reduce confidence by two.	A:=vkon[vtrackno] - 2; vkon[vtrackno] : = <u>if</u> A ⟩0 <u>then</u> A <u>else</u> 0

Appendix 4. TRACKING PROGRAM: FIGHTER MODULE.
Fully annotated in pure ALGOL.

```
begin integer injected x, injected y, vtrackno, v console;

EFADE:  fade:= -1; /* set fade flag*/
ETRAK:  v console  := ckbno -1/*set console from keyboard*/
        vtrackno:= tabtrak [ptrak[v console]];/* set internal
                                                  track number */
        if vtrackno <0 then /* track is not in system*/
                               go to WRSEQ;
        if vidcount [v console] ≠ 0 then /* this is not a
                                                 vertical point.*/
                begin if fade >0 then go to ESEQC;
                               /* this start has been faded */
                      fade := 0; /* clear fade flag*/
                      if finit [v console]>0 then go to ENEWTRAK
                              /* track is newly initiated */
                                 else go to ESLFADE

                end;
        if tseqc [vtrackno]=tudtime [vtrackno] then
                /* track has been sequenced in this aerial period*/
                begin fade:=0; /* clear fade flag*/
                      go to ESEQC

                end;
        if vtrackno>11 then /* this is a fighter*/
           begin integer injected x, injected y, discrepancy;
                 if fade <0 then /* fade  flag is set*/
                    begin if flaga [v console]<0 then
                                /*target was outside gate size*/
                                  go to SETFREPRO
                                     elso go to ACLEAR

                end;
```

```
injected x := vrollx [v console];
injected y := vrolly [v console];/* store injected coordinates*/
if tabtrak [ptrak[v console]-1]<0 then
   /*associated target has been cancelled*/
    begin if tsegno [vtrackno - 12] ≠ 18 then
                 /* this fighter is not in recovery segment */
                 begin tx [vtrackno]:= injected x;
                       ty [vtrackno]:= injected y;
                       /* set coordinates to injected values */
                       go to ACLEAR

                 end;
LDISCREP; /* calculate discrepancy between injected and
                                                predicted coordinates */
if discrepancy < tgate [-1] then
    /* fighter is within fighter gate size */
    begin if flaga [v console] <0 then
                 /* target was outside gate size */ go to SETFREPRO
                                else go to ACLEAR;

    end;
tx[vtrackno]: = bddt3 [2]: = injected x;
ty[vtrackno]: = bddt3 [3]: = injected y;
/* set coordinates and ddt table to  injected value */
bddt3[1]: = vtrackno left 7 and 130944 + 5;

PERIPH (4206); /* pack ddt */

SETFREPRO: B: = store 2 + vtrackno;
           if frepro [B -12] = 0 then
                 /* reprofile flag is clear */
           begin increment (frepro [B - 12]);
                 /* set reprofile flag for this intercept */
                 frepro [store 2 - 1]: = frepro [store 2 - 1]-1;
                 /* decrement count of reprofiles waiting */

           end;
```

```
ACLEAR: flaga [v console]:= 0; /* clear flaga*/
        fade := 0;  /* clear fade flag*/
end fighter;
/* this is a target*/
else if fade <0 then /* fade flag is set*/
         begin if vkon [vtrackno]= 0 then /* confidence is zero*/
                                 fade:= 0 /* clear fade flag*/
                            elso vkon [vtrackno]:=vkon[vtrackno]-1;
                                          /* reduce confidence*/
               go to ESEQC
         end;
injected x:= vrollx [vconsole];
injected y:= vrolly [vconsole]; /*store injected coordinates*/
if vkon [vtrackno] <0 then /*this target is newly initiated*/
                    vkon [vtrackno]:= 0 /* clear confidence factor*/
else begin  LDISCREP;
            /* calculate discrepancy between injected and
                                    predicted coordinates */
            if discrepancy < tgate [vkon[vtrackno]]then
                  /*target is within gate */
                  begin if vkon [vtrackno] ≠ 0 then
                         /* confidence is non zero */
                          vkon [vtrackno]:= vcon[vtrackno] + 1;
                          go to ESEQ

                  end;

     end;

begin integer smoothing factor, B;
      B:= vtrackno;
      smoothing factor: = tpos [vcon[B]];
bddt3[2]:= tx [B]:= ((.5 - smoothing factor)*injected x
                       + smoothing factor *tx [B]) left 1;
bddt3[3]:= ty [B]:= ((.5 - smoothing factor *injected y
                       + smoothing factor *ty [B]) left 1;
end;       /* smooth coordinates*/
```

```
bddt3[1]:= vtrackno left 7 and 130944 + 5;
PERIPH (4206); /* pack ddt */
begin integer dt, new unsmoothed x velocity, velocity smoothing
            factor, new unsmoothed y velocity, B;
       B:= vtrackno;
       dt:= tudtime [B] - tpretudtime [B];
       new unsmoothed x velocity: = (tprex [B] - injected x)/dt;
       velocity smoothing factor: = trel [vcon[B]];
       txvelo[B]:= (new unsmoothed x velocity * velocity smoothing
                   factor + (.5 - velocity smoothing factor) * txvelo
                   [B] ) left 1;
       new unsmoothed y velocity := (tprey [B] - injected y)/dt;
       tyvelo [B]:= (new unsmoothed y velocity * velocity smoothing
                   factor + (.5 velocity smoothing factor)*tyvelo
                   [B] left 1;
end;     /* calculate  new velocity*/;

LMHDIS; /* calculate and display heading and mach numbers */
A: = vkon [vtrackno]- 2;
vkon [vtrackno]:= if A > 0 then A else 0;
/* reduce confidence factor by two*/
if tabtrak [ptrak[vconsole]+ 1 ] > 0 then
/* fighter is off the airfield*/
begin flaga [vconsole] := -1; /* set flaga */
      go to ESEQC
end;

if tote [tabtrak[ptrak[v console]]+12]= 0 then
   /* fighter has not been allocated */  go to ESEQC
if frepro [store 2 + vtrackno] ≠ 0 then
   /* intercept reprofile flag is set */ go to ESEQC
increment (frepro [store 2 + vtrackno]);
  /* set reprofile flag */
frepro [store 2 - 1]:= frepro [store 2 - 1]- 1;
  /* decrement count of profiles awaiting recalculation */
end.
```

Appendix 5. TRACKING PROGRAM: FIGHTER MODULE.
ALGOL subset with register optimisation.

```
begin   injected x, injected y, vtrackno, v console;

 EFADE:  fade: = -1;
 ETRAK:  B: = v console : = ckbno - 1;
vtrackno:=A: = tabtrak [ptrak[B]];
             if A ⟨O then go to WRSEQ;

        B: = v console;
        if vidcount [B] ≠ 0 then
                   begin if fade ⟨ 0 then go to ESEQC;
                         fade: = fade + 1;
                         if finit [B] ⟩ then go to ENEWTRAK
                                        else go to ESLFADE
                   end;
        A: = tudtime [vtrakno] - tseqc [vtrakno];
             if A = 0 then
                  begin fade: = A;
                        go to ESEQC
                  end;
        if vtrakno ⟩ 11 then
                  begin comment FIGHTER;
                        integer injected x, injected y,discrepancy;
                        if fade ⟨ 0 then
                           begin if flaga [v console]⟨ then go to
                                                  SETFREPRO
                                                  else go to ACLEAR

                           end;
```

```
            B: = v console;
            injected x: = vrollx [B];
            injected y: = vrolly [B];
            if tabtrak [ptrak[B]-1] < 0 then
                  begin comment CANTGT;
                        B: = vtrackno;
                        if tsegno [B-12] ≠ 18 then
                           begin tx [B]: = injected x;
                                 ty [B]: = injected y;
                                 go to ACLEAR
                           end,
                  end;
            LDISCREP;
            if tgate [-1]> discrepancy then
                  begin if flaga [v console]< 0 then go to
                                 SETFREPO
                                 else go to ACLEAR
                  end
            B: = vtrakno;
            tx[B]: = bddt3[2]: = injected x;
            ty[B]: = bddt3[3]: = injected y;
            bddt3[1]: = vtrakno left 7 and 130994 + 5;
            PERIPH (4206);

SETFREPRO:  B: = store 2 + vtrakno;
            if frepro [B - 12] ≠ 0 then
                      begin frepro [B - 12]: + 1;
                            B: = store 2;
                            frepro [B - 1]: = frepro [B - 1]-1
                      end;
ACLEAR:     flaga [v console]:  = fade : = 0;
            go to ESEQC;
            end fighter;
```

```
else
if fade <0 then begin
comment DECRK;
B: = vtrackno;
A: = vkon [B]
if A = 0 then begin fade: = A; go to ESEQC
              end;
vkon (B): = A -1;
go to ESEQC
                end;
B: = v console;
injected x:= vrollx [B];
injected y:= vrolly [B];
B: = vtrackno;
else begin if v con [B] <0 then v con [B]: = 0
LDISCREP;
A: =  discrepancy -  t gate [vcon[vtrackno]];
B: = vtrackno;
if A < 0  then begin comment  INCRK; if vcon [B] ≠ 0 then
                                     vcon [B] : +  1;
                                     go to ESEQC
              end;
begin integer smoothing factor, temp;
      B: = vtrackno;
      A: = smoothing factor : = tpos [vcon[B]];
      temp: = (65536 - A) *tx [B];
      bddt3[2]:=tx[B]:=(smoothing factor * injected x +
                        temp) left 1;
      temp: = (65536 - A) *ty [B];
      bddt[3]:=ty[B]:= (smoothing factor * injected y +
                        temp) left 1;
end;
```

```
bddt3[1]: = vtrackno left 7and 13094 + 5;
PERIPH (4206);
begin integer dt, new unsmoothed x velocity, velocity
                  smoothing factor, new unsmoothed y velocity,
                                                       temp;
      B: = vtrackno;
      dt: = tudtime [B]- tpredtime [B];
      new unsmoothed x velocity:= (t prex [B]- injected x)/dt;
      A: = velocity smoothing factor: = trel[vcon[B]]
      B: = vtrackno;
      temp:= (65536 - A) * txvelo [B];
      txvelo [B]:= (velocity smoothing factor * new unsmoothed
                        x velocity + temp) left 1;
      new unsmoothed y velocity:= (t prey [B]- injected y) dt;
      temp: = (65536 - velocity smoothing factor) * tyvelo[B]
      tyvelo [B]: = (new unsmoothed y velocity * velocity
                     smoothing factor + temp) left 1;
end;
LMHDIS;
B:= vtrackno;
A:= vcon [B]- 2;
vcon [B]: = if A > 0 then A else 0;
B: = ptrak [v console]
if tabtrak [B  + 1] > 0 then
            begin flaga [v console]: = -1;
                  go to ESEQC
            end
if tote [tabtrak[B] + 12] =  0 go to ESEQC;
B:= store 2 + vtrackno;
if frepro [B] ≠ 0 then go to ESEQC;
frepro [B]: + 1;
B: = store 2;
frepro [B - 1]: = frepro [B-1]-1;
go to ESEQC
```

UNOPTIMISED OBJECT CODE

EFADE	4	-1	
	5	FADE	set fade flag
ETRAK	4	CKEYBOARD	
	1	-1	
	5	VCONSOLE	set console from keyboard.
	0	VCONSOLE	
	0	PTRAK	
	4	TABTRAK	
	5	VTRACKNO	set internal track number.
	9	T1	
	0	VCONSOLE	
	4	VIDCOUNT	This is not a vertical point
	9	[	FALSE
	0	VCONSOLE	
	4	FADE	This start has been faded.
	9	[	FALSE
	8	ESEQC	TRUE
]	10	FADE	clear fade flag
	4	FINIT	track is newly initiated.
	9	ENEWTRAK	TRUE
	8	ESLFADE	FALSE
]	0	VTRACKNO	
	4	TSEQ	
	0	VTRACKNO	
	2	TUDTIME	track has been sequenced in this aerial period.
	7	(	TRUE
	4	+ 0	
	5	FADE	
	8	ESEQC)	

Appendix 6. Infix notation for machine code.

```
EFADE: -1 =: FADE;
ETRAK: CKBNO -1 =: VCONNO = : B;
       TABTRAK(PTRAK(B)) ⟨O go to WRSEQ =: VTRAKNO;
       VIDCOUNT (VCONNO) ≠ O (FADE ⟩ O go to ESEQC;
       FADE: + 1; FINIT (B) ⟨O (go to ELSFADE else go to
                                               ENEWTRAK));
       TSEQC(VTRAKNO) ⊖ TUDTIME (B) = O (=:FADE go to ESEQC);

READ: VTRAKNO - 11 ⟨ O go to fighter.
      FADE ⟨O go to DECRK;
      VROLLX(VCONNO) =: W3S(4);
      VROLLY(B) =: W3S(5);
      VKON(VTRAKNO) ⟩ O go to KIN IT
           call LDISCREP;
           TGATE(VKON(VTRACKNO)) ⊖ W3S [VTRAKNO =:B]⟨O go to
                                                    INCREK
KIN IT:,O =: VKON(B);
        (TPOS(VKON(B))=; W3S) ⊖ 65536) *TX(VTRAKNO) =:W3S -(1);
        W3S*W3S (4) + W3S (1) left 1 =: TX(B) =: BDDT 3(2);
        (W3S ⊖ 65536)* TY (B) =: W3S (1);
        W3S * W3S(5) + W3S (1) left 1 =: T7(B) =: BDDT 3(3);
        VTRAKNO left 7 and 130944 + 5 =: BDDT 3(1);
        PERIPH (4206);
        TPRETUDT (B) ⊖ TUDTIME =: W3S (1)
        W35(4) ⊖ TPREX (B) ⊖ (clear auxiliaric register)
        O /W3S(1) =: W3S(3);
        TVEL (VCON(B)) =: W3S ⊖ 65536 * TXVELO(TRAKNO) =:W3S(2);
        W3S(3) *W3S + W3S (2) left 1 =: TXVELO (B);
        W3S(5) ⊖ TPREY(B) ⊖ O / W3S (1) =: W3S (3);
        W3S ⊖ 65536 * TYVELO (B) =: W3S (2);
        W3S(3) *W3S + W3S (2) left 1 =: TYVELO (B);
        call LMHDIS;
        VKON(VTRAKNO) -2 ⟩O (=: VKON (B) else O=: VKON(B));
        TABTRAK (PTRAK (VCONNO) +1) ⟩ O
                (-1 =: FLAGA (VCONNO); go to ESEQC);
TESTOTE: TOTE (TABTRAK (B) + 12) = O go to ESEQC;
        STORE 2 + VTRAKNO =: B;
        FREPRO (B) ≠O go to ESEQC;
        FREPRO (B): +1;
        FREPRO (STORE 2 - -) -1 =: FREPRO (B-1);
        go to ESEQC
```

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DECRX; VKON (VTRAKNO) = O go to ACLEAR (3): - 1 =: VKON (B);
       FADE: +1; go to ESEQC;
INCRX: VKON (VTRAKNO) = O go to ESEQC;
       VKON (B) : + 1; go to ESEQC;
FIGHTER: FADE ⟨O (go to READF);
       VROLLX(VCONNO) =: W3S(4);
       VROLLY (B) = : W3S (5);
       TABTRAK (PTRAK(B) -1) ⟨O go to CANTGT
FIGHTERIO: call LDISCREP;
       TGATE (-1) ⊖ W3S ⟨O go to READF;
       B: = VTRAKNO;
       W3S(4)=: TX(B) =: BDDT3(2);
       W3S(5)=: TY(B) =: BDDT3(3);
       VTRAKNO left 7 and 130944 + 5 =: BDDT 3(1);
       PERIPH(4206);
SETFREPRO: STORE 2 + VTRAKNO =: B;
       FREPRO (B-12) = O go to ACLEAR;
       FREPRO (B-12): + 1;
       B:= STOREZ;
       -1 + FREPRO (B-1) =: FREPRO(B-1)
ACLEAR:B:= VCONNO;
       O =: FLAGA(B)=: FADE;
       go to ESEQC;
READF: FLAGA (VCONNO) ⟨ O go to SETFREPRO
       else go to ACLEAR;
CANTGT:TSEGNO(VTRAKNO - 12)-18 = O go to FIGHTER1O;
       W3S (4) = : TX (B);
       W3S (5) = : TY (B);
       go to ACLEAR.
```