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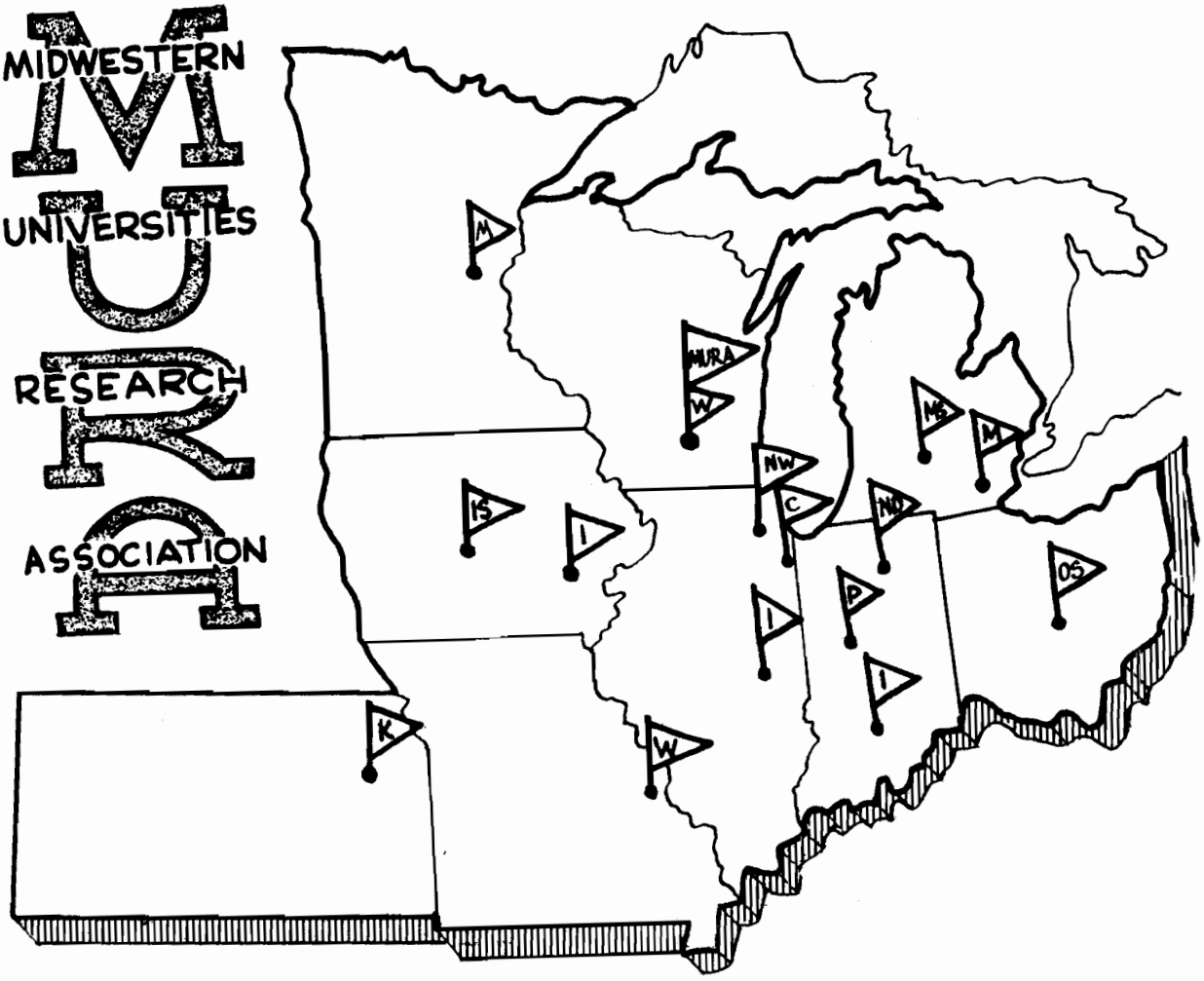

REPORT TTT SCOPE
(Programme 119)
June, 1957

NUMBER 299
Internal
(IBM Program)

TTT SCOPE
Programme 119

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This program augments TTT (Programme 39) with 9800 different modes of cathode ray tube presentation. The gentle reader should consult the write-up of this programme for refreshment.

The seven variables of interest in this problem are:

E, the energy
$(E - E_s)$, E_s is the synchronous energy
ϕ, the phase of the last oscillator passed
x, the betatron oscillation coordinate
p, the betatron oscillation momentum
$a = \sqrt{x^2 + p^2}$
t, the time

All of these variables will be generically referred to as V.

In a "bounded plot" any V can be plotted as ordinate (O) against any V as abscissa (A). In fact two such plots, O_1 against A_1, and O_2 against A_2, can be made. The entire run will be placed on one film frame. This frame will be delineated by horizontal and vertical "axes" at the top, bottom, left, and right edges of the frame. In the upper right hand corner, the Programme ID Number (119) will occur; just to the left of this the Run ID Number will occur. O_1A_1 will be plotted by bright spots; O_2A_2 (if present) by dim spots. (Recall the IBM Cathode Ray Display Units Model 740 and 780 provide two spot intensities.)

In an "unbounded plot" any V can be plotted as ordinate (O) against number of steps as abscissa. A given run can embrace many frames. The first frame of such a run will contain only the Problem ID Number (119) and the Run ID Number. Successive frames will be provided with left, right, top, and bottom edge "axes" and a frame number (1, 2, 3, $\cdots$) in the upper right hand corner. For each spot plotted the abscissa will be advanced N_{DT} positions (recall that there are 1024 possible positions across the face of the scope). N_{DT} does not need to divide 1024 integrally since the routine keeps proper accounts. Due to spot diameter an N_{DT} of about 4 is advised unless the spots are well separated in ordinate. Two V's can be plotted as ordinates (O_1 and O_2) on such an unbounded graph, O_1 in bright spots, and O_2 (if present) in dim spots.

Counting for steps on which to display a spot is identical to the print counting of the normal TTT. No plotting will occur during N_{WOS} steps; then during N_{WS} steps, plotting will occur every N_S steps. The cycle will then repeat. These parameters must be entered (with many others) on the TTT SCOPE AGENDUM SHEET, a sample of which is attached. As in TTT itself, a step is defined as a passage through one of the entities (ANGLE, GAP, or FOIL) out of which the machine is constructed via the SENARIO. The scope counting cycle always begins at the beginning of the N_{WOS} phase at the beginning of a given run. It is impossible to alter this initial phase. Scope display and printing are non-interfering and are carried

out simultaneously. If it is desired to suppress printing one should simply set

$$N_{WOP} > N_E .$$

A variable V is scaled to V^1 by means of:

$$V^1 = \frac{V - V_o}{V_{SF}}$$

V^1 is then plotted horizontally or vertically across the scope face which is regarded as embracing the range:

$$O \leq V^1 < 1 = O \bmod 1$$

If V^1 equals or exceeds 1 the spot will appear from the left (or bottom) edge, i.e. modulo the scope face. If V^1 is negative it will be reflected in the left (or bottom) edge. Space for the V_o, V_{SF} for each V are provided on the TTT SCOPE AGENDUM SHEET.

The type of plot obtained is controlled through two data words; SW1 (pertaining to O_1A_1 in the bounded case, O_1 in the unbounded case) and SW2 (pertaining to O_2A_2 in the unbounded case, O_2 in the unbounded case).

If SW1 = SW2 = 0 no scope presentation will occur on the run.

If SW1 ≠ 0, SW2 = 0 only the O_1A_1 (or O_1) case will appear.

If SW1 ≠ 0, SW2 ≠ 0 the O_1A_1 and O_2A_2 (or O_1 and O_2) cases will appear.

To make up an SW the appropriate pair of the following numbers should be added and recorded on the TTT SCOPE AGENDUM SHEET.

Bounded Cases:

E	1	as ordinate (O)
E - E_s	2	
ϕ	4	
x	8	
p	16	
a	32	
t	64	

E	128	as abscissa (A)
E - E_s	256	
ϕ	512	
x	1024	
p	2048	
a	4096	
t	8192	

Unbounded Cases:

E	-1
$E - E_S$	-2
ϕ	-4
x	-8
p	-16
a	-32
t	-64

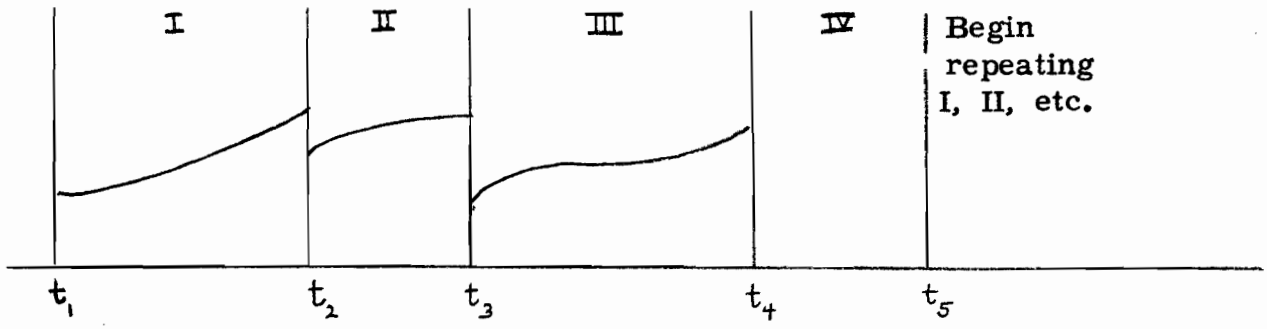
as ordinate (O)

All data quantities are held from run-to-run. Onl those which change need be entered on subsequent runs. Quantities which are not used on a given run need not even be present in the machine. The TTT SCOPE AGENDUM SHEET should be stapled after the TTT SENARIO AGENDUM SHEET but before the TTT AGENDUM SHEETS (or series sheets) of a series of TTT runs. Again follow the rule that when anything changes, the sheet to change it must appear in the stack at the appropriate place.

Sense Switch 3 must be down for scope display to occur. If the switch be raised during a run, the display will stop. However, the phase in the counting cycle will not be lost, so that display will again occur in proper phase, if the switch be depressed.

With respect to ID Number, this programme belongs to Category I so that both a HUMAN ID NUMBER and a RUN ID NUMBER can be embraced therein. This number will be printed properly and displayed properly on the scope.

E_S, the synchronous energy, will have the form



where:

$$(E_S)_I = \alpha_I + \beta_I \left(\frac{t' - t_1}{\tau_I}\right) + \gamma_I \left(\frac{t' - t_1}{\tau_I}\right)^2 + \delta_I \left(\frac{t' - t_1}{\tau_I}\right)^3$$

$$(E_S)_{II} = \alpha_{II} + \beta_{II} \left(\frac{t' - t_2}{\tau_{II}}\right) + \gamma_{II} \left(\frac{t' - t_2}{\tau_{II}}\right)^2 + \delta_{II} \left(\frac{t' - t_2}{\tau_{II}}\right)^3$$

$$(E_S)_{III} = \alpha_{III} + \beta_{III} \left(\frac{t' - t_3}{\tau_{III}}\right) + \gamma_{III} \left(\frac{t' - t_3}{\tau_{III}}\right)^2 + \delta_{III} \left(\frac{t' - t_3}{\tau_{III}}\right)^3$$

$$(E_S)_{IV} = 0$$

Here:

$t^1 = t - t_F \leq t_5 - t_1$

$t_F = n(t_5 - t_1)$, where n is an integer.

The restrictions

$\tau_I > t_2 - t_1$

$\tau_{II} > t_3 - t_2$

$\tau_{III} > t_4 - t_3$ must be observed.

All these quantities may be entered on the TTT SCOPE AGENDUM SHEET.

The quantities FF1 and FF2 on the TTT SCOPE AGENDUM SHEET control the advancing of the film. If they are left unaltered, the advances will be made as described above. If it is desired to place a series of bounded graphs on a single frame

FF1 = 8 338 276 352
FF2 unaltered

should be entered on the second run of the series. (We still want a clean frame for the first run.) If it is desired to place all frames of an unbounded run on a single graph

FF1 unaltered
FF2 = 8 338 276 352

should be entered for that run. If after one of the above options has been taken, it is desired to return to the normal operation described above

FF1 = 8 321 499 160
or FF2 = 8 321 499 160

should be entered on the next run.

If it is desired to magnify a portion of a graph by proper choice of $V^{(O)}$ and V_{SF} without having the modular display of spots which fall outside the range of the scope, one should mark the TTT SCOPE AGENDUM SHEET appropriately in the space provided.

TTT SCOPE AGENDUM SHEET (PROGRAMME 119)

(To be attached by means of staples after the TTT SENARIO AGENDUM SHEET but before the TTT AGENDUM SHEETS of a series of TTT runs on which the cathode ray tube display facility is desired.) (Sense Switch 3 must be down or else no scope display will be made.)

Check if "Magnification and Overflow Suppression" is desired	

INTEGERS

Address	Value	Parameter	Address	Value	Parameter
2226		SW1	2231		N_S
2228		SW2	2232		N_{DT}
2229		N_{WOS}	2368		FF1
2230		N_{WS}	2324		FF2

FRACTIONS

Address	Value	Parameter	Address	Value	Parameter
2233		$E^{(o)}$	2250		$t_3 - t_2$
2234		E_{SF}	2251		$t_2 - t_1$
2235		$(E-E_s)^{(o)}$	2252		τ_I
2236		$(E-E_s)_{SF}$	2253		α_I
2237		$\phi^{(o)}$	2254		β_I
2238		ϕ_{SF}	2255		γ_I
2239		$x^{(o)}$	2256		δ_I
2240		x_{SF}	2257		τ_{II}
2241		$p^{(o)}$	2258		α_{II}
2242		p_{SF}	2259		β_{II}
2243		$a^{(o)}$	2260		γ_{II}
2244		a_{SF}	2261		δ_{II}
2245		$t^{(o)}$	2262		τ_{III}
2246		t_{SF}	2263		α_{III}
2247		t_5	2264		β_{III}
2248		$t_5 - t_4$	2265		γ_{III}
2249		$t_4 - t_3$	2266		δ_{III}

November 3, 1958

MEMORANDUM

TO: Computer Users

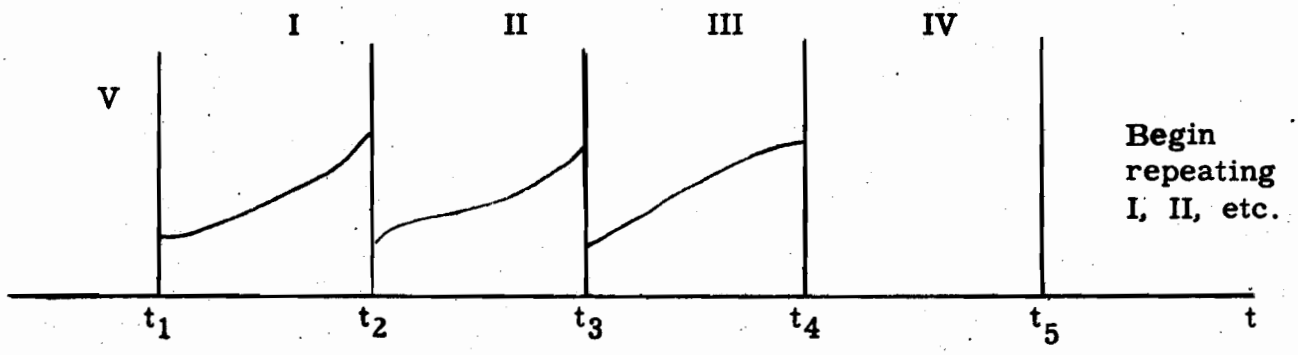
FROM: Jess Anderson

SUBJECT: Computer Program - TTT

The TTT and TTT Scope Programs have been augmented as described below. This memo should be attached securely to and become an integral part of the full write-ups of both programs.

A voltage type 4 ($\alpha_1 = 4$, cf. page 3 of the main write-up) has been provided.

If $\alpha_1 = 4$, V(t) will have the form



where

$$10^4 V_I = \frac{a_I + b_I\left(\frac{t' - t_1}{\tau_I}\right) + c_I\left(\frac{t' - t_1}{\tau_I}\right)^2 + d_I\left(\frac{t' - t_1}{\tau_I}\right)^3 + e_I\left(\frac{t' - t_1}{\tau_I}\right)^4}{f_I + g_I\left(\frac{t' - t_1}{\tau_I}\right) + h_I\left(\frac{t' - t_1}{\tau_I}\right)^2 + i_I\left(\frac{t' - t_1}{\tau_I}\right)^3 + j_I\left(\frac{t' - t_1}{\tau_I}\right)^4}$$

$$10^4 V_{II} = \frac{a_{II} + b_{II}\left(\frac{t' - t_2}{\tau_{II}}\right) + c_{II}\left(\frac{t' - t_2}{\tau_{II}}\right)^2 + d_{II}\left(\frac{t' - t_2}{\tau_{II}}\right)^3 + e_{II}\left(\frac{t' - t_2}{\tau_{II}}\right)^4}{f_{II} + g_{II}\left(\frac{t' - t_2}{\tau_{II}}\right) + h_{II}\left(\frac{t' - t_2}{\tau_{II}}\right)^2 + i_{II}\left(\frac{t' - t_2}{\tau_{II}}\right)^3 + j_{II}\left(\frac{t' - t_2}{\tau_{II}}\right)^4}$$

$$10^4 V_{III} = \frac{a_{III} + b_{III}\left(\frac{t' - t_3}{\tau_{III}}\right) + c_{III}\left(\frac{t' - t_3}{\tau_{III}}\right)^2 + d_{III}\left(\frac{t' - t_3}{\tau_{III}}\right)^3 + e_{III}\left(\frac{t' - t_3}{\tau_{III}}\right)^4}{f_{III} + g_{III}\left(\frac{t' - t_3}{\tau_{III}}\right) + h_{III}\left(\frac{t' - t_3}{\tau_{III}}\right)^2 + i_{III}\left(\frac{t' - t_3}{\tau_{III}}\right)^3 + j_{III}\left(\frac{t' - t_3}{\tau_{III}}\right)^4}$$

$$10^4 V_{IV} = 0.$$

Here

$$t' = t - t_F < t_5 - t_1$$

$$t_F = n\,(t_5 - t_1),\ n \text{ an integer.}$$

The restrictions

$$\tau_I > t_2 - t_1$$

$$\tau_{II} > t_3 - t_2$$

$$\tau_{III} > t_4 - t_3$$ must be observed.

The values must be such that $10^4\ V < 1$ and all quantities entered on the SENARIO AGENDUM SHEET are less than 1.

The data are given by the following set of identified entries just following the GAP entry on the SENARIO AGENDUM SHEET.

TYPE	VALUE	COMPONENT
1	t_5	
2	$t_5 - t_4$	
3	$t_4 - t_3$	
4	$t_3 - t_2$	
5	$t_2 - t_1$	
6	τ_I	
7	a_I	
8	b_I	
9	c_I	
10	d_I	
11	e_I	
12	f_I	
13	g_I	
14	h_I	
15	i_I	
16	j_I	
17	τ_{II}	
18	a_{II}	
19	b_{II}	
20	c_{II}	
21	d_{II}	
22	e_{II}	
23	f_{II}	
24	g_{II}	
25	h_{II}	
26	i_{II}	
27	j_{II}	

28	τ_{III}
29	a_{III}
30	b_{III}
31	c_{III}
32	d_{III}
33	e_{III}
34	f_{III}
35	g_{III}
36	h_{III}
37	i_{III}
38	j_{III}

Some of the time differences may be zero; any quantity which is not pertinent (i.e., is zero) may be omitted, except that card 38 (j_{III}) must be present and must be last.

Note that the time origin $t = 0$ can be at any place on the above graph. The value of t_5 serves to locate the phase of the voltage variation with respect to the origin once the latter has been chosen.

Each run through the machine can be given an initial time t_o (which need not be zero). However, once chosen, the initial time, the time origin, and the time phase of all time varying components must be consistent.

MEMORANDUM

No. 2 of June 25, 1957

This memorandum should be attached to the write-up of TTT SCOPE (Programme 119) and become thereby an appendage thereof.

If the agendum sheet for TTT SCOPE be lucidly and glaringly marked "Use the E_{SA} overwrite", then any computations involving the synchronous energy E_S will use in place of E_S the quantity E_{SA} where

$$E_{SA} = E_{SOA} + C_e V_{PA}$$

E_{SOA} and V_{PA} are two parameters to be entered on the agendum sheet in locations 2247 and 2248, respectively, in place of t_5 and $t_5 - t_4$. C_e is the end counter of the problem and measures the number of steps taken since the beginning of the program. Recall that a step means a passage through one of the entities (GAP, ANGLE or FOIL) out of which the machine is constituted.

June 24, 1958

MEMORANDUM

TO: Users of TTT Scope (Programme 119)

FROM: Jess Anderson

RE: BUCKET PLOT AREA MODIFICATION OF TTT SCOPE (PROGRAMME 119)

The TTT Scope programme has been modified to compute and print the area of plotted buckets. This description of this device should be attached in a permanent and secure fashion to the many augmentations already distributed concerning this programme.

The following properties of the modified programme should be noted:

1. The area routine is called into use by entering the datum -0 at address 2905 in the integer group of the TTT Agendum for each run for which areas are desired. In addition, an integer value for ϵ should be entered at address 2906. This value will be retained from one run to the next; thus it need not be entered after the first time unless it change. If no ϵ is entered by the user, the value 12 will be used. Notice that there are a few blank lines on the TTT Agendum for the insertion of these extra data.

2. This routine applies to "bounded" type plots only, i.e., SW1 must be a positive number.

3. The scope programme provides for the simultaneous plotting of two sets of variables. This routine considers only the first of these two, designated by an O_1A_1 pair on the normal scope agendum.

4. The scope face is treated as a Cartesian plane with its origin at the center and is a 1024 x 1024 raster. Thus the maximum possible area would be $1024 \cdot 1024 = 1048576$ in these square units.

5. The computation of the area begins with the first point plotted and terminates whenever the point just plotted lies within ϵ of the initial point. To prevent the problem from ending with the first few points, should they lie within ϵ of the initial point, the test for termination is not applied for the first 40 points.

6. As soon as this termination criterion is met, the area is printed as an integer identified with an I on its line and the line label 01984. This line will appear without regard to other printing specified by other parameters of the problem.

7. This routine alters in no way other features currently a part of TTT Scope.