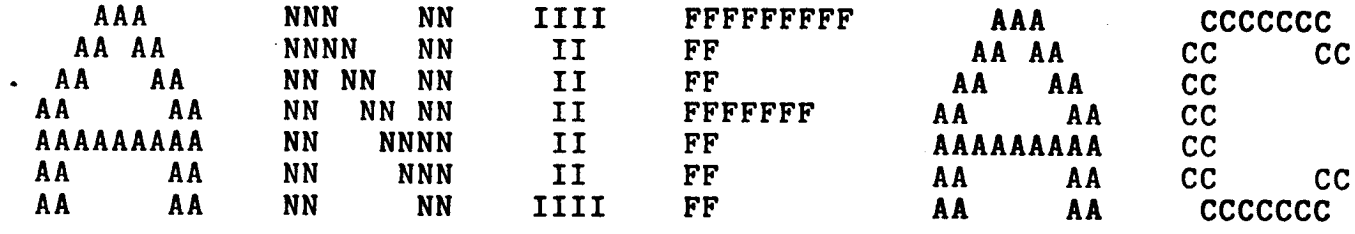



# THE ANALYSIS

## High Volume Production Using System IV Technology In A New Configuration

Presented by Computer Image Corporation Denver, Colorado

# INDEX

# THE ANALYSIS

High Volume Production Using System IV Technology In A New Configuration

## A. INTRODUCTION

### A.1 ANIFAC n

System IV in a new configuration is a new method of producing high volume, animation programming for video distribution. To date, System IV has been used as a single element of a production studio to produce advertising commercials and elements of commercials, training, and education but has never been used in the configuration proposed to produce the high volume, character animation required for series programming. It is, therefore, necessary to present an analysis based on the available and measurable operating characteristics of System IV in its present configuration which provides a realistic test of expectations for the prosposed configuration. Computer Image has named the proposed configuration ANIFAC n (n is equal to the number of workstations).

The main differences between the present configuration and the proposed configuration are in :

a. Facility and production organization
b. Artwork prep. (Paint Box, improved method)
c. Recording process (MLR, improved method)

These will be discussed in detail.

### A.2 Above-The-Line

The conventional "above-the-line", creative effort employed in the production of an animated series or special is essentially the same as for System IV. The major difference in production technique is in the below-the-line method using System IV technology.

### A.3 Below-The-Line

The fundamental objectives underlying the design of the System IV are to provide the means for directing and manipulating characters in visual electronic space, being able to watch the action in real-time (playback at 30 frames per second), being able to make changes in the choreography (action) with ease, on an interactive basis; and being able to record onto video tape for distribution, bypassing the traditional inking, painting and camera.

At present, the images of the characters are manifest in two ways: a) defined by artwork which is contained on a high contrast film (kodalith) and scanned continously by an input camera and b) defined by signals generated internally by System IV's waveform generators. A third method which is being proposed is to augment the function of artwork input using an electronic "paintbox".

By any method of image definition the action is controlled by an extremely powerful comprehensive internal animation control program which is activated when an artist manipulates buttons and knobs on a control panel while in the act of composing key frames. Two or more key frames have the effect of specifying such actions as bending, volumetric distortions, rotations, translation, flips, pops, color changes, etc. of the various parts (arms, eyes, etc.) of a figure over time. Velocity changes, (fairings such as, slow-out, slow-in slow-out, slow-in, pop, linear) are also specified before playback to produce the desired action on the in-betweens.

These methods (definition of characters with artwork and key frame manipulation of the artwork with automatic production of in-betweens) provide an extremely high ratio of finished animated frames to original art frames (kodaliths). That is to say, all of the action of a character might be specified by several pieces of original art. The more a character is used in a production (as a series, or special) the higher the ratio becomes.

## B. ORGANIZATION

### B.1 Production Organization

The production organization is designed to combine the best features of machine animation with creative capacities of animators and directors to provide the highest volume, best quality animation. Animators (artists who breath life into drawings) sitting at work stations compose key frames and program fairing commands and coordinated background moves to produce the actions called for by the storyboards. Basic timing is provided by exposure (or bar) sheets. Key frames and playbacks displayed on repeater monitors are viewed by the animation director who oversees the several work stations involved in a production. A technical director takes control of the recording process when scenes are approved by the director.

Prior to production, characters are assigned to individual animators who prepare the breakdowns for artwork preparation under the direction of the character designer(s). Also prior to production, the animators prepare command files and proceed to animate the basic library of actions that will be used in the story line with guidance by the character designer(s) and under the direction of the animation director. This individual and team familiarization process is an overhead preproduction expense which pays dividends as production begins, both in speed of production and consistency of character. Learning curve production expenses are reduced (Hanna Barbera pays twice as much for below-the-line production costs of the first episode in a series as for the fourth episode).

## B.2 Departments

### a. CREATIVE, Above-the-line

Computer Image has found there not be much difference in the creative processes required than in those required for conventional character animation. Writing, layout, sound recording character design and direction all have to be good for the product to be good. Of course, there are differences in that experimentation with character actions, "schtick" and special effects are so fast, easy and fun that feedback from the electronic below-the-line activity can influence the creative aspects of production (note: Dave's & Rob's experiments) and certainly provide new ideas for characters, and perhaps stories.

One important difference should be noted. Due to the library and recall characteristics of System IV technology, individual character actions can be combined and recombined with other such actions, making the production of what appears to be newly animated sequences very economic.

The creative department consists of (show) directors, freelance writers, animation directors, character designers, layout artists, freelance actors, storyboard artists, sound recording capability and background designers and artists. Some of the production artists may actually work in the Art Department. Directors, who are assigned by the producer, are responsible for completing a show on schedule, within budget and studio quality. The director and the animation director can be the same person depending on the length and complexity of a show.

The staff of creative department should be capable of delivering the designs, storyboards, character designs, layouts, sound tracks and exposure (bar) sheets that are needed by the below-the-line, production departments.

### b. PRODUCTION, Below-the-line

The below-the-line is organized into three departments; ART, ANIMATION, and POST PRODUCTION. These departments are managed by the production manager and are controlled by the director in charge of a production during a production.

## B.2.1. Art Department

The art department headed by the art director consists of a staff capable of providing all of the art production support required by the animation department. Within their combined talents, the artists should be able to produce mechanical line drafting, film overlay cutting, (logo) design, rough layout drawings, black and white stat cammera work, full color studio camera card, illustration, air brushing, all phases of paste-up art including typesetting, and comprehensive storyboards. Our experience has shown that artists who see a character breakdown and watch the animator manipulate the elements electronically, quickly develop an understanding of the process of electronic production. With a little experience, the artist becomes aware of the special requirements of video

reproduction and is soon collaborating effectively with the animators in the production of kodaliths.

The art director should have experience relating to the requirements mentioned (above) and should be trained in electronic techniques in Denver along with other key members of the studio. Prior knowledge of video is helpful. In addition to the now conventional methods of artwork preparation, a proven new method known generically as "paint box" is included in the proposed facility for use by the art department. With paint box, high resolution, full color art cells can be produced rapidly and with ease by an artist using a stylus on a tablet. The picture is stored in a digital memory for transmission to a work station (high resolution frame store) when needed. More important than the speed and convenience afforded by this device is the consistency of geometry and color provided when a character is recalled periodically for animation. The animator cannot be plagued by misadjustments of the high resolution camera which continuously scans the input artwork (kodaliths), which is sometimes the case, now.

The Art Department also contains the background production group and the background studio which consists of panners, studio camera(s) and model manipulators.

B.2.2 Animation Department

The Animation Department consists of a staff capable of transforming creative ideas as manifest in storyboards, soundtracks, layouts exposure sheets and character designs into finished production. The animation department is organized into teams consisting of a director, an animation director, a technical director and animators sufficient to meet the requirements of a production. Lengthy productions may require that there be assistant directors. The director is responsible for coordinating the art production, animation and post production. The Animation Director is responsible for quality and consistency of the action, color and timing and directs the animators. The Animation Director should be well versed in machine animation and all phases of art prep and preproduction and should be trained in Denver. When the director approves a scene, the technical director supervises the recording. He records the scene using the MLR compositor and is responsible for quality control of the video record with executive responsibility for the VTR logs.

The director, animation and technical directors sit at the director's console and oversee production via monitors, in audio-head-set-contact with the animators and librarian who retreives art, animation and computer command-file tapes previously programmed. The director has a computer monitor which gives access to a "catalogue" program (data base management system) with which the directors keeps track of scenes and actions being produced for monitoring the work flow and for use later in editing during post production.

The animation director schedules the production of scenes on various work stations, checks the art requirements, calls for hook ups to the background panner(s) and coordinates the flow of picture information between work stations for animators working on the same scene (ganging).

The output of the animation department is the A&B roll video tape recordings of completed animated scenes ready for editing. The use of MLR for recording the scenes is a variation on existing methods. The advantages are higher quality, greater control of consistency and significant savings in the time required for making mulitple layer recording. The MLR will be discussed as a separate issue.

### B.2.3 Post Production Department

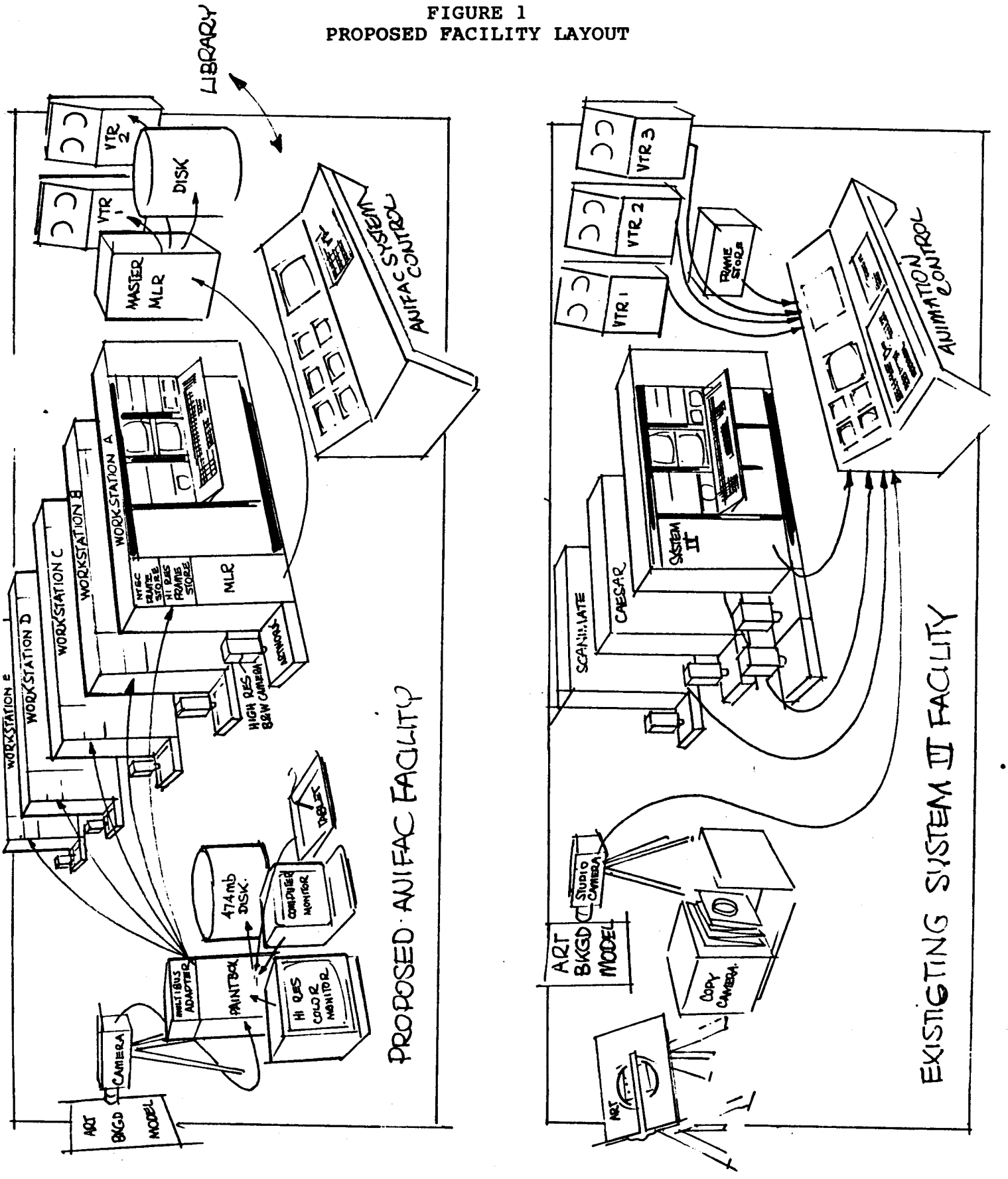
The Post Production department consists of a small staff capable of performing post production assembly (editing) of the scenes into a finished show, adding commerical breaks, and/or credits as required. The talents required are readily available in the video industry. In addition to the VTR, editor and switcher, a character generator, studio color camera and digital video effects are being recommended.

## B.3 Proposed Facility Layout

The organization of the production process goes hand in hand with the facility layout. Such a layout is a function of the availability of useful tools which support the objective, which is to lower the cost of animation production, while maintaining or improving quality. Since 1967, Computer Image has pioneered the commerical developmment of electronic animation and until recently ancillary or supporting technology was neither available nor proven economic for the high volume markets. Our experience dictates that frame store, paint box and other high speed digital processing technologies which are now available be incorporated into the facility layout being proposed.

Figure 1 is a diagramatic representaton of the proposed facility layout which includes a comparative representation of the existing facility for comparison.

FIGURE 1
PROPOSED FACILITY LAYOUT



## C. ANALYSIS OF PRODUCTIVITY (Finished Minutes of Animation Per Unit Of Time)

In making assessments of a production processs, "critical path analysis" (CPA) is often used. CPA is merely a method of outlining the serial and parallel interconnections of sequences of sub processes which contribute to the production of a product. The "Critical Path" in a process is that part which can be most costly and unbalancing of all the other parts if not performed in a timely and economic manner. It can therefore, affect the economics of the product most critically. In animation, it is the part called "below-the-line" and specifically, that which is addressed by machine animation and videotape recording. (Key frames, in-betweens, inking, painting, camera). Therefore, the analysis of productivity centers on two of the sub-processes, a) animation by machine (key frames, in-betweens, inking, painting) and b) video tape recording (camera).

### C.1 Animation by Machine

For the analysis to be comprehensive and usefully extrapolateable the first step is to attempt to determine what is meant by finished animation. For example, terms like "complex" or "Disney" or "Hanna Barbera" or "Simple" or "Industrial" are often used in an attempt to quantify different types of animation with regard to their different costs of production while simultaneously relating an understanding of quality. As the cost of machine animation is directly related to the number of finished minutes of animation produced in a given period of time, as: finished minutes per 8-hour shift, per unit of cost. (A unit of cost can be related to the cost of equipment and people with overhead to run the equipment.) So, in order to know what is meant by "Finished Animation" so that quantitative analysis can be applied, it is defined in terms that can be understood, analysed and projected with regard to requirements of a storyboard, and of course, measured in actual performance.

The first parameter introduced is: "Composition Time per Key Frame". (Minutes per key frame.) An animator, sitting at a work station console composes a character pose known as a key frame. The animator is answering three questions; "which", "what" and "how much". "Which" refers to "which" of the individually animatable pieces known as sections that define the character. "What" refers to "what" do you want to do with each section, i.e., the number of machine parameters that are to be applied to each section; as: translate, rotate, stretch, bend, etc. "How much" refers to "how much" of the parameter is applied by turning a knob. This process is repeated until the image of the character and all its parts are composed as required by the pose on that keyframe. The COMPLEXITY of the animation dictates the amount of time this will take for each key frame. Complexity is a function of the number of sections and the number of parameters that must be adjusted for each section. Experience has shown that an estimator of production time gains a familiarity with other parameters that influence complexity, such as the requirments for matching the action of one character with another or with backgrounds.

The next parameter to be introduced is "KEY FRAME DENSITY". This parameter is a measure of the number of key frames that need to be composed for a given length of finished animation. It can be seen that it takes longer to animate a scene that has a higher number of key frames than a lower number. It can also be seen that a cycle that may be specified by say, 6 key frames, but is repeated several times causes a reduction in overall key frame density.

These two parameters, "Composition-time-per-key frame" and "key frame density" essentially marry the vagaries of "types" of animation to the cost of machine production, and can be used in analysis and measurement of productivity. The production of in-betweens is of course, automatic, and in-betweens are"shot on ones"; which, at 30 frames per second produces high quality action.

## C.1.1 An Estimate Of Productivity

An estimate of (animation) productivity per work station can now be made using the two parameters "composition time per key frame" and "key frame density". Assumptions have to be made however regarding the type of animation so that key frame densities and composition times can be specified. We define average animation as typical of good quality, "Saturday Morning" programming. The estimates herein were made by Computer Image animators.

### C.1.1.1 Assumptions

a. Overall

1. Animator is familiar with character and its key frame poses.

2. Adequate and attentive animation direction and approval is available.

3. Artwork prepared properly for scenes being animated.

4. Preproduction, character familiarization including basic library is complete.

## C.1.2 Estimates related to animation type

a. Animation mix in an average episode
   1. 40% new animation non repetitive with lip sync
   2. 30% cycle animation
   3. 30% library supplemented animation

b. Average of animated equivalent characters per scene=2

c. Number of animatable elements per character = 6 to 10 average 8.

d. Key frame density, (3 to 6 K.F.'s/sec. is full animation, lots of personality, superior to Sat. a.m.) estimate for new animation - 2-1/2 key frames/second average. (Will give impression of full animation)

## C.1.3 Estimate of Composition Time

Estimate of composition time per key frame, based on 2b and 2c above is between 2 and 5 minutes per character. Estimate 4 minutes per character.

a. Calculations of rates of animation based on estimates.

Rate A
2.7 s/h: 1. RATE For New Animation (40% of an episode)

4 min/key frame X 2 1/2 key frames/second, character X 2 character/scene = 20 minutes for one second of a 2-character scene It takes 10 to 20 minutes to type in lip sync for 20 seconds of animation per character for an average (worst case) of one minute type time per second of animation per character. Therefore, add 2 minutes for lip sync for each second of 2 character animation for total of 22 minutes to produce an average second. Thus, the rate of new animation (Rate A) is equal to 60/22= 2.7 seconds per hour.

Rate B
7.5 s/h: 2. RATE For Cycle Animation (30% of an episode)

The average time required to produce a cycle of 5 seconds duration is composed of insertion time (10 minutes) and transition time (animating smooth entry and exit from cycle) (30minutes) for a total of 40 minutes per 5 seconds of animation. Thus, the rate for cycle animation is equal to 60/40 X 5 = 7.5 seconds per hour.

Rate C
10 s/h: 3. Library Supplemented Animation (30% of episode)

It is estimated that 2 to 3 scenes of 4 seconds in length can be composed from previously animated material in one hour of machine animation time. Thus, the average rate for library supplimented animation is 2.5 X 4 = 10 seconds per hour.

## C.1.4 Calculations

To calculate the average amount of animation that can be produced at a work station in an 8 hour shift, applying the estimated "mix" of the estimated rates, the following formula is used:

Rate X Time = Amount produced
R X T = P

That is:
Seconds Finished/Hour of work X hours of work = seconds finished

There are three rates (A, B, & C) and three different amounts required due to the "mix". To solve the equation for these variables we can assume a total amount to be produced, say 100 seconds. (A plug variable). From that we can calculate the amount that needs to be produced (i.e., 40%, 30%, 30% of the 100 minutes) and then the time required for each amount at each rate. When we add up the time to get total time for producing 100 seconds of the mix, we can calculate the average amount of production (in seconds) per unit of working time (in-8 hour shifts).

a. Rate A New Animation, 40% of episode (40 seconds)
R X T = P
2.7 seconds/hour X T (hours) = 40 seconds
T = 40/2.7 = 14.8 hours

b. Rate B, Cycles, 30% of episode (30 seconds)
7.5 (seconds/hour) X T (hours) = 30 seconds
T = 30/7.5 = 4 hours

c. Rate C, Library 30% of episode ( 30 seconds)
10 (seconds/hour) X T (hour) - 30 seconds
T - 30/10 = 3 hours

d. Total hours to produce 100 seconds of animation is 14.8 + 4 + 3 = 21.8 hours.

e. The average rate of production (estimated) for episode material is:

21.8 hours for 100 seconds or
100/21.8 = 4.58 seconds per hour per work station
or 8 X 4.58 = 36.6 seconds per 8 hour shift per work station

This estimate fits conservatively into the ballpark of limited experience that Computer Image has had to date with production running times of more than 60 seconds. With two-shift operation (using the third shift for recording and maintenance). A facility consisting of an ANIFAC 4 (4 work stations) could produce (by this estimate) 4 X 2 X 36.6 divided by 60 = 4.8 minutes per day or 4.8 X 5 = 24 minutes per 5-day week.

### C.1.5 Measurements of Productivity

Tests will be conducted and timed to assess productivity under various conditions of animation complexity and mix. Artwork has been prepared for 2 scenes taken from a storyboard supplied by the Reid group. The soundtrack has been read and bar sheets prepared. No preliminary familiarzation or librarying of moves or cycles or command files have been prepared in advance. When the artwork is placed on the input camera light box, it will be for the first time.

The first scene was chosen for purposes of showing high production rates when cycles and far & medium shots are used, and to show moving backgrounds under animator control. The second scene was chosen to show richness of character expression and lip sync techniques in medium to close up.

We expect to measure the time it takes to compose key frames under these conditions, and derive an average time. This measurement will be helpful in assessing the time it may take to animate scenes of varying complexities, where complexity is a function of number of sections number of parameters per section and key frame density.

We also expect to measure the ammount of animation programmed during the time we're working on the two test scenes mentioned.

There will also be 2 "wing it" tests. In the first "wing it" the artwork already will have been prepared. In the second "wing it" artwork will be prepared based on definition provided by the Reid group. Machine experimentation will be demonstrated and attempts will be made to meet unknown, directorial objectives.

In order to assist in extrapolating the results of measurements taken, a graph (Figure 2) has been prepared which shows the relationship between finished seconds of animation per workstation per hour and the number of finished minutes per week assuming 2-shifts per day, 5 days per week for an ANIFAC 2, ANIFAC 4 and an ANIFAC 6.

### C.2 Video Tape Recording

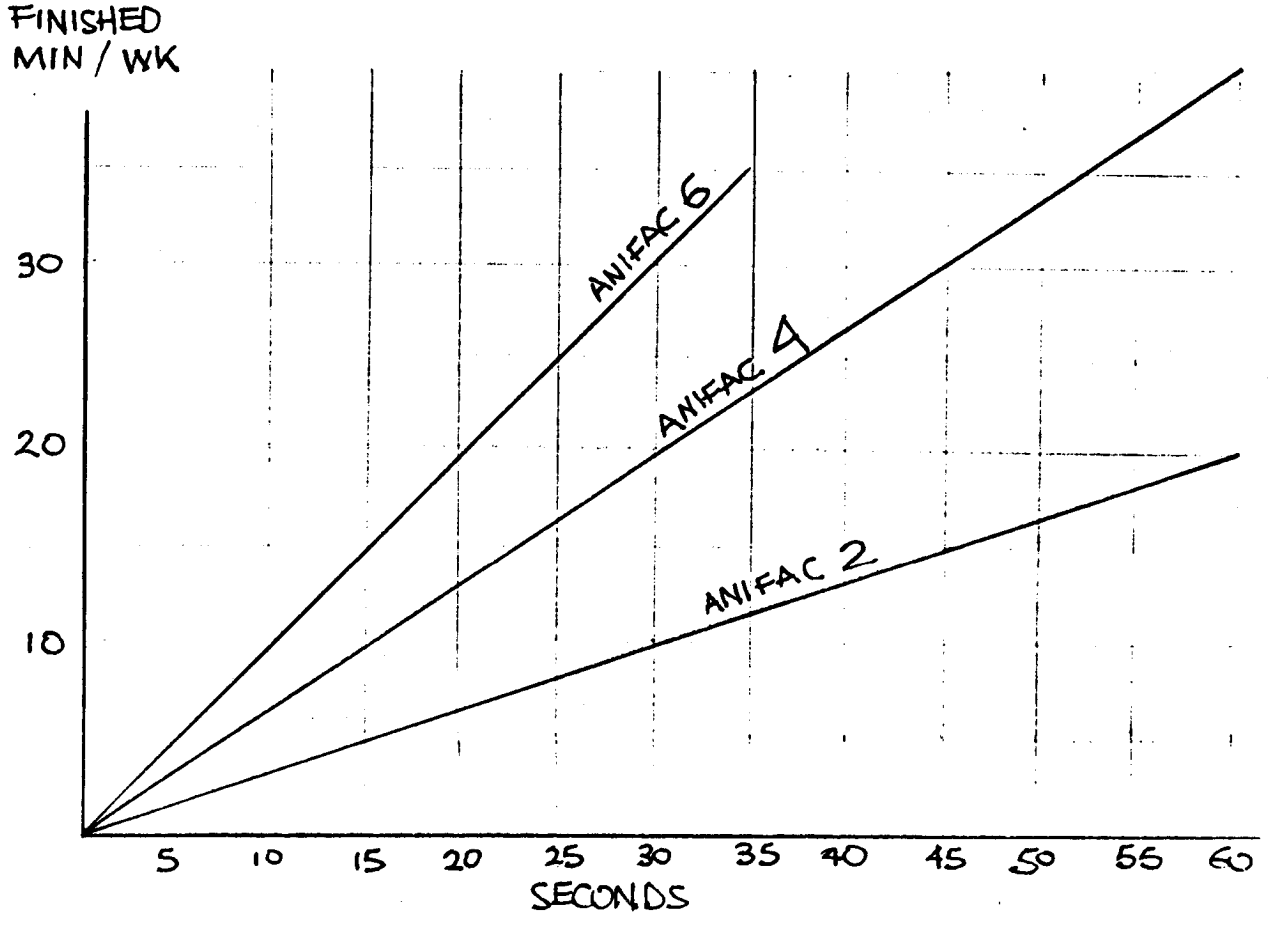
Video tape recording is also on the critical path since a machine work station is tied up during playback of the animation to a VTR for recording. The recording presently in use in the Denver facility would be a bottleneck for the high volume production requirements of an ANIFAC facility.

The process for recording the video is similar to the process used in film compositing where multiple exposures are matted together in repeated passes through an optical printer. Each piece or section of video is recorded separately, and each subsequent piece is "keyed" over the previous recording. This process is called "Multiple Layer Recording" or sometimes, "Multiple Pass Recording."

Three things are accomplished by this technique. First, portions of a character or object that are visually in front of other

portions can be made to electronically occlude the unseen portions, as these two layers are processed in a video switcher. Second, the process works in real-time at video rates, which was required until recently because video tape machines recorded at one speed only, 30 frames per second. Third, the color quality as well as the capability of being able to introduce animated surface characteristics (as in shining metalics) is accomplished in this technique.

FIGURE 2
EXTRAPOLATED MEASUREMENTS GRAPH




Seconds animated per 8-hour shift. Assuming two 8-hour shifts per day, 5 days per week for 2, 4, and 6 workstation.

n=sec./shift/workstation
2n=sec./2 shifts/workstation
10n=sec./2 shifts/workstation/week

ANIFAC 2 $n \times_{1} 20 = n \frac{20}{60}$

ANIFAC 4 $n \times 40 = n \frac{40}{60}$

ANIFAC 6 $n \times 60 = n \frac{60}{60}$

However, as the number of passes increases, analog noise and color shifting begins to degrade the quality of the finished product. Also, the non-automated machine and color alignments are time consuming. It may take from 5 to 20 minutes to record a single pass. If a scene requires 8 layers, the recording time becomes a major factor in the production time.

To attack this problem, Computer Image has designed an automated process called "MLR" using state of the art technology and components. It removes any limitation on the number of passes in any scene, and makes each analog recording a "First Generation". This is accomplished by changing the animated video signal into a digital video signal and circulating and keying each layer in the digital domain until the frame is composited. When complete, it is recorded frame at a time on a single frame tape recorder. This process dovtails neatly with the slow motion playback feature of the System IV. The automated features of the combined systems will not only improve quality and diminish the time required for recording, but also allow the recording of large quantities of animation to be recorded on the third shift.

## D. CONTRACTS, GENERAL SUGGESTIONS

The design of an ANIFAC facility is very flexible. It can and should be designed to meet the economic needs of the varieties of animation productions that are required in the business plan. It will be helpful to have as specific information as is available with regard to the types of production (lengths, complexities, etc.) contemplated.

Should Computer Image be successful in proving that an ANIFAC facility is a good investment for the REID group, then it is suggested that we proceed generally as follows:

### D.1 Facility Design

We propose to begin immediately on the design of a turnkey facility. Such facility would be built and tested in Denver, and used for basic portions of the training of key individuals of the production team prior to shipment. Such design would include the specification of all equipment, layout, wiring and cabling diagrams, power and cooling layout as well as specifications of all support material for operation, maintenance and man loading. The cost of the design would be applied as a credit towards the cost of the facility equipment. ($25K/work station).

### D.2 Manufacturing

We propose to begin immediately and concurrent with the facility design, to manufacture a minimum number (to be determined) of System IV work stations and order all long-lead-time items which can be specified immediately and which are necessary to complete the facility as quickly as possible. We believe that 4 work stations can be integrated into the facility in 6 months, with additional work stations available, approximately one every two weeks. The 2 per month manufacturing rate will be achieved in the 4th month from start. Individual operator training can start about the 4th month.

The cost of the ancilliary units which with the work stations comprise an ANIFAC facility will cost approximately $750K to $800K. Such equipment includes 1-main MLR, 2 single frame recorders, 1-Hi Res Paint Box system, switcher, monitors, and internal communications equipment in the director's station. System IV work stations cost $800K each. A video post production facility costs approximately $600K and will be ordered assembled by Computer Image as part of the turnkey operation for cost plus 12%. (All amounts in U.S. dollars, FOB Denver.)

## D.3 Developments

Various improvements and developments are underway at Computer Image which will be discussed and made available to the Reid Group when they are ready. For discussion purposes they are:

a. Program conversion to "C".
b. Automatic track reading for lip sync

## E. ANIMATION TEST MEASUREMENTS and EVALUATION of the RATES OF PRODUCTION by TASK

### E.1 Test Logs

The total time it takes to complete an episode or a scene is the sum of times required to complete all of the tasks in the production process. All the tasks that might be used in any production are listed on each test sheet. The tasks are categorized as to: 1) the frequency (once or repeated) with which they are normally engaged-in per episode, per scene, or per art input (designating character camera angle) and 2) whether or not these tasks require machine time. By these means of classification, the tasks which comprise the above-the-line and pre-production overheads are clearly delineated. Further, tasks can be grouped to measure different production rates that were discussed in the analysis. For the tests being conducted, the tasks which have been completed prior to the test are so indicated - with completion times recorded where known. For the "wing it" test where art breakdown and preparationn have not been completed, the times for these tasks to be completed will be measured.

Columns for start and stop times are provided on the test sheets so that exact logs of each task can be kept for easy summation and computation of rates of the completed animation.

### E.2 Types of Animation Strategies, a brief listing

Computer Image animators use various animation strategies to produce various results. These will be demonstrated and discussed during the tests.

a. Single Frame - To use delta-phase modulation;

   1. Elements (like the fish) are made to undulate continuously with the application of waveforms which may be simple or complex cycles.

b. "DEAD SIMPLE" - Two key frames only to produce gentle soaring, zooms, etc.

c. Pose-To-Pose- For control of;
   1. Prescribed path of a character.
   2. Timing.
   3. Re-use of previously animated poses and/or sequences.

d. Straight-Ahead for spontenaity, excellent for experimentation.

### E.3 Abbreviated Glossary of Terms Describing Tasks

1. STORY - Developing and writing the story and script.

2. CHAR. DES - Designing and specifying the look and action characters, and lively objects.

3. STORYBOARD - Drawing the storyboard, a series of pictures which describe the story.

4. LAYOUT - Preparation of drawings which show the detail of the sets, backgrounds and actions within the scenes.

5. TALENT - Selecting voices to go with the characters.

6. RECORDING - Sound recording (on separate tracks) the voices, sound effects and background music for the episode.

7. BACKGROUND - Preparation of painted or electronically animated, special effect backgrounds.

8. READ S. TR. - Read the soundtrack to prepare bar sheets or exposure sheets.

9. PREP BAR SHTS. - Prepare bar sheets which describe character actions including lip sync relative to frame numbers on which action occur.

10. BRKDN. DES. - Breakdown design, animator draws the individual parts which make up a character as they will be seen from camera angle specified for scene.

11. ART PREP - Transforming the breakdown designs onto cells ready for animation.

12. LOAD ART - Placing cells onto light box and adjusting input camera or electronic equivalent.

13. BUILD C.S. - Build control structure. Control structure is one of four machine operating modes in which preliminary control information is specified as it applies to a character or object to be animated. (Electronically cut into individually manipulatable pieces) and organized for hierachical programming, and assigning required activating parameters, etc. This is sometimes called the "getting-ready-to-animate" mode.

14. RETRV C.S. - C.F. - Retreive a control structure command file previously prepared.

15. KF ANIM - Key frame animation, composing key frames.

16. BUILD CYCLES - Setting up key frames in a sequence to produce a cycle of motion.. Includes flipping through key frames and playback of cycle before repeats and insertions.

17. INSERT CYCLE - Inserting a cycle into scene, causing repeats of cycle and blending into transitional action if required.

18. ANIM BKG. - Animating (panning, zooming) of background.

19. ANIM SFX. - Animating special effects.

20. MACHINE COMPILE - Machine compile, time taken by System IV preparing for playback.

21. PLAYBACK - Playing back the compiled animation in real time or slow motion, (if specified).

22. RETRV FM DISK - Retrieval of previously stored command files, key frames, cycles or animated scenes from System IV`s disk.

23. MULTI CHAR REG. - Registration of actions of multiple characters and/or objects.

24. POPS (ACF lip sync) - Type of animation produced by poping between different elements on the art work, such as head turns and lip sinc.

25. ROTOSCOPE TO BKG - Registration of character and/or object actions with backgrounds.

26. RECOMPOS - Retrieving previously prepared actions and recomposing them to form apparently new action.

26. VTR - Video Tape Recording.

27. POST EDIT - Editing finished scenes to final form.