

---

# **Jason Freeman**

---

# **Glimmer**

---

**for chamber orchestra  
and audience**

---

# **Score**

**Jason Freeman**  
**Glimmer (2004)**  
**for chamber orchestra and audience**

copyright © 2004 by Jason Freeman

**Glimmer was commissioned by the American Composers Orchestra,  
Steven Sloane, music director, Robert Beaser, artistic director,  
Dennis Russell Davies, conductor laureate.**

**This work was funded in part by the Composer Assistance Program of  
the American Music Center.**

**Additional thanks to Akademie Schloss Solitude (Jean-Baptiste Joly,  
director) and to the Columbia University Computer Music Center  
(Brad Garton, director).**

<b>Supplementary DVD Contents</b>	<b>2</b>
<b>About the Piece</b>	<b>3</b>
<b>Duration</b>	<b>3</b>
<b>Instrumentation</b>	<b>3</b>
<b>Notes About Specific Instruments</b>	<b>4</b>
<b>Seating</b>	<b>5</b>
<b>Notes for the Audience</b>	<b>7</b>
<b>Notes for the Conductor</b>	<b>9</b>
<b>Notes for the Performers</b>	<b>10</b>
<b>Notes for the Management</b>	<b>11</b>
<b>High-Level System Overview</b>	<b>13</b>
<b>High-Level Software Overview</b>	<b>14</b>
<b>High-Level Hardware Overview</b>	<b>24</b>
<b>Notation</b>	<b>29</b>
<b>Pitch Map</b>	<b>31</b>
<b>Color Map</b>	<b>33</b>
<b>Timeline</b>	<b>35</b>

This score is intended for use by conductors, management, technical personnel, and anyone else interested in learning more about the piece.

I did not write this score linearly from start to finish, so you need not read it linearly from start to finish.

If you are looking for time-based notation to follow while listening to the piece, skip to the timeline.

# Supplementary DVD Contents

The supplementary DVD includes three simulations of *Glimmer*:

- **Simulation of One Musician Light (no audio).** This simulation shows a single musician's light over the course of a performance. It is intended for use during individual practice. Please note that there are long periods of silence (i.e. black light) in the opening and closing minutes, due to the structure of the piece.
- **Simulation of All Musician Lights with Audio.** This simulation shows the lights for all twenty-five musicians. Each colored square represents the light for a single musician. The arrangement of lights on the screen corresponds to the suggested seating chart (see Seating below). The audio simulation of the orchestra is extremely crude. Use it as a means to better understand how the piece works, not what the performance will sound like.
- **Video Projection (no audio).** This track shows the video projection which the audience sees during the performance. Each colored rectangle represents a group of musicians / audience members. The arrangement on the screen corresponds to the suggested audience seating chart (see Seating below).

# About the Piece

*Glimmer* engages the concert audience as musical collaborators who do not just listen to the performance but actively shape it. Each audience member is given a light stick which he or she turns on and off over the course of the piece. Computer software analyzes live video of the audience and sends instructions to each musician via multi-colored lights.

I wrote *Glimmer* because I wanted to directly involve listeners in the creative process within a traditional concert setting. I hope that their participation will lead them to hear the music in a different way and to have some fun.

## Duration

*Glimmer* lasts exactly ten minutes.

Allow five additional minutes just before the piece begins to explain to the audience how to participate.

## Instrumentation

The twenty-five musicians in the orchestra are divided into seven groups:

### GROUP A

Violin I-1  
Violin I-2  
Violin I-3  
Violin I-4

### GROUP B

Violin II-1  
Violin II-2  
Violin II-3  
Violin II-4

### GROUP C

Viola 1  
Viola 2  
Viola 3

### GROUP D

Cello 1  
Cello 2  
Bass

### GROUP E

Tuba  
Horn  
Trombone  
Bassoon

### GROUP F

Flute  
Oboe  
Clarinet  
Trumpet

### GROUP G

Percussion 1 (Vibraphone)  
Percussion 2 (Marimba)  
Percussion 3 (Tubular Bells)

# Notes About Specific Instruments

## Strings

### Bowing

Do not attempt to synchronize your bowing with other players, since each player receives independent instructions.

Try to play sustained notes in a single bow. When this is not feasible, change bowing as smoothly as possible.

### Timbre

As dynamics vary from *pp* to *ff*, gradually change from *poco sul tasto* to *poco sul ponticello*.

### Additional Notes

Violin I-1 and Violin I-3 use *sul E* throughout.

Violin I-2 and Violin I-4 use *sul A* throughout.

Violin II-1 and Violin II-3 use *sul D* throughout.

Violin II-2 and Violin II-4 use *sul G* throughout.

Viola 1, 2, and 3 use *sul C* throughout.

Cello 1 and 2 use *sul C* throughout.

Bass uses *sul D* throughout.

## Winds and Brass

### Breathing

Try to play sustained notes in a single breath. When this is not feasible, take a short breath as discreetly as possible.

### Trumpet

Use a straight mute throughout.

## Percussion

### Rolls

Play all notes as unmeasured rolls.

Damp all notes as soon as your light fades to black.

### Mallets

Exact choice of mallets is left to your discretion. Use a single pair of mallets for the entire piece; there may not be time to switch. The mallets should allow for both smooth, unmeasured rolls and clear, accented attacks.

### **Tubular Bells**

Consider using yarn mallets instead of hammers to create smoother unmeasured rolls. Use the pedal as necessary to cover over individual attacks in unmeasured rolls.

### **Vibraphone**

Use the pedal as necessary to cover over individual attacks in unmeasured rolls. Do not use the motor.

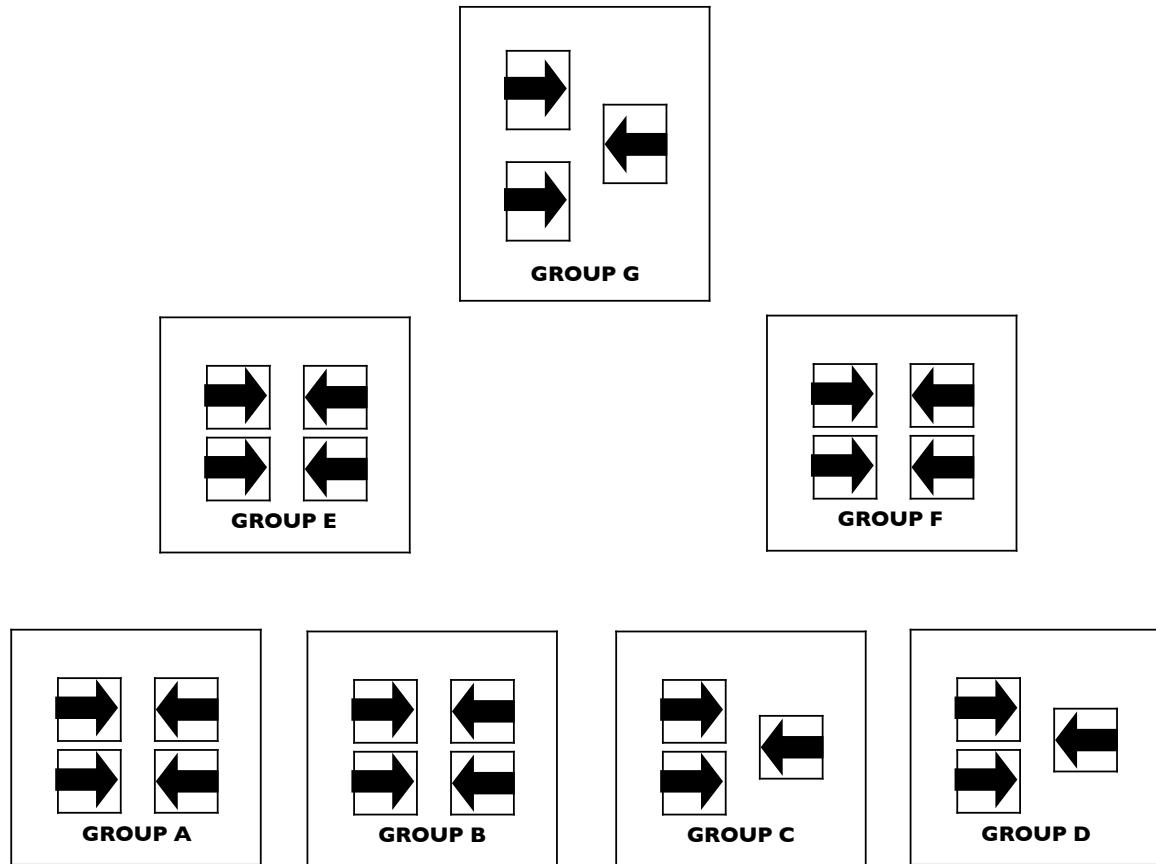
### **Marimba**

Consider using a pair of small bass drum beaters instead of yarn mallets to create smoother unmeasured rolls.

## **Seating**

### **Orchestra**

#### **Suggested Seating Arrangement**



Arrows indicate the direction each musician faces.

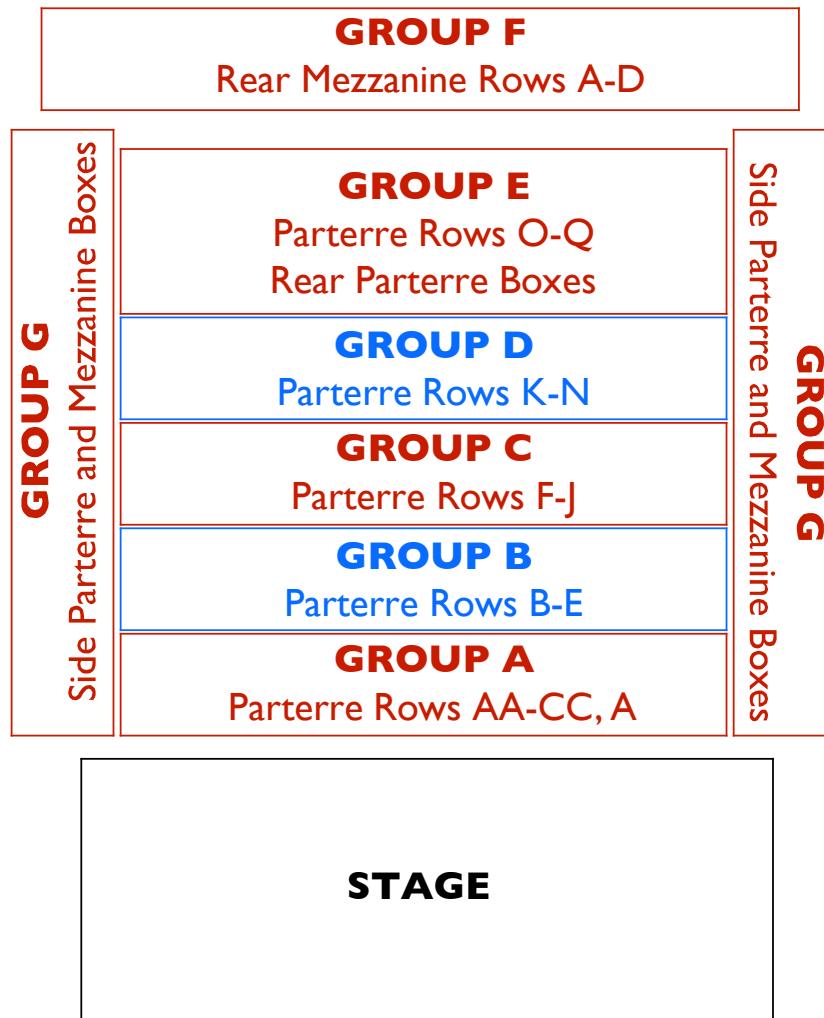
## **Other Seating Arrangements**

Other seating arrangements may be used so long as:

- Each group of musicians sit together.
- Groups are separated from each other physically, visually, and aurally.
- Musicians within each group have eye contact with one another.

## **Audience**

### **Group Divisions (Zankel Hall)**



### **Other Group Divisions**

The audience may be divided in different ways in different halls, so long as:

- Each group contains approximately the same number of people.

- Directly adjacent groups alternate between red and blue light sticks, as with Groups A-E in the figure. (This helps the video analysis software and the group members themselves accurately recognize group boundaries.)

## Notes for the Audience

### Introduction to the Piece

Just before the performance begins, someone — preferably the conductor — must explain to the audience how to participate. Here is a sample text:

*Glimmer engages you not only as a listener, but also as a musical collaborator who actively shapes the performance. As you switch a light stick on and off over the course of the ten-minute piece, computer software will interpret your actions by analyzing live video of the audience, and it will relay instructions to the orchestra by changing the colors of lights on each player's stand.*

*You are seated in one of seven audience groups, and your group controls a specific section of the orchestra. The music played by that section depends on the percentage of people in your group whose light sticks are turned on. The music also depends on how your group's light-stick activity changes over time, and on how it compares to the activities of other groups.*

*Go ahead and turn on your light stick now (simply twist it).*

[Wait a few seconds while the video analysis software is calibrated.]

*Great! Now, please turn it off by twisting in the other direction. You will be turning your light stick on and off throughout the piece; please try to do so as quietly as possible.*

*We have divided the audience into seven groups (A through G), and each of those groups is linked to a group of three or four musicians in the orchestra. By turning your light sticks on and off throughout the piece, you directly affect what those musicians play. Let's take a moment to look at each group:*

[Screen shows slides with audience groupings.]

**GROUP A** is rows AA, BB, CC, and A in the Parterre.

*You are linked to the first violins.*

*GROUP A, please turn on your light sticks! Thanks, you can turn them off now.*

**GROUP B** is rows B through E in the Parterre.

*You are linked to the second violins.*

*GROUP B, please turn on your light sticks! Thanks, you can turn them off now.*

**GROUP C** is rows F through J in the Parterre.

You are linked to the violas.

GROUP C, please turn on your light sticks! Thanks, you can turn them off now.

**GROUP D** is rows K through N in the Parterre.

You are linked to the cellos and bass.

GROUP D, please turn on your light sticks! Thanks, you can turn them off now.

**GROUP E** is rows O through Q in the Parterre, plus boxes 7 and 9 in the rear of the Parterre.

You are linked to the horn, bassoon, tuba, and trombone.

GROUP E, please turn on your light sticks! Thanks, you can turn them off now.

**GROUP F** is rows A through D in the rear Mezzanine.

You are linked to the flute, oboe, trumpet, and clarinet.

GROUP F, please turn on your light sticks! Thanks, you can turn them off now.

**GROUP G** is all of the boxes on the sides (everybody who has not been called yet).

You are linked to the percussion.

GROUP G, please turn on your light sticks! Thanks, you can turn them off now.

Now that you know how to participate, let me quickly explain how the piece works. At the most basic level, when more people in your group turn on their light sticks, your musicians will play louder. Sometimes, the notes they play will pulsate faster or the timbre of their sound will become more intense as well.

At a higher level, there is a competition of sorts among all seven audience groups. Audience groups which do more interesting things are rewarded — their musicians become more prominent in the orchestra, and often something about what they play will change. Audience groups which do less interesting things are...not rewarded. Their musicians become less prominent within the orchestra, and sometimes — especially at the beginning and end of the piece — they will not play at all.

So what does it mean to be interesting? Here's a hint: if everyone in your group leaves their lights on for the entire piece, that's not very interesting. If everyone in your group leaves their lights off for the entire piece, that's also not very interesting. But if your group works together, however that may be, to gradually change over time the percentage of people in your group whose light sticks are on, then that could be interesting and your group may do quite well.

Throughout the piece, listen for your musicians in the orchestra; the music is very simple to help facilitate that. There is also a computer animation on the video screen which will help you follow what is going on in the piece. Each group is represented by a rectangle. The more people in your group with their light sticks on, the brighter the rectangle. And the most interesting group at any moment has a circle around its name.

There is no conductor for the piece, so there is no downbeat to begin. I'll just leave the stage, the lights will dim, and go ahead and start whenever you are ready.

# Notes for the Conductor

## What am I supposed to be doing?

This piece is performed without conductor. The musicians are directed by the multi-colored lights mounted on their stands. Those lights are controlled by the computer, and the computer is in turn controlled by the audience. The music begins when the first audience member turns on his or her light stick, and the computer software automatically ends the piece by fading out all of the musicians' lights.

The multi-colored lights are a necessity, because each musician in the orchestra receives independent instructions generated in real time by the computer, and no conductor can communicate twenty-five different messages to twenty-five different players simultaneously.

Your role is to prepare the orchestra in rehearsals and to prepare the audience just before the piece begins.

## Rehearsals

Strictly speaking, *Glimmer* is not possible to rehearse without a full audience. But the computer software can simulate audience interaction, and the multi-colored stand lights and computer equipment can be set up at each rehearsal. So it is possible to approximate the performance environment.

These are some of the challenges which may need to be addressed:

- **Help musicians learn to respond to the multi-colored lights.** Musicians will be given a practice DVD along with their part, but the rehearsals are their only chance to practice with the actual lights.
- **Adjust dynamic range and balance.** Each multi-colored light can display the same range of colors, and each musician should respond to those colors with the same range of dynamics. *ff* should be approximately equal in perceived loudness, whether played on flute, trumpet, or violin.
- **Adjust accents.** Accents should be clearly articulated so that they stand out from the ensemble.
- **Work on tuning.** Good intonation is critical to a successful performance of *Glimmer*, yet it is impossible to predict exactly which simultaneities will occur in the performance. Each group of musicians can tune unison notes and clusters

individually, and the orchestra can rehearse tuning a variety of chords which are likely to occur.

- **Deal with unexpected catastrophes.** Discuss how to respond to a technological catastrophe during the performance.

To facilitate rehearsal, the computer software can be quickly cued to start from any rehearsal marking on the timeline (see Timeline below). The piece can also be “frozen” — by pausing at any point in the timeline, pausing data from the simulated audience, and pausing color changes in the musician lights — in order to isolate and rehearse a particular situation.

## Audience Introduction

Just before the performance of *Glimmer* begins, explain to the audience how to participate (see Notes for the Audience above).

# Notes for the Performers

## Individual Practice

*Glimmer* is a difficult piece to practice; it is impossible to predict exactly what you will be asked to play during the performance. Here are some suggestions for how best to prepare:

- **Practice with the supplementary DVD.** The DVD includes a computer simulation of the light which will be mounted on your music stand, showing how the light changes color over the course of a performance. Use it to learn what to expect and to practice how to respond.
- **Memorize your part.** There will probably not be enough light on stage during the performance for you to read your music.
- **Practice intonation.** Work on playing the four notes in your part consistently in tune over a full dynamic range.

## Interpretive Freedom

The directions given to you by your multi-colored light intentionally leave some things open to interpretation, so that you can make musical decisions during the performance based on what you hear around you.

- **Accents.** From time to time, you are directed to attack notes with accents, but you are never told how much to accent those attacks. Use your judgment to

make sure that your accent will be heard prominently above the rest of the orchestra, but will not be so excessive as to sound out of place.

- **Dynamics and timbre.** You are instructed to change dynamics and (for most instruments) timbre and/or vibrato as well, based on the brightness of your light. You will probably discover that there is a margin of error in the accuracy and consistency of your response to brightness, especially after changes in color or long periods of black (silence).

Take advantage of that margin of error! You can (and should) vary your response to a small degree, in order to blend with the other players in your group, react to the music you hear around you, and help to push the music in whatever direction you think it is going.

## Unexpected Catastrophes

It is unlikely, but always possible, that something will go wrong during the performance. In particular, your light, or all of the lights, may stop working.

If this happens, try to continue as best you can. If your light goes black, stop playing. If your light freezes on a color, then continue playing as that color directs you.

Here is what might happen next:

- **The problem is quickly resolved.** The light(s) start working again and the performance continues.
- **The problem needs more time to be fixed, and the performance must be stopped.** Someone will come out on stage to alert you and give you further instructions.
- **The problem cannot be fixed at all, or the piece is almost over.** The power to all the lights will be cut off, sending them to black. Stop playing, and the piece will end.

---

## Notes for the Management

### Equal-size Audience Groups

The analysis algorithms used in *Glimmer* assume that each audience group is approximately equal in size. If the audience is not evenly distributed, smaller groups will be favored, and their musicians will tend to dominate the orchestra. And if an audience group is empty, then the corresponding group of musicians will be silent for the entire piece.

To avoid these problems, keep track of box office sales and try to predict which areas of the audience may be empty or nearly empty during the performance. Adjustments to audience groupings can be made in the computer software a few days before the concert in order to accommodate such situations. Or if the logistics of the venue permit it, audience members can be asked to change seats at the concert in order to create a more even distribution.

## **Light Stick Distribution**

Ushers should distribute light sticks to audience members just before the performance of the piece begins.

Different audience groups use different color light sticks. If an audience member uses the wrong color light stick, his or her actions will not affect the music.

## **House and Stage Lighting**

For accurate video analysis of the audience, the entire hall must be as dark as possible during both the performance and the explanation which is given to the audience just beforehand:

- **No stage lights can be used.** The only stage lighting comes from the video projector and the multi-colored lights on each musician's stand. (During the introduction, a single dim light may be used for the person introducing the piece.)
- **The house must be totally dark** except for emergency lighting.
- **Do not open any house doors** during the introduction or the performance.

## **Technical Setup Time**

On the day of the concert, **approximately five hours** are needed to set up and test all of the equipment for the concert. If the hall is available for five hours the day before the performance, then only one hour is required on the performance day.

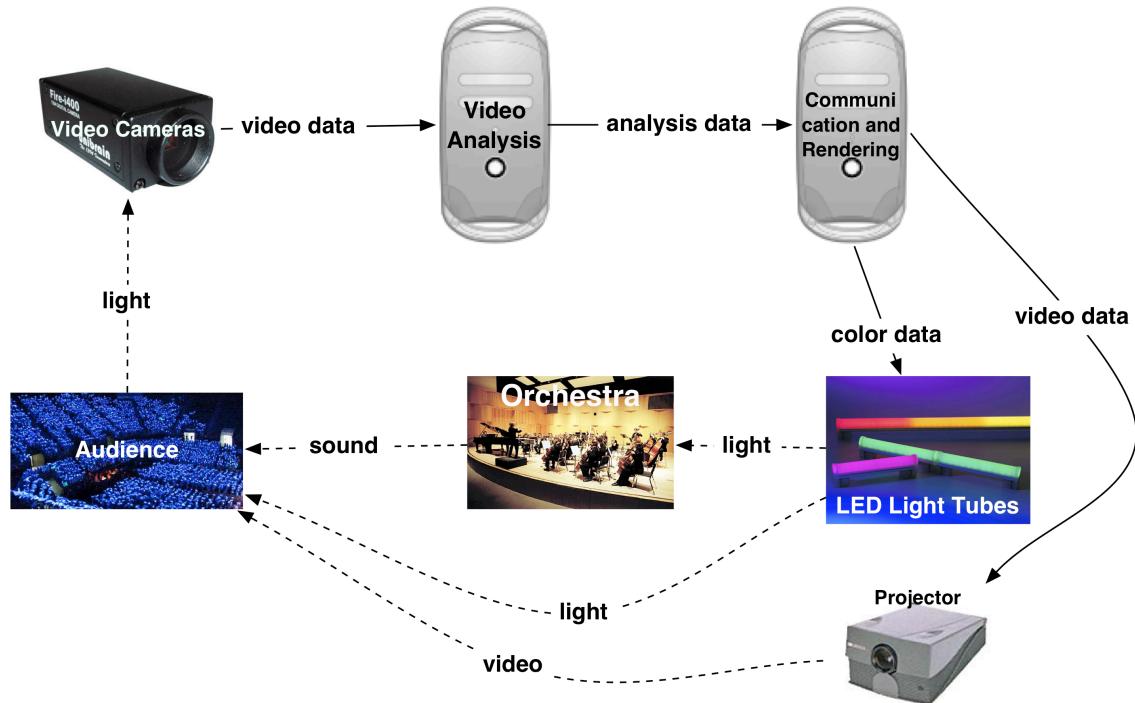
Most of this setup can be done quietly while other work takes place in the hall. But for the last **hour** of that setup time, the stage and house lights must be completely dark, just as they will be during the performance (see House and Stage Lighting above).

## **Dress Rehearsal**

During the dress rehearsal, do a complete run of the piece with a small audience:

- Stage and house lighting must be completely dark (see House and Stage Lighting above).
- At least twenty-one people must be available to act as audience members (three per group). The more people participate, the better.

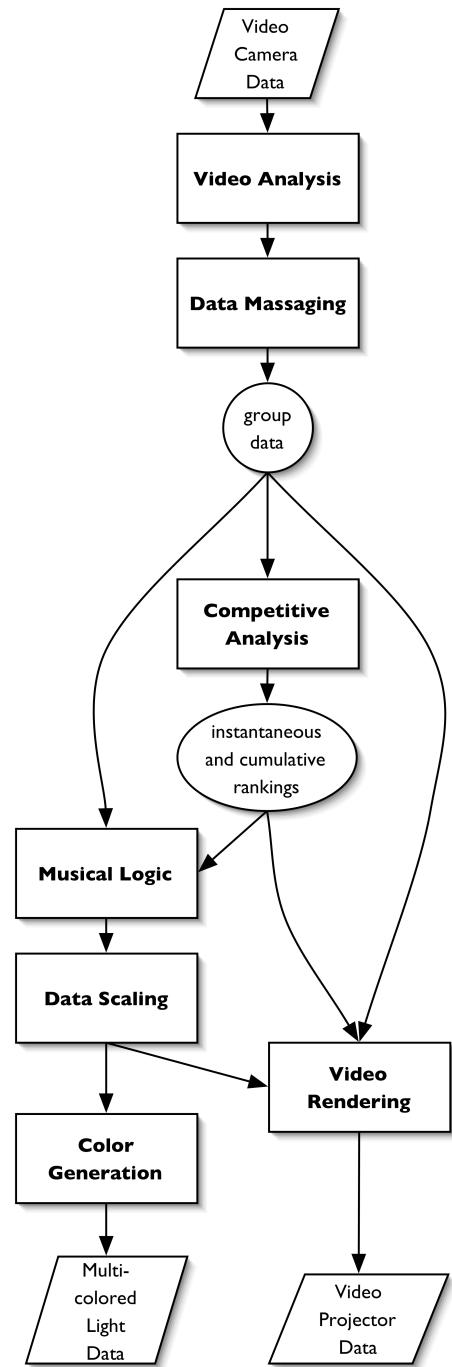
## High-Level System Overview



Conceptually, *Glimmer* is designed as a continuous feedback loop. Solid lines indicate physical wires connecting components. Dotted lines indicate “wireless” communication — of sound and video to ears and eyes, or of light sticks to video cameras.

Audience members turn their light sticks on and off. That changes the video images captured by the cameras. That video data is turned into analysis data and then, through musical logic running on the computer, into color data for the multi-colored lights and video data for the projector. The musicians react to the lights to play the music. The audience, in turn, reacts to the music they hear, the video they see, and the lights they see — by making changes to their light sticks, and thus beginning another loop through the system.

# High-Level Software Overview



This figure presents a high-level overview of the various software components and the flow of data through them. The following sections give high-level descriptions of each of these software components.

All of the software is written for use with Cycling '74's Max/MSP 4.5 and Cycling '74's Jitter 1.2 on Mac OS X 10.3. Complete source code is available upon request.

# Video Analysis

## Goal

- Compute the percentage of audience members in each group with their light sticks turned on.

## Technique

- Grab video from the cameras at a rate of at least 4 frames per second.
- Adjust image brightness, contrast, and saturation to maximize accuracy.
- Create seven image buffers, one for each group.
- When a new frame of video is received, do the following for each buffer:
  - Copy the most recent video frame into the buffer.
  - Reduce the video frame to a single-plane (grayscale) image:
    - When two groups are close together, extract the red or blue plane from the color image (for red or blue light sticks, respectively). Then set all pixels to black in which the extracted plane's luminosity is lower than the luminosity of either of the other two color planes.
    - When a group is physically separated from other groups, simply convert the color video image to grayscale based on the total luminosity of each pixel.
  - Apply an image mask to black out extraneous areas of the frame (e.g. areas which show other audience groups, emergency lighting, or nothing at all).
  - Reduce background noise by applying a threshold filter which blacks out pixels below a given luminosity.
  - Count the number of “blobs” of adjacent non-black pixels in the image.
  - Divide the number of blobs by the number of people in the group to compute the percentage of light sticks turned on (output as a number between 0 and 1).

## Notes

The software includes real-time GUI controls for several parameters:

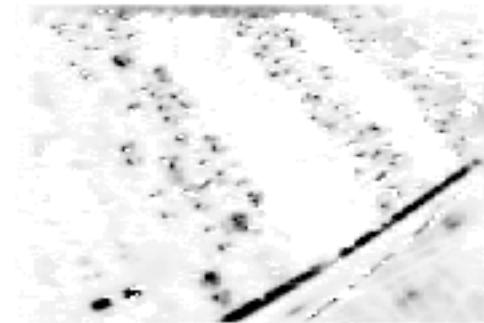
- Image masks, which can be drawn onto the video image, saved as graphics files, and reloaded on application startup.
- Threshold filter values.
- Minimum number of pixels in each blob.
- Toggles for image dilation and erosion before blob counting.
- Brightness, contrast, and saturation values.
- Maximum number of people in each group.
- Plane extraction method.
- Gradient image scaling, in which the brightness of areas closer to the camera is reduced.

## **Example**

Here is an example of a raw video frame which might be processed by the video analysis component (this image shows groups A through E):



After the red plane is extracted, it looks like this:



(Note: This image has been inverted to facilitate better printing quality.)

After the image is cropped (with an image mask) to exclude areas outside of group A, it looks like this:



And after the background noise is reduced (with a threshold filter), it looks like this:



The algorithm counts 39 blobs.

## Data Massaging

### Goals

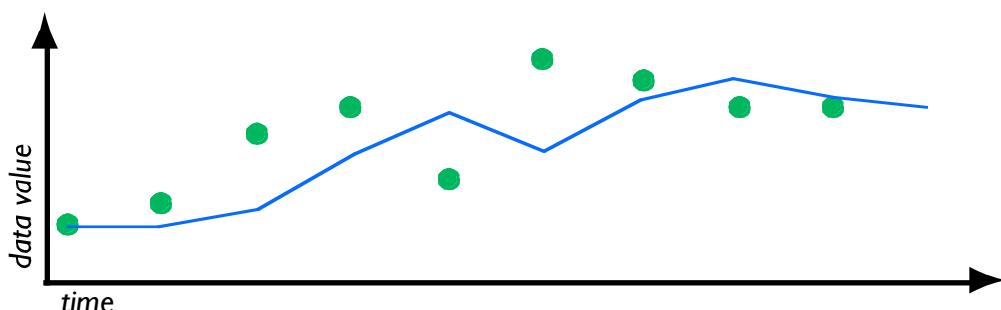
- Smooth out sudden changes in data which are artifacts of the video analysis algorithm.
- Interpolate data values between video analysis frames.

### Technique

- Use a linear lag. When a new value is received, move towards it gradually and continuously over 500 ms, instead of jumping to it immediately.

### Notes

- The software includes a mechanism to adjust this lag time during runtime.



In this figure, the green dots represent data values arriving from the video analysis component, and the blue line represents the massaged data values.

# Competitive Analysis: Instantaneous

## Goals

- Determine which group is currently the most “interesting” (i.e. has the fastest rate of change). Call this group the “winner.”
- Favor positive rates of change over negative rates of change in choosing the winner.
- Rank all groups based on how recently each has been the winner.
- Do not change winners too frequently.
- Do not change winners at regular time intervals.

## Technique

- For each data set received from the data massager, do the following:
  - For each group’s data value:
    - Compute the average difference between successive values over the last several values.
    - Add each group’s inertia factor to this average difference.
  - Find out which group has the highest sum:
    - Name it the winner.
    - Move it to the front of the group rankings list.
  - If the winner has changed:
    - Set the old winner’s inertia factor to 0.
    - Set the new winner’s inertia factor to 1, then gradually let it decay to 0 along an exponential curve. Set the decay time to between two and six seconds: the *lower* the current data value for the new winner, the *longer* its decay time.

## Notes

- The number of previous values considered in the average difference calculation can be modified during runtime.

# Competitive Analysis: Cumulative

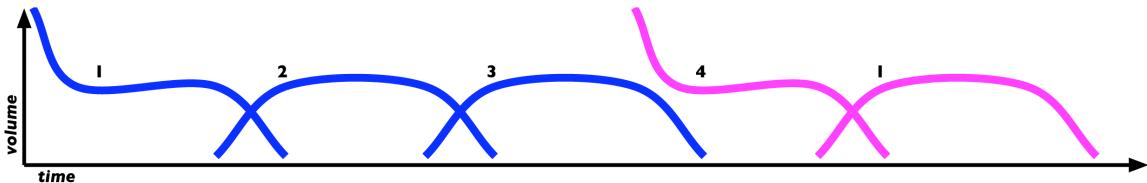
## Goals

- Rank all groups based on how long they have been the winner over the course of the entire performance.

## Technique

- Use an array to track the total amount of time each group has been the winner.
- Rank groups by sorting the total winning times.

# Musical Logic: Single Sustained Note



In this figure, the numbers above each curve indicate which musician within a group plays it, and the color families of each curve indicate which note within the pitch set is being played (see Color Map below).

## Instantaneous Volume

- The instantaneous volume is taken from the group data. When 0% of a group's light sticks are on, the group is silent (0); when 100% of a group's light sticks are on, the group plays at maximum volume (1).

## Crossfading

- Each player within the group starts playing from *niente*, then *crescendos* to the instantaneous volume, then *decescendos* to *niente*. Player entrances are staggered so that the sum of all player volumes is always equal to the instantaneous volume.
- The crossfade rate is based on the group data. When just over 0% of a group's light sticks are on, the group takes 6 seconds to crossfade from one player to the next; when 100% of a group's light sticks are on, the group takes only 1.5 seconds to crossfade.

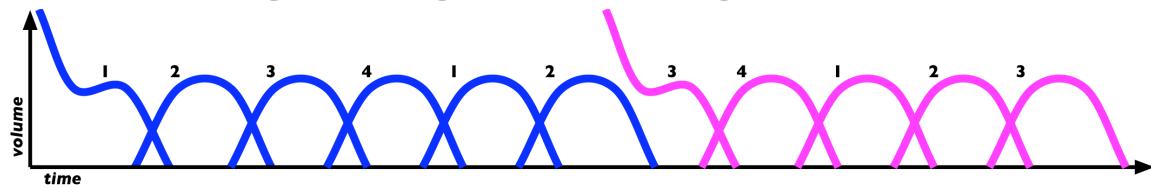
## Note Selection

- Notes are chosen from an ordered, looped sequence of 1, 2, 3, or 4 pitches.
- Each group has a different set of available pitches, and different subsets of those pitches are available at different points within the piece (see Pitch Map and Timeline below).
- Whenever the group becomes the winner of the instantaneous competitive analysis, it moves to the next pitch in the sequence.

## Accents

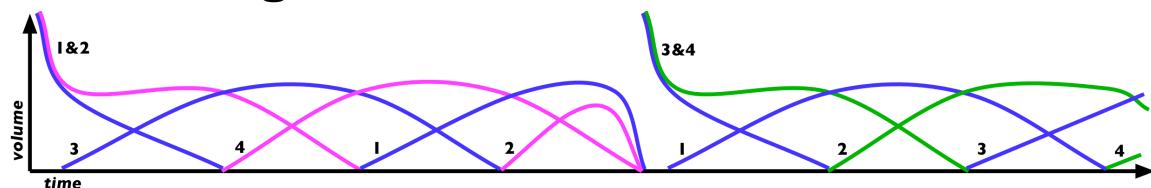
- Whenever a group becomes the winner of the instantaneous competitive analysis, it accents its note. This corresponds with a note change, except at the very beginning of the piece, where the pitch sequence contains only one note.
- The accent is played by a single musician in the group.

## Musical Logic: Single Pulsating Note



This is identical to the Single Sustained Note section above, with one critical difference: the crossfades are much faster: between 0.9 seconds and 1.65 seconds. So it sounds more like a slowly pulsating note — with fairly sudden changes at regular time intervals — than a sustained note with a slowly evolving timbre.

## Musical Logic: Two Note Clusters

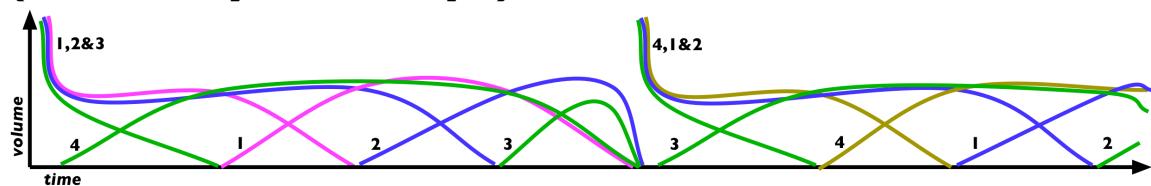


This is similar to Single Sustained Note and Single Pulsating Note, but two different notes are always played simultaneously by the group. At any given moment, one of the players is always at the peak of a crossfade, one player is in the crescendo portion of a crossfade, and one player is in the decrescendo portion of a crossfade. In four-player groups, one player is always silent.

The crossfade rate is slower than for Single Pulsating Note but faster than for Single Sustained Note: between 1.35 seconds and 2.7 seconds.

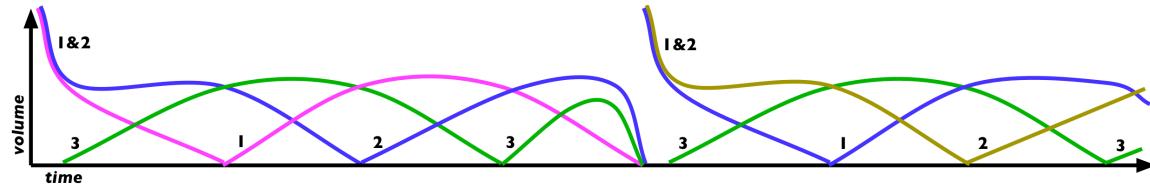
Accents are played by two musicians in the group.

## Musical Logic: Three Note Clusters (Four Player Groups)



This is identical to Two Note Clusters, but three different notes are always played simultaneously by the group. At any given moment, two of the players are always at the peak of a crossfade, one player is in the crescendo portion of a crossfade, and one player is in the decrescendo portion of a crossfade. Accents are played by three musicians in the group.

# Musical Logic: Three Note Clusters (Three Player Groups)



Three-player groups cannot play three different notes simultaneously and still do crossfades. So instead, they do a hybrid of Two Note Clusters and Three Note Clusters. Only two different notes are played simultaneously by the group, but with each successive crossfade, those notes rotate through all possible two-note subsets of a three-note set. Accents are played by two musicians in the group.

## Data Scaling

### Goals

- Scale the player volumes based on instantaneous group rankings, so that the maximum possible volume is higher for groups with higher rankings.

### Technique

- Scale player volumes using the following formula:

$$\text{scaledVolume} = \text{volume} * (1.0 - 0.07 * (\text{groupRank} - 1))$$

(volume varies between 0.0 and 1.0)

- When rankings change, move *groupRank* to its new value gradually over two seconds, rather than suddenly jumping to the new value.
- When a group becomes the winner, update *groupRank* immediately.

## Color Generation

### Goals

- Convert data on pitch and volume for each player into a color in a 24-bit RGB color space.
- Give short preparation cues.

### Technique

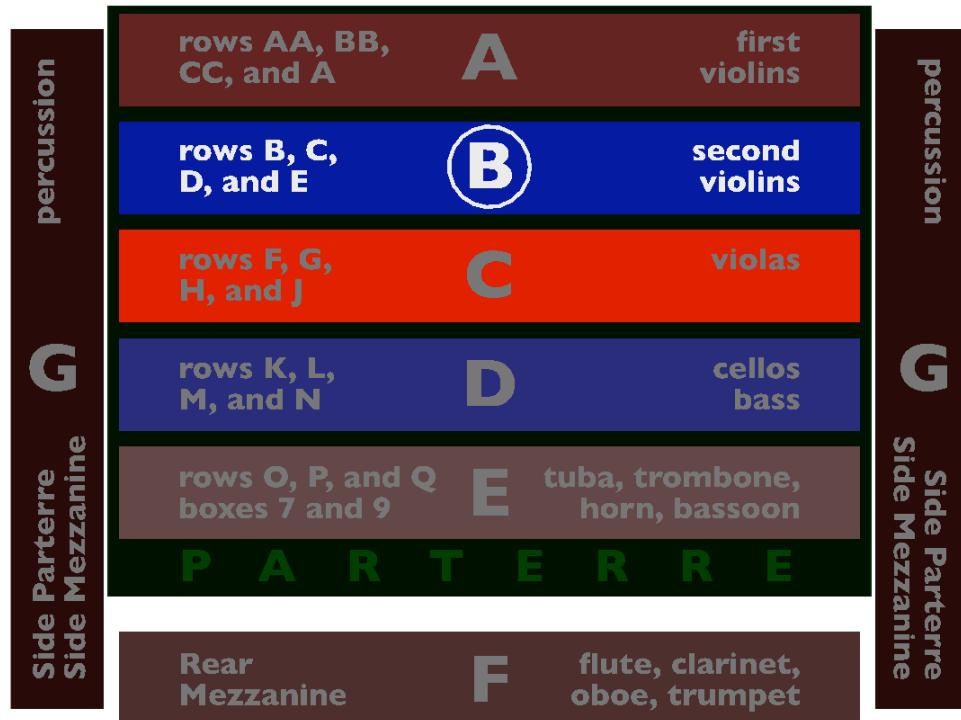
- Compute a color to represent the data in HSL (hue-saturation-luminosity) color space:

<b>note</b>	<b>hue (0-255)</b>	<b>color</b>
lowest	32	brown
second lowest	96	green
second highest	160	blue
highest	224	pink
<b>saturation (0-255)</b>		
always 255		
<b>volume (0-1)</b>	<b>luminosity (0-255)</b>	<b>brightness</b>
0 (tacet)	0	black
just above 0	16	very dark
1.0	112	very bright

- Give a 700 ms preparation cue for unaccented notes which begin from *niente*:
  - Compute hue and saturation as above.
  - Set luminosity to 13 (very dark) for 350 ms, then to 5 (extremely dark) for 350 ms.
- Give a 700 ms preparation cue for accented notes (which usually correspond to color changes as well):
  - Compute hue and saturation as above.
  - Set luminosity to 165 (extremely bright) for 350 ms, then to 6 (extremely dark) for 350 ms.
- Convert the HSL color to an RGB color.

For additional information and illustrations, see Color Map below.

# Video Rendering



## Goals

- Provide visual feedback to the audience to help them better understand the connection between their actions and the music they hear:
  - Show the raw audience data and the instantaneous volume for each group.
  - Show which group is the current winner.
  - Show which type of musical logic each group is using.
  - Show which groups have become tacet for the remainder of the piece.

## Technique

- Draw a rectangle for each group and position it in a two-dimensional space to match the group's location in the audience. Label it with information about the musicians and audience members in the group.

- Fill each rectangle using two superimposed rectangles which alpha-blend to create a single perceived fill color.
- Fill the lower rectangle in grey based on the group's raw audience data. RGB values vary from (0, 0, 0) for 0.0 audience data to (102, 102, 102) for 1.0 audience data.
- Fill in the upper rectangle based on the group's instantaneous volume and light-stick color:
  - Red-stick groups vary from RGB values (0, 0, 0) to (255, 0, 0) as instantaneous volume varies from 0.0 to 1.0.
  - Blue-stick groups vary from RGB values (0, 0, 0) to (0, 0, 255).
- Set the alpha value of the upper rectangle based on the group's current musical logic:

<b>musical logic</b>	<b>alpha value</b>	<b>color</b>
tacet	0	grey
single sustained note	64	pastel red or blue
single pulsating note	128	normal red or blue
two or three note clusters	255	bright red or blue

- Draw a circle around the current winner's group name.
- When a group becomes *tacet* for the rest of the piece, fade its rectangle and its label to black, so that the group is no longer visible.

## Notes

- Video is rendered at 1280 x 1024 pixel resolution at a minimum of 14 frames per second.

# High-Level Hardware Overview

This section provides details about the major hardware components which were used for the premiere performance at Zankel Hall.

## Audience Light Sticks

Buzline Light-up Stirrers (175 blue units and 475 red units)

- 4" single-color battery-operated stick with ultra-bright LED bulb.
- Simple, silent twist of cap turns on and off.



SKU 1040650 (red) and 1040651 (blue)

### Contact

Mary Staubitz (dealer)  
iPROMOTEu, Boston Office  
337 Centre St. #2  
Jamaica Plain, MA 02130  
866-625-7700 (toll-free)  
617-522-1056 (local)  
617-522-1618 (fax)  
[mary@ipromoteu.com](mailto:mary@ipromoteu.com)  
<http://www.ipromotu.com>

Buzline / Buztronics, Inc. (manufacturer)  
4343 West 62<sup>nd</sup> Street  
Indianapolis, IN 46268  
(317) 876-3413  
<http://www.buzline.com>  
<http://www.buztronics.com>

## Video Cameras and Digitizer

Four Sony Digital Handycam camcorders (Sony TRV-10, TRV-11, TR-940, and HC-30) captured the entire audience. One camera, mounted on a mic stand with a boom, captured the entire main Parterre (groups A-E). The remaining three cameras were mounted on tripods and captured the rear mezzanine and the boxes on both sides of the audience. All cameras were located at the front of the side boxes on the mezzanine level.

The Sony cameras provided:

- Adequate video resolution.
- Good performance in low-light conditions.
- Analog video outputs. (Long cable runs with digital IEEE1394 cable would have been prohibitively expensive.)
- Convenient image monitoring via built-in LCD screens.

Each camera was fitted with a Sunpak 0.42x or 0.45x ultra-wide-angle lens adapter.

Analog outputs from the four cameras were converted from RCA to BNC format and routed through patchbays at Zankel Hall to a control room backstage. These four video

feeds were sent to a Supercircuits QS25 Color Quad Processor, which output a single 720 x 480 pixel resolution video feed showing all four cameras. (Each camera occupied one 360 x 240 quadrant of the image.) From there, the single video feed was digitized into a 720 x 480 DV stream using a Canopus ADVC-55 digitizer and fed into the video analysis computer via IEEE1394.

A Sony TRV-33 camcorder acted as a backup digitizer, sending an IEEE1394 feed to the backup video analysis computer.

### **Contact**

SuperCircuits, Inc.  
One SuperCircuits Plaza  
Liberty Hill, Texas 78642  
(800) 335-9777  
<http://www.supercircuits.com>

Canopus Corporation  
711 Charcot Ave.  
San Jose, CA 95131  
(888) 899-EDIT  
[sales@canopus.com](mailto:sales@canopus.com)  
<http://www.canopus.com>

## **Computers**

Four Apple Powerbook laptop computers ran in the control room backstage: a main and backup video processing computer and a main and backup control computer. Each computer had at minimum an 800 Mhz G4 processor, 768 MB of RAM, and dual-display support.

All four computers ran standalone, double-clickable applications which were built using Cycling '74's Max 4.5 and Jitter 1.2 environments on Mac OS X 10.3.7 ("Panther").

The software self-configured based on each machine's hard-coded IP address:

- 10.0.1.100: control (main)
- 10.0.1.101: control (backup)
- 10.0.1.102: video (main)
- 10.0.1.103: video (backup)

All computers resided on a subnet with mask 255.0.0.0 in order to communicate properly with the Color Kinetics power supplies (see Musician Lights below).

The four computers and four Color Kinetics power supplies were connected via a LinkSys EZXS88W 8-Port 10/100 Auto-Sensing Switch.

The backup control computer was also connected to a Peavey 1600x fader box via an M-Audio MIDISport USB interface, so that audience data could be entered manually in the event of a video camera or analysis failure.

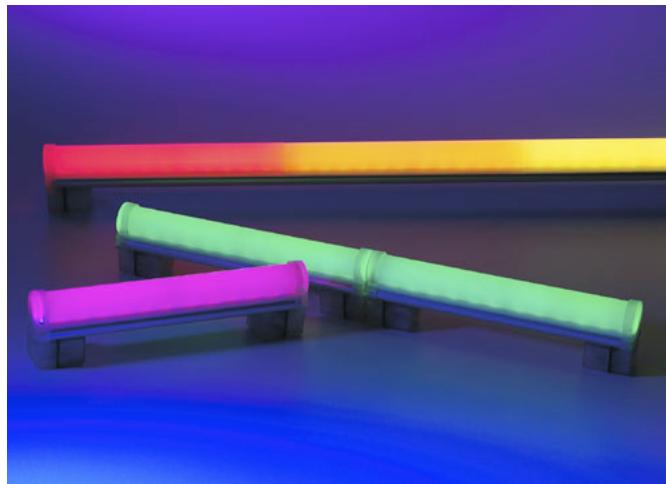
## **Musician Lights**

Each musician had a 1-foot Color Kinetics iAccent LED light resting on the lip of his or her stand. These lights provided:

- 24-bit RGB color space.
- Low latency and high frame-rate.
- Quiet operation.
- Easy real-time control from computer via proprietary Ethernet / UDP protocol.
- Independent control of each light.
- Minimum of cabling: single cable for power / data, daisy-chain capability.

The iAccent lights were controlled by four Color Kinetics PDS-500e power supplies on the sides of the stage. Each power supply had two 25-foot leader cables, each of which led to the first light in a musician group; and a 100-foot Ethernet cable, which led to the Ethernet switch in the control room. Additional lights in each musician group were daisy-chained to the first light using 10-foot jumper cables. (Multiple power supplies were required because of a 74-foot limit on each cable run.)

A single Smart Jack 3 USB adapter was used to configure the DMX address on each iAccent light when they were delivered but was not needed during rehearsal or performance of the piece.



### **Contacts**

Chris Smith-Peterson  
Sales Representative - Eastern Region  
Color Kinetics Incorporated  
10 Milk Street Suite 1100  
Boston, MA 02108  
[csp@colorkinetics.com](mailto:csp@colorkinetics.com)  
(617) 701-2287  
(617) 482-8610 fax  
<http://www.colorkinetics.com>

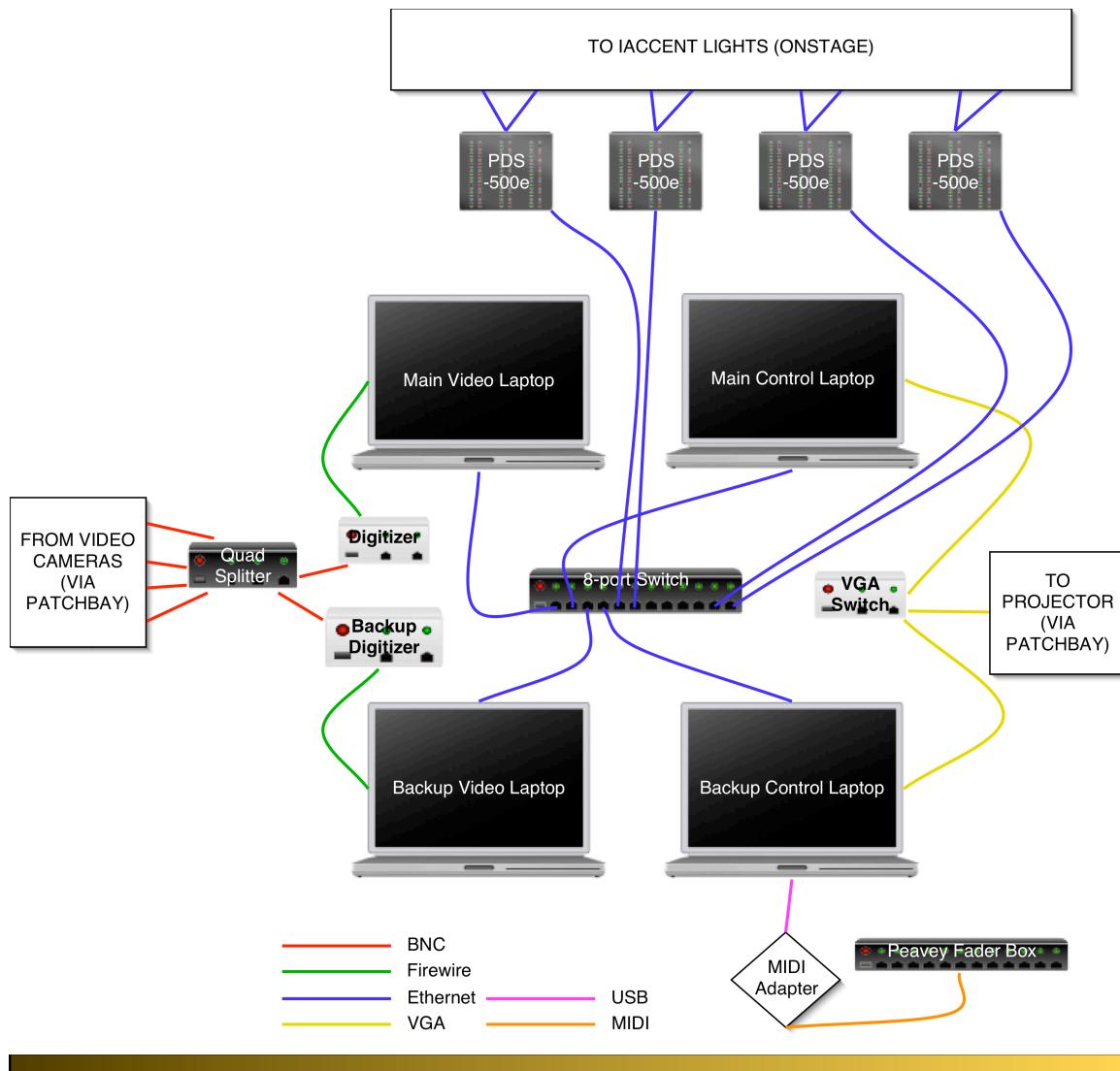
Doug Vierling  
XS Lighting and Sound (rental)  
1 Goldenwood Circle  
Central Islip, NY 11722  
Phone: 516-933-8881  
Fax: 516-933-8885

# Video Projection

VGA output at 1280 x 1024 pixel resolution @ 60 Hz from both the main and backup control computers was routed to an Inline IN3564HR VGA Switch. The output of the switch was converted to a 5-BNC signal and routed to Zankel's Digital Projection Lightning 15sx LA00163 projector via a patchbay. It was projected onto a 22 x 15 foot screen on the back wall of the stage.

## Wiring Diagram

Wiring diagram of equipment in the backstage control room:



# Notation

## Score

The remainder of this score describes *Glimmer* with means most closely resembling traditional music notation.

### Pitch Map

The first part of the pitch map shows the four-note set available to each group of musicians. These pitch sets do not change over the course of the piece. However, in different portions of the piece, groups are limited to subsets of pitches; these are shown in the second part of the pitch map.

### Color Map

The color map explains the meaning of the multi-colored lights mounted on each musician's stand. The meaning of colors does not change over the course of the piece.

### Timeline

The timeline shows changes to the musical logic over the course of the piece (see High-Level Software Overview above). These parameter changes are automatically cued at specific points in time during the performance. Usually, they do not trigger immediate musical changes, but rather alter the rules by which future audience data is transformed into instructions for the musicians.

The seven staves denote instantaneous rank of the musician groups (see High-Level Software Overview above). There is no fixed mapping of staves to musician groups; the mappings frequently change as the algorithm updates its analysis.

Beginning at 7'15", musician groups drop out of the piece one by one until only one group remains at 9'45". The order in which groups drop out is determined by the cumulative competitive analysis, not by instantaneous competitive analysis. So when the group with the lowest cumulative rank drops out at 7'15", that particular group remains tacet for the rest of the piece.

The following figure defines the meaning of the markings used in the timeline:

Symbol	Musical Logic	Pitch Selection
(blank)	<b>tacet</b>	
	<b>single sustained note</b>	<b>from 1-note subset</b>
	<b>single sustained note</b>	<b>from 2-note subset</b>
	<b>single sustained note</b>	<b>from 3-note subset</b>
	<b>single sustained note</b>	<b>from full 4-note set</b>
	<b>single pulsating note</b>	<b>from 3-note subset</b>
	<b>single pulsating note</b>	<b>from full 4-note set</b>
	<b>two note cluster</b>	<b>from full 4-note set</b>
	<b>three note cluster</b>	<b>from full 4-note set</b>

## Parts

Each musician's part includes:

- Portions of this score, including “About the Piece,” “Duration,” “Instrumentation,” “Notes for the Performers,” and “High-Level System Overview.”
- Customized versions of sections of this score, including “Notes for Specific Instruments,” “Notation,” “Pitch Map,” and “Color Map.”
- The supplementary DVD and a description of its contents.
- A single-page large-print “cheat sheet” to sit on each player’s music stand during the performance.

# Pitch Map

Each of the seven groups of musicians plays only four different pitches over the course of the piece. The following figure shows the pitches available to each group; the colors of the noteheads correspond to the color families of the light cues (see Color Map below).

	<b>GROUP A</b> Violin I-1 Violin I-2 Violin I-3 Violin I-4
	<b>GROUP F</b> Flute Oboe Clarinet Trumpet
	<b>GROUP B</b> Violin II-1 Violin II-2 Violin II-3 Violin II-4
	<b>GROUP G</b> Percussion 1 (Vibraphone) Percussion 2 (Marimba) Percussion 3 (Tubular Bells)
	<b>GROUP C</b> Viola 1 Viola 2 Viola 3
	<b>GROUP E</b> Tuba Horn Trombone Bassoon
	<b>GROUP D</b> Cello 1 Cello 2 Bass

The following figure shows which pitches are available to each group under different musical logic systems (as indicated by the graphical symbols used in the timeline), and the sequence of pitches within those systems. The colors of the noteheads correspond to the color families of the light cues (see Color Map below).

**Musical Logic:**

A      F      B      G      C      E      D

**A**

**F**

**B**

**G**

**C**

**E**

**D**

A horizontal bar at the bottom is divided into six segments of increasing length from left to right, corresponding to the six groups A through F.

# Color Map

Multi-colored lights mounted on each musician's stand provide information about pitch, dynamics, timbre, and accents.

## Sustained Notes

	<p><b>Continuous changes in brightness indicate changes in dynamics and timbre (brighter = louder).</b></p> <p><b>poco sul tasto</b> ————— (strings only) ————— <b>poco sul ponticello</b> <b>non vibrato</b> ————— (all except percussion) ————— <b>poco vibrato</b></p> <p><b>pp</b> ————— <b>ff</b></p>
<b>Color families indicate which of the group's four notes to play:</b>	
<b>highest note (pink)</b>	
<b>2nd highest note (blue)</b>	
<b>2nd lowest note (green)</b>	
<b>lowest note (brown)</b>	

## Tacet

When the light is black, do not play.

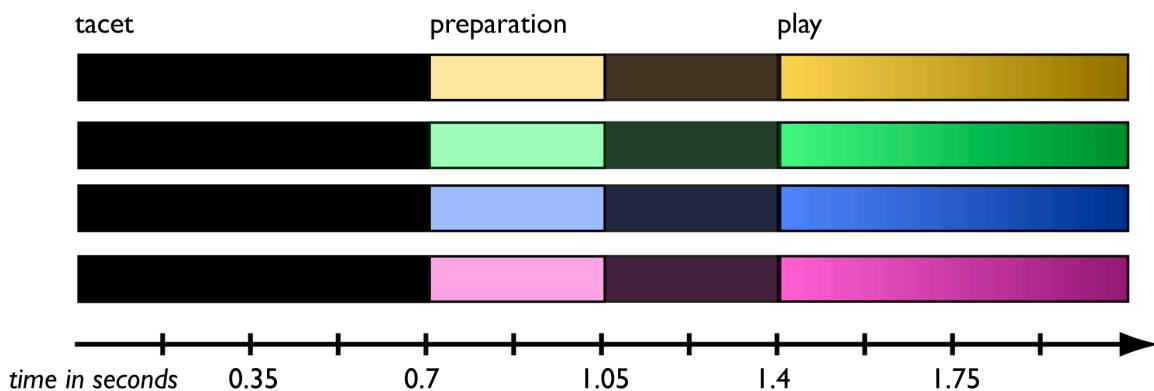
## Preparatory Cues

0.7-second preparatory cues are given before sudden changes.

### Accented Attacks

0.35 seconds of very bright light is followed by 0.35 seconds of very dark light, which is followed by the beginning of the note. The color family of the preparatory cue is the same as the color family of the note it cues.

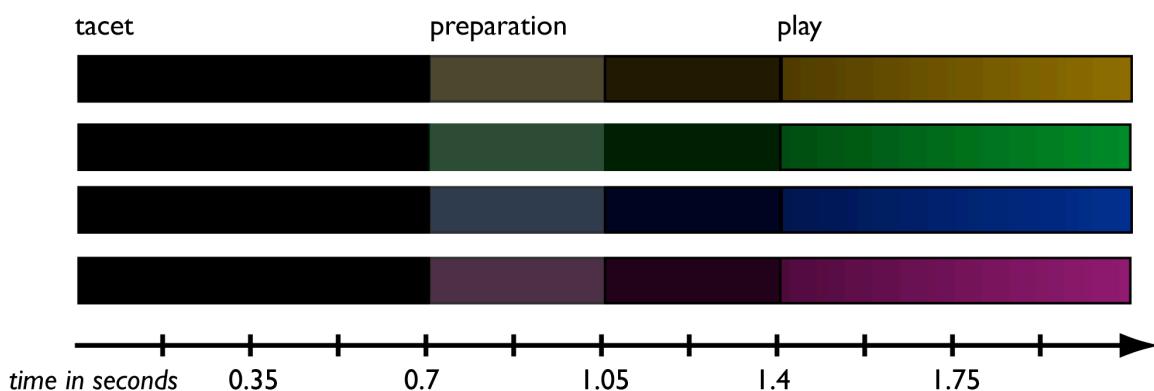
The figure below shows how these accented preparatory cues are given for each of the four color families. Occasionally, the preparation immediately follows the previous note, rather than silence as in this figure. In these cases, leave a short gap of silence between the previous note and the new attack.



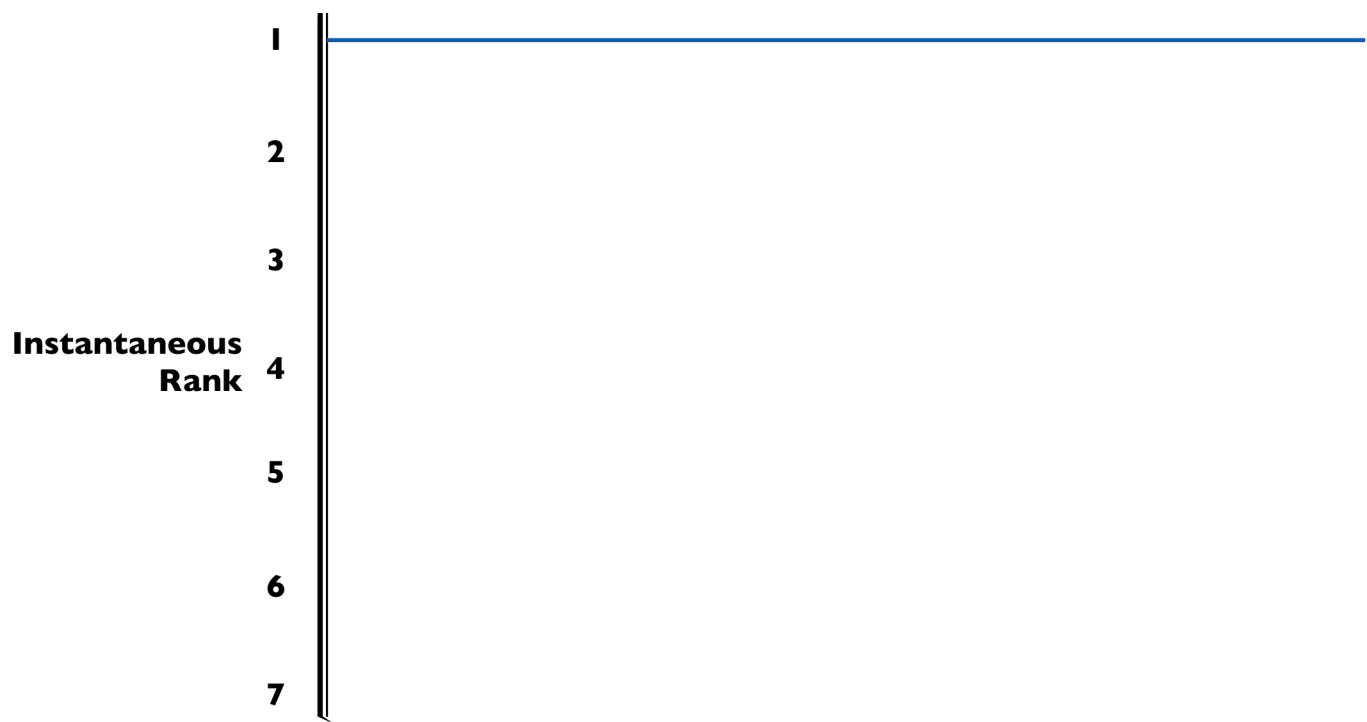
### **Unaccented Notes**

0.35 seconds of very dark light is followed by 0.35 seconds of extremely dark light, which is followed by the beginning of the note. The color family of the preparatory cue is the same as the color of the note it cues.

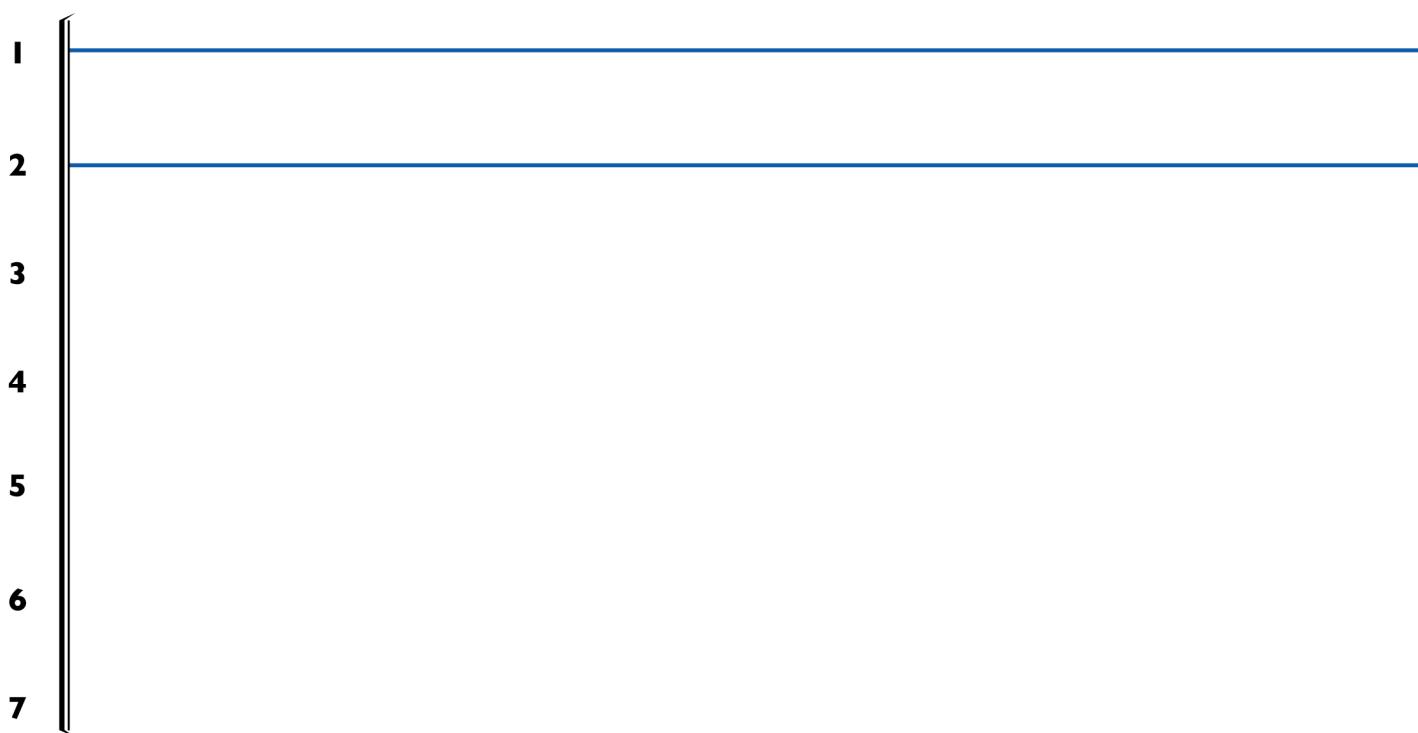
This figure shows how these unaccented preparatory cues are given for each of the four color families.



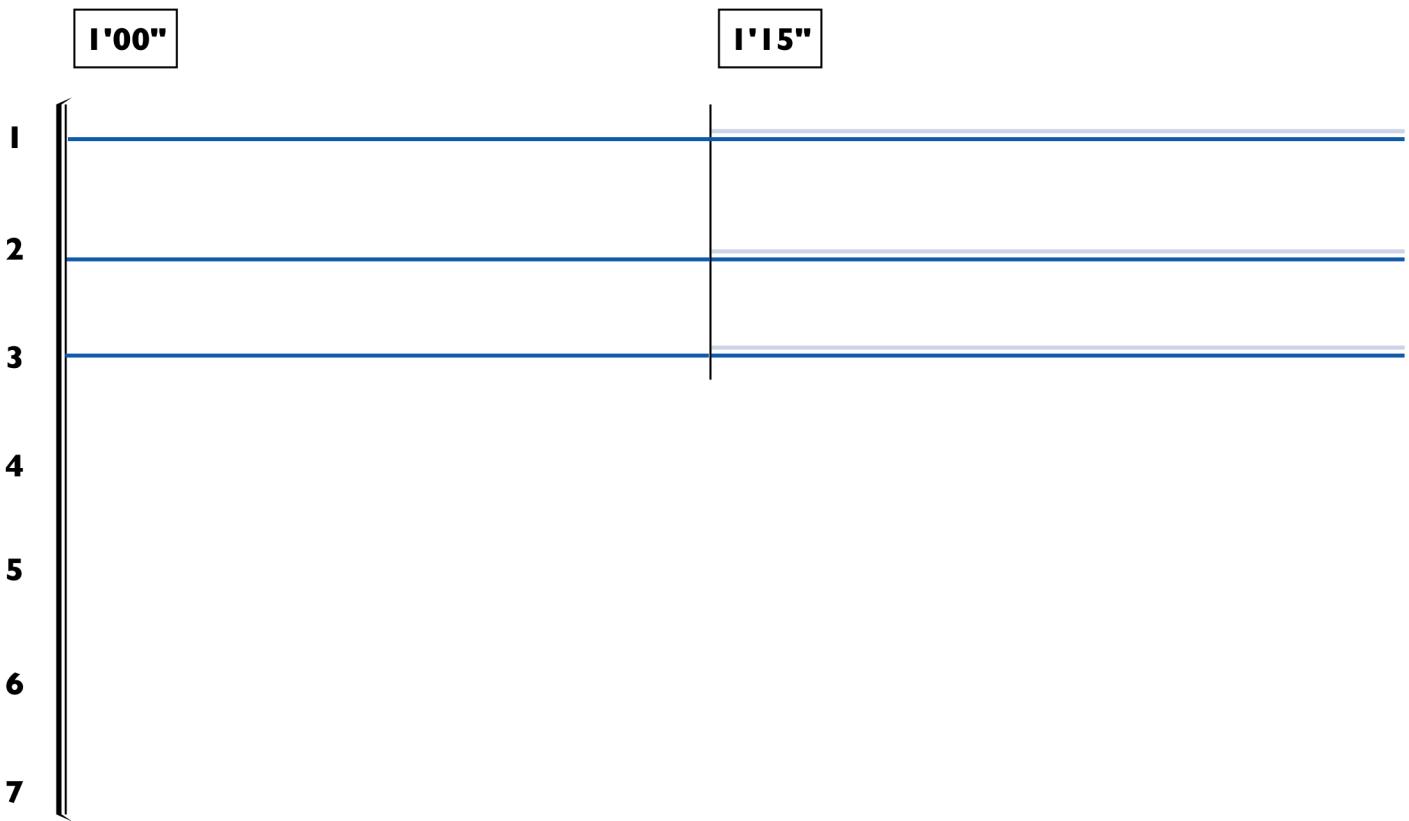
# Timeline



0'30"



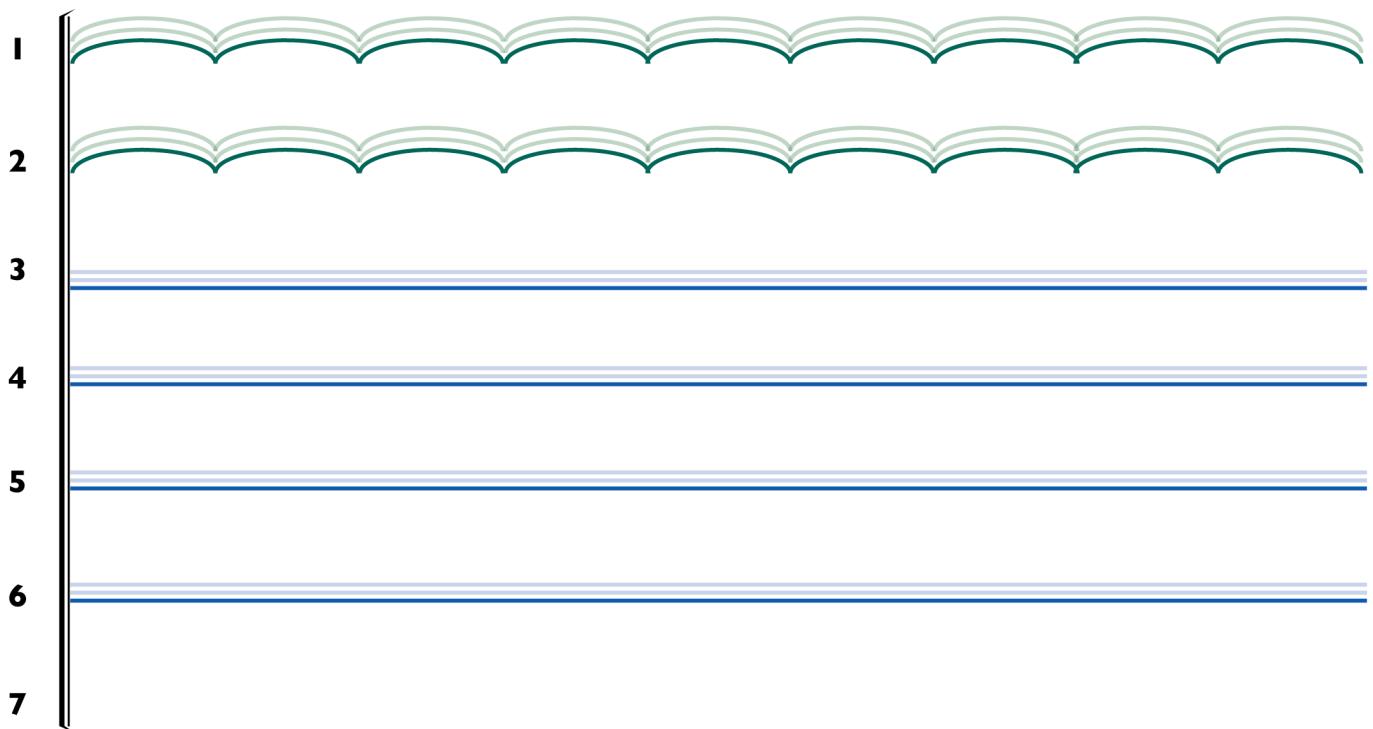
Freeman — Glimmer — Score — 35

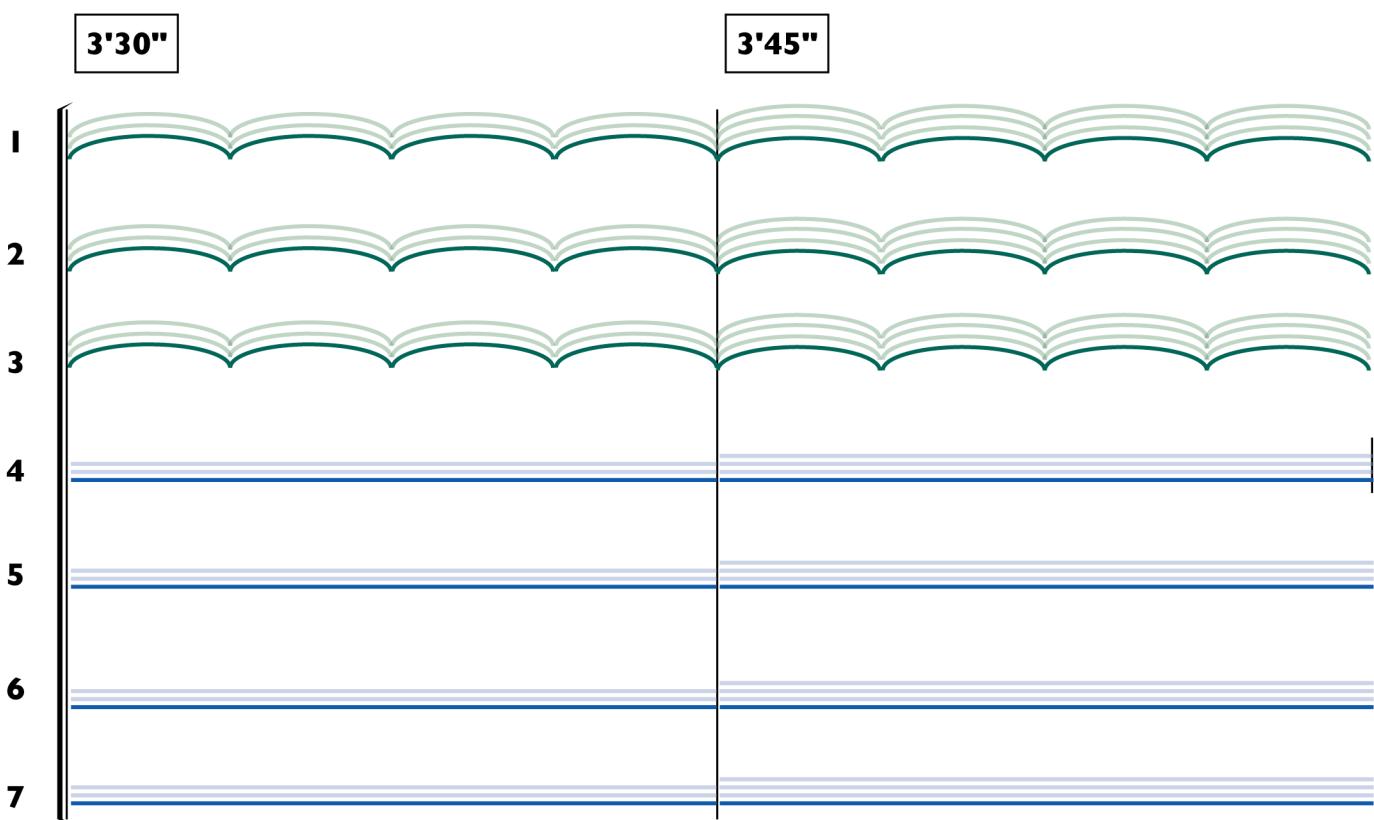
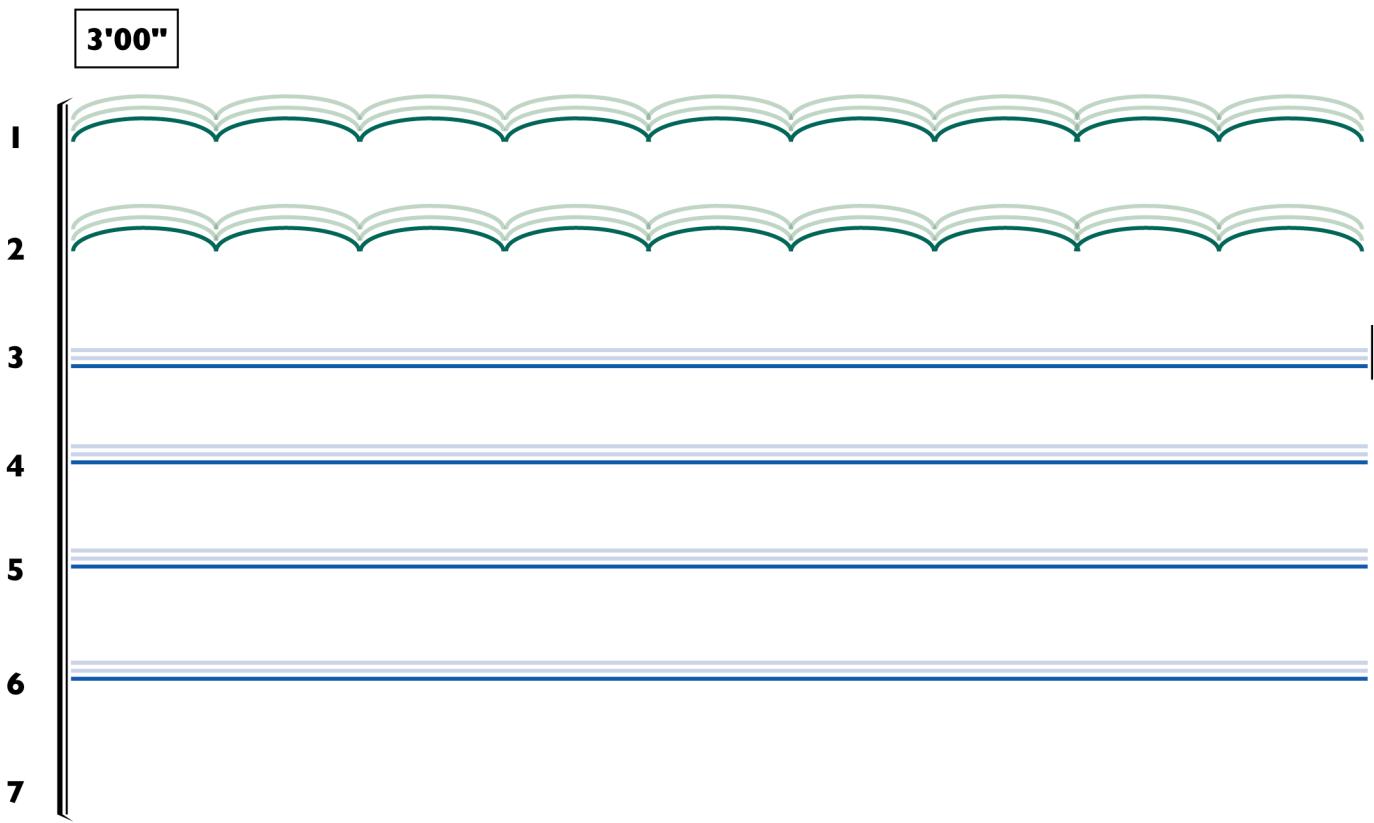


**2'00"**

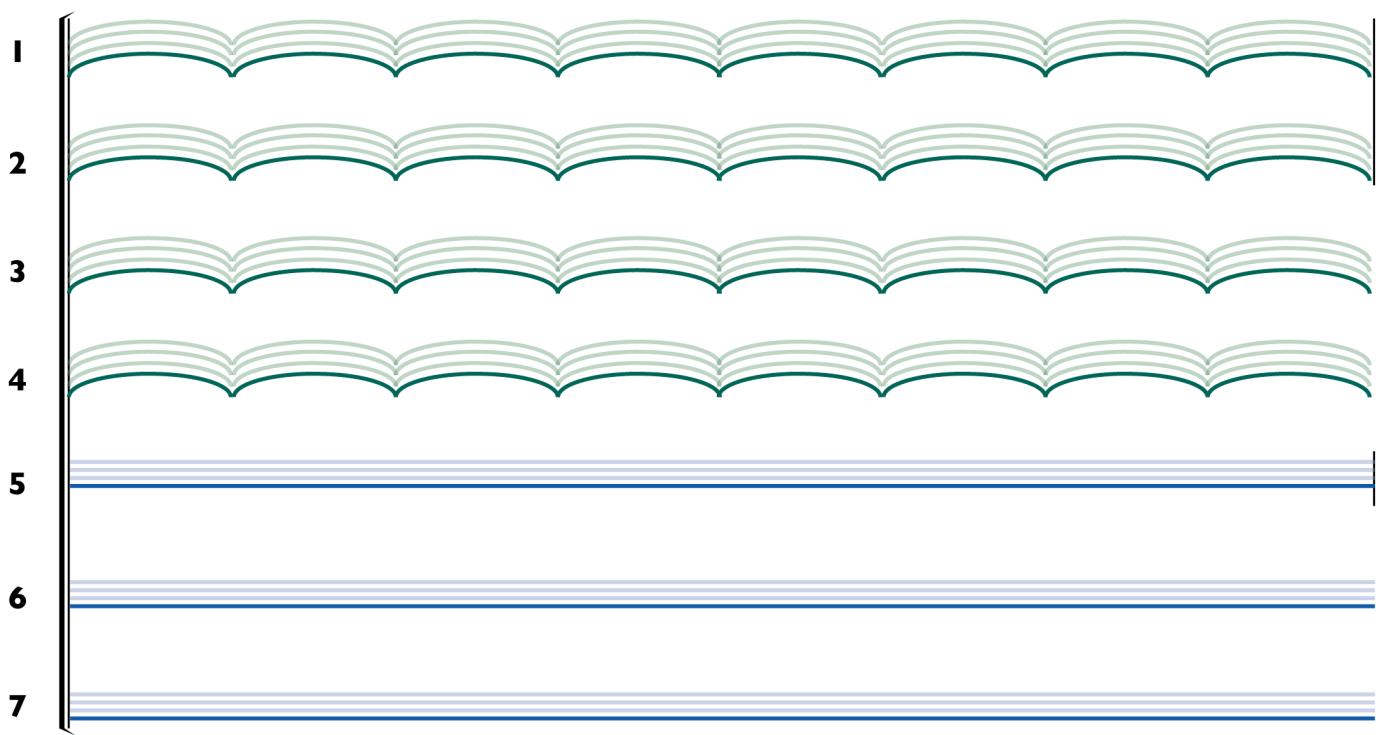


**2'30"**

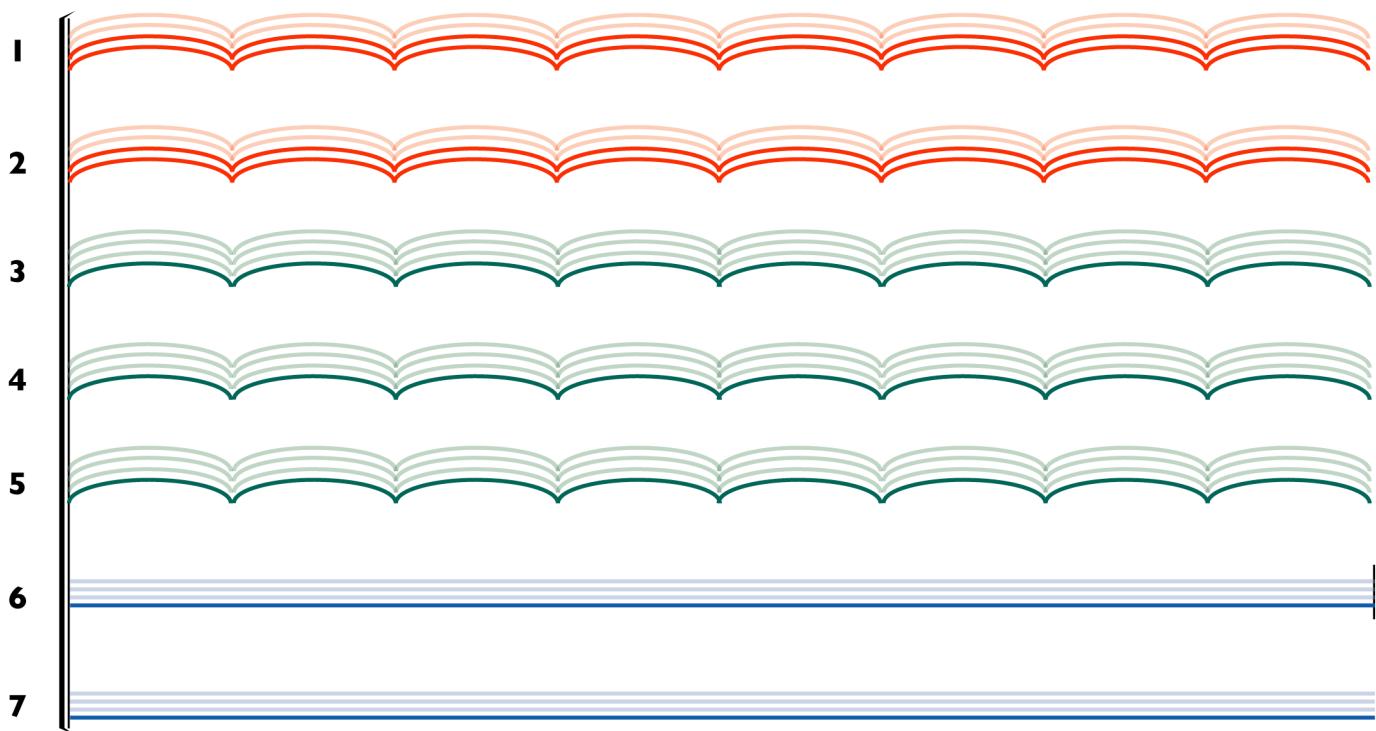




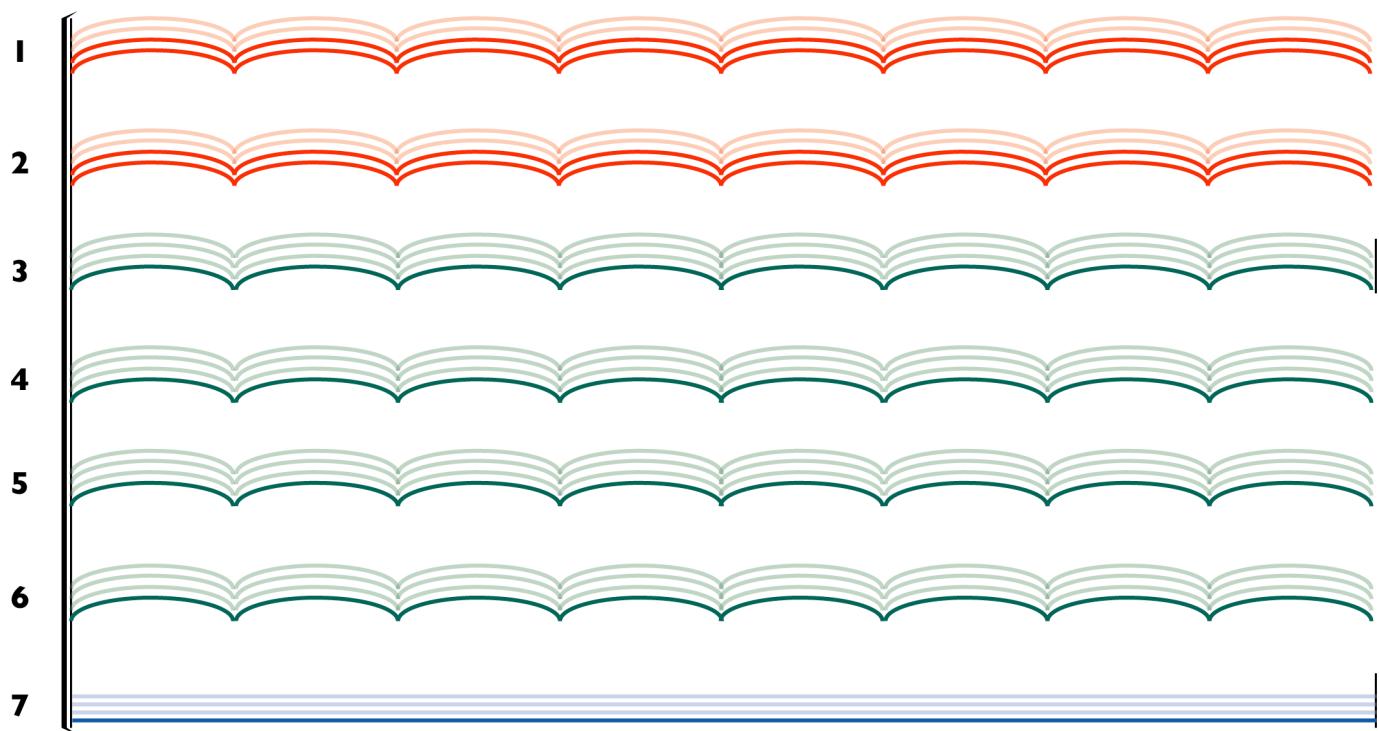
**4'00"**



**4'30"**

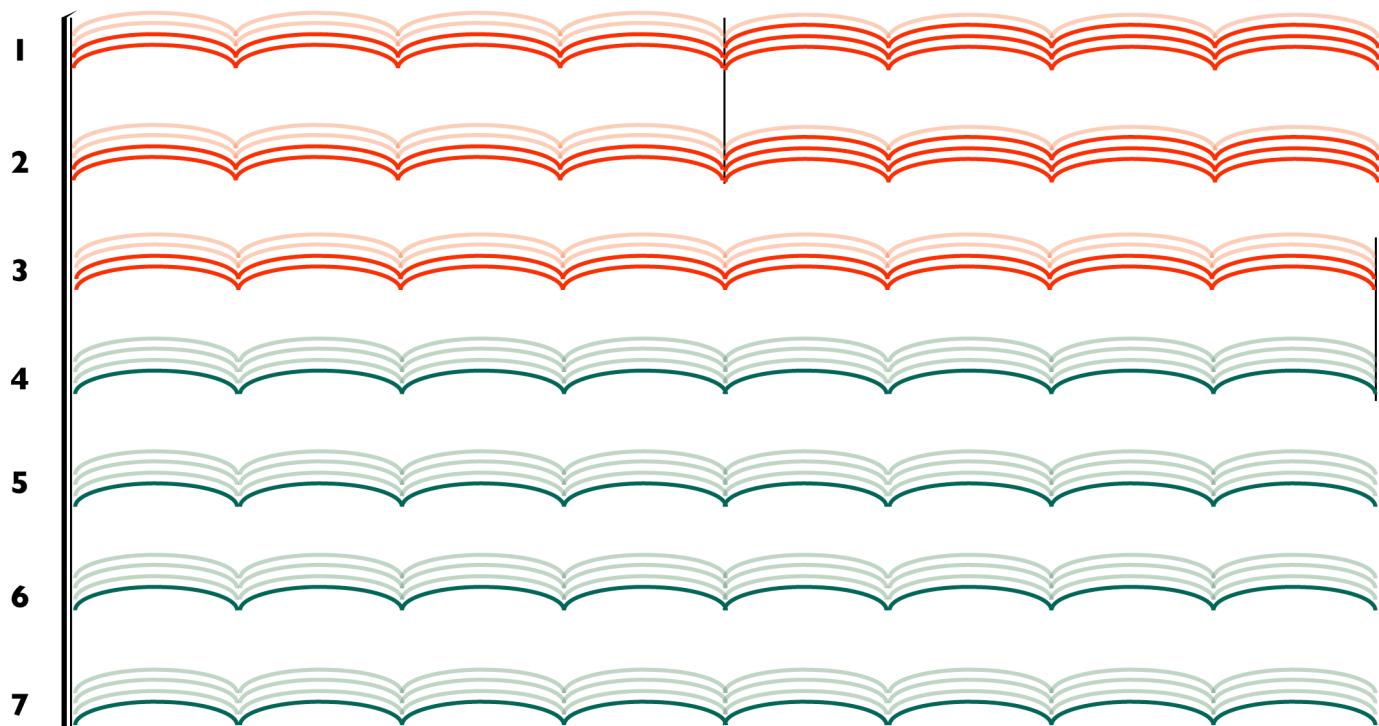


**5'00"**

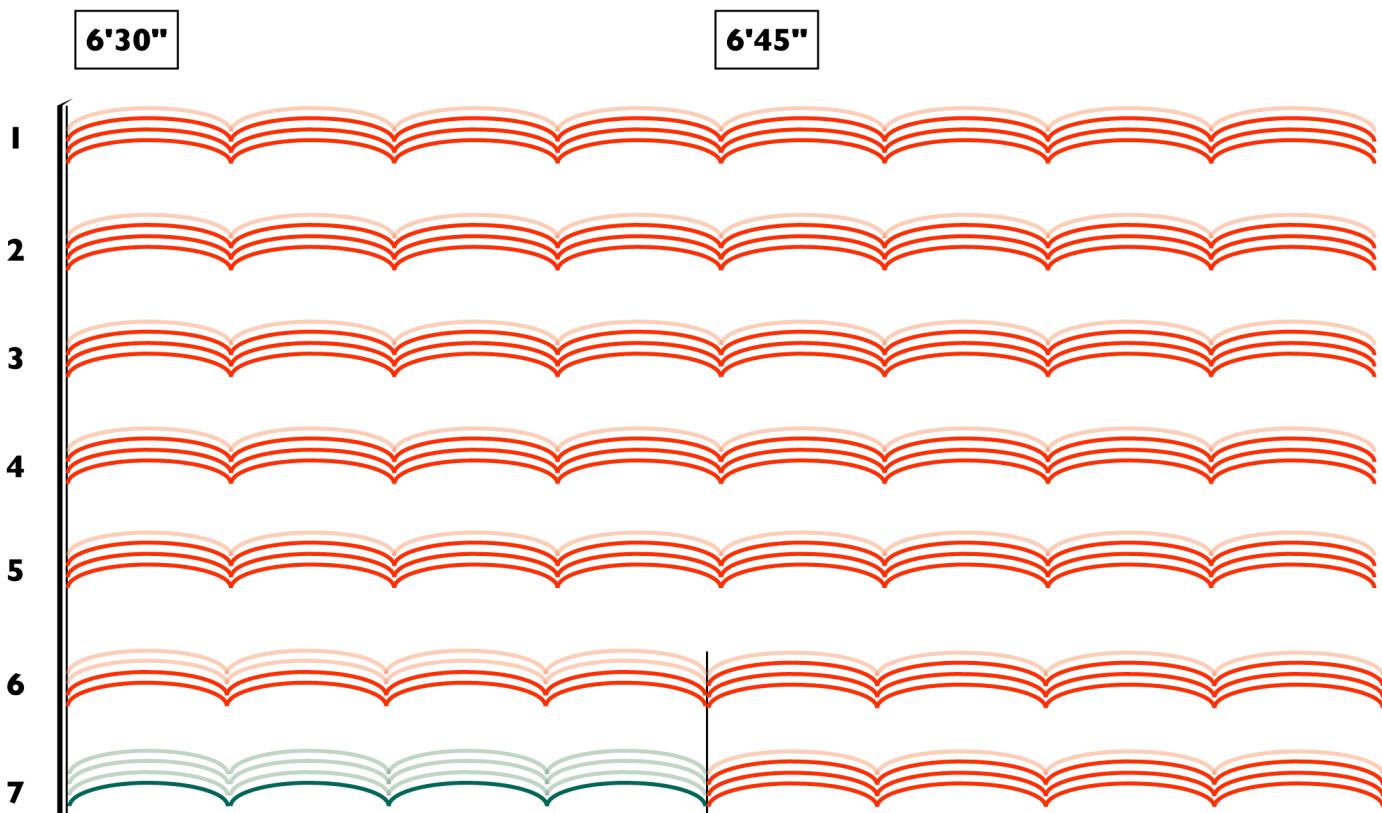
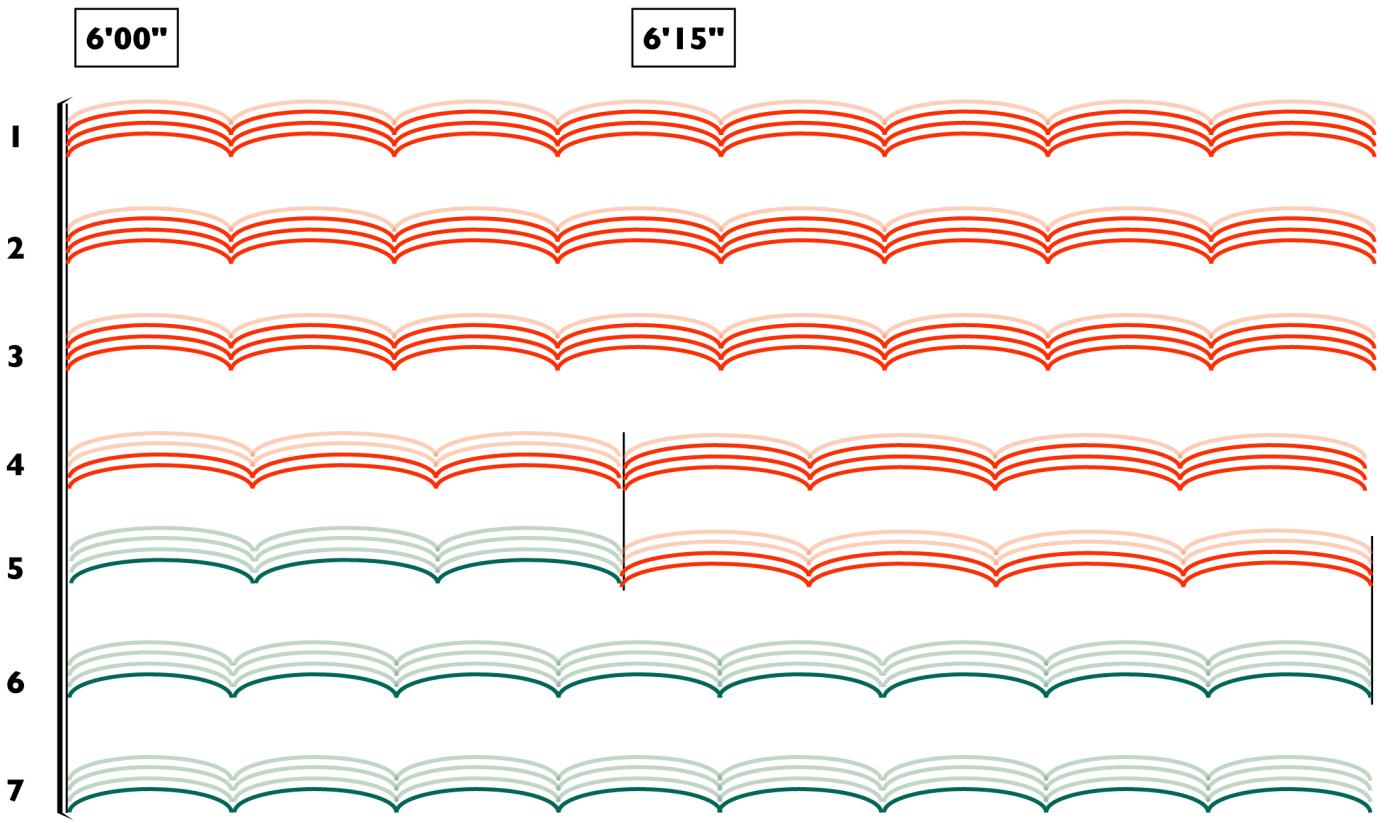


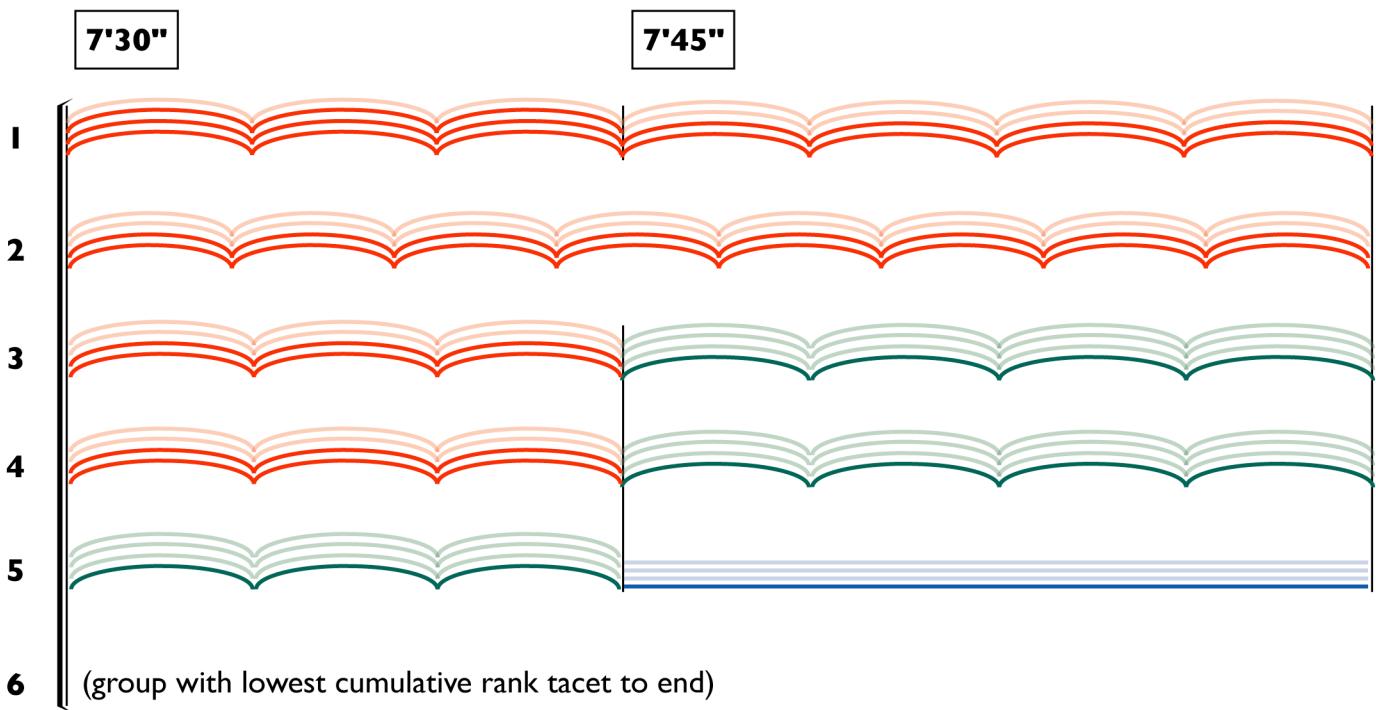
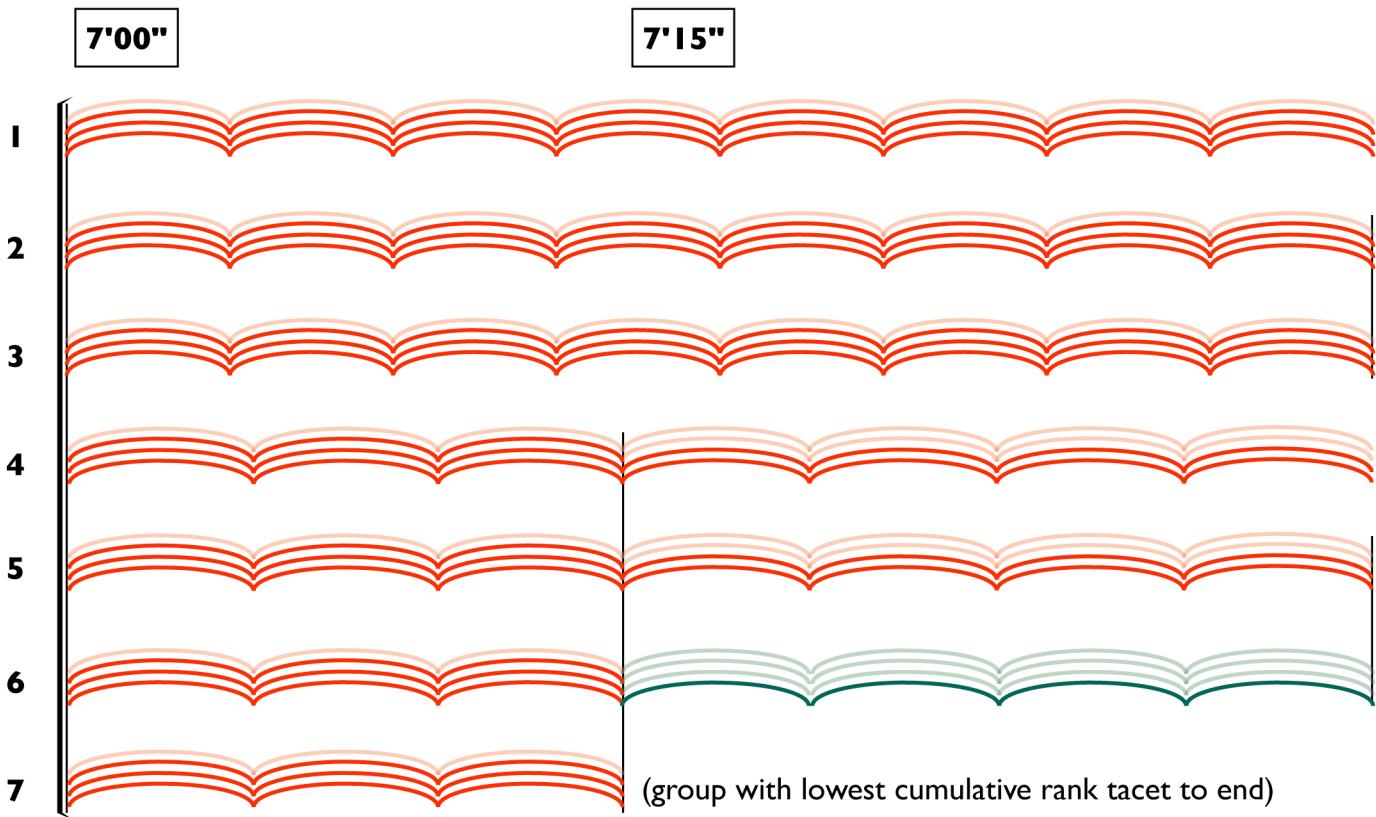
**5'30"**

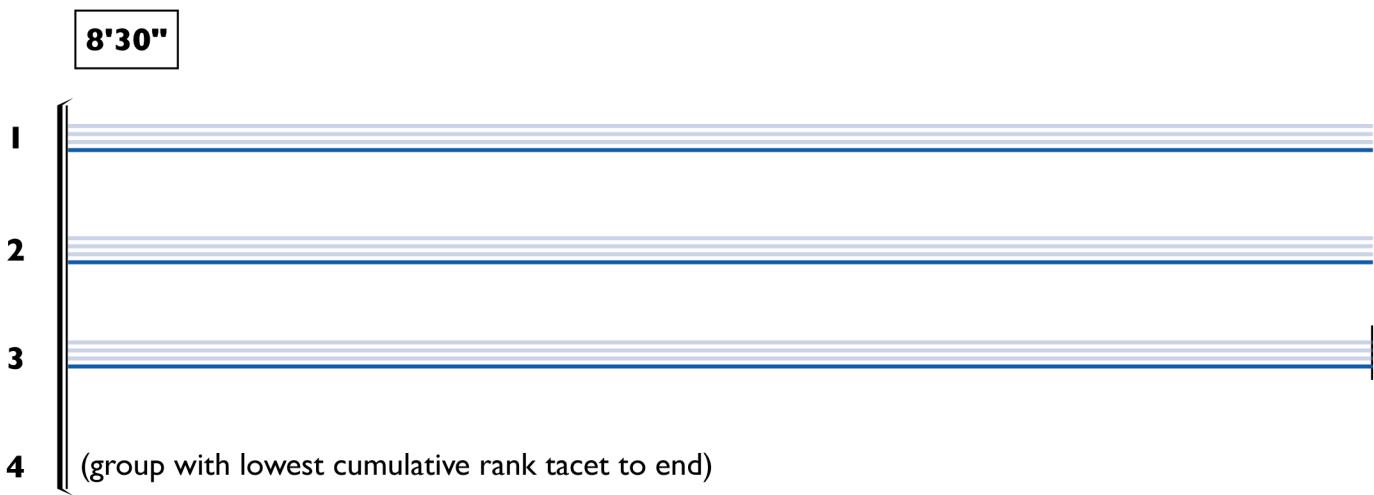
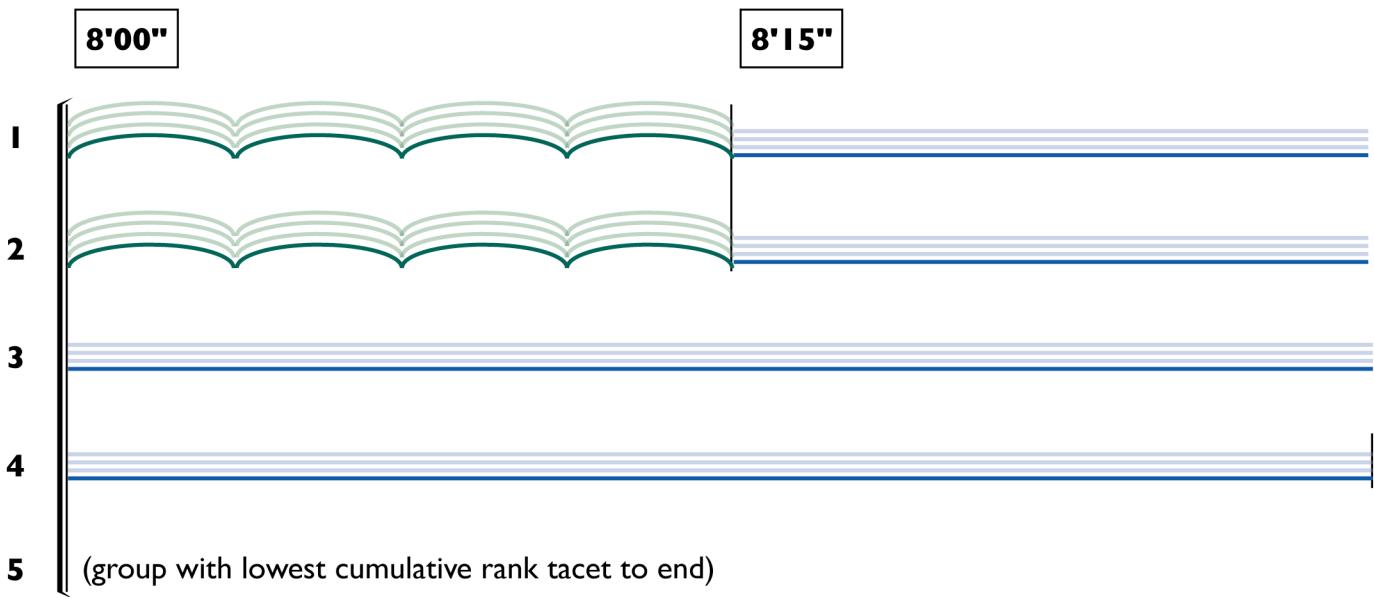
**5'45"**

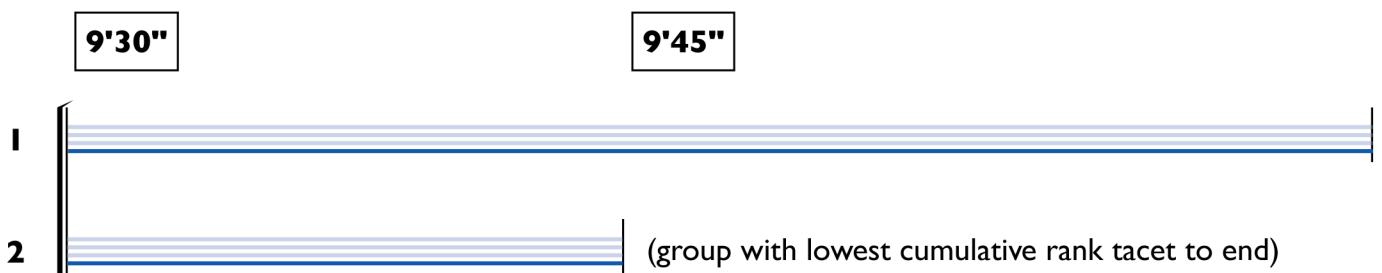
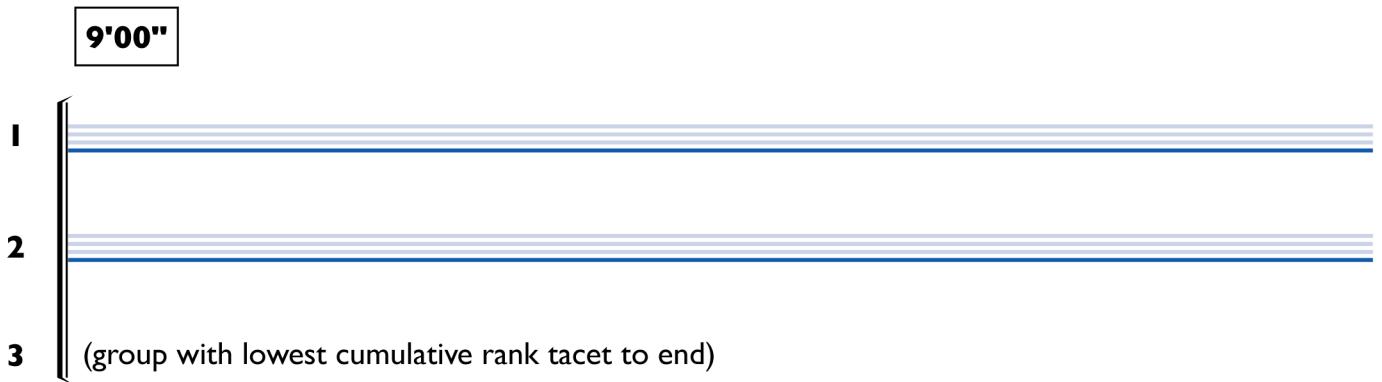


Freeman — Glimmer — Score — 40









**10'00"**

