method of taking patches apart, or an instructor may have some valuable hints. The following method is one that I have used with success with my own students and I would recommend that you try it.

The Rapout° Approach to Electronic Instrument Configurations

°Reasonable Analytical Procedure for Observing Usable Techniques

1. Locate and trace all audio signal routing and their offsets.
   a. How many sound sources are used (VCO's, noise sources, external sources via mikes, tape recorders, etc.)?
   b. Are these signals detected via ED's or PVC's to generate controls, or are they used as real voices within the instrument?
   c. Locate and trace all signal routing from their source to the final output via sub-mixes and final mixes.
2. Identify all variable audio parameters.
   a. In what ways are the audio signals processed (filters, amps, reverb, etc.)?
   b. Are these processing modules variable manually as specified by the composer, or are they voltage controlled by means of an active input? Note the control voltage attenuation level and predict how much effect a voltage (positive or negative) will have on the parameter—how much will the pitch of a VCO change with an applied voltage, what will be the maximum gain of a VCA, how much spectral change will be caused by the control of a filter, etc. At this point you will be aware of the number of voices involved and the number and degree of possible change in those parameters which can contribute to the basic sonic nature of the sounds.
3. Locate all control voltage sources, routing, and processing:
   a. to audio sources and any external processing onvolved—what controls the VCO's, and is the control inverted, integrated, sampled, quantized, etc., before it reaches the VCO? Do the same for each sound source or audio processing module (mixers, VCA's, etc.).
   b. to function generators. If a function generator has a manually variable or voltage controllable sub-function, what is doing the controlling, what is its range of effect in relation to the established offset, etc.?
4. Locate all timing pulse sources, their period and any processing.
   a. are the pulses manually activated or automated?
   b. if automatically generated, what is their period or speed and is this function voltage controlled? If voltage controlled, what is doing the controlling and what is the expected range of variation in relation to the offset period?
   c. is there any timing pulse processing involved—electronic switches, gate inversion, etc.?
5. Identify all structural correlations—audio and control.
   a. Within a single voice, is pitch related to loudness by means of common control sources? Are filter sweeps related to VCA control, etc.?
   b. Are separate voices related by common controls? Does the loudness of one voice have anything in common with the pitch of another voice?
   c. What are the relationships between control voltage sources? Is the speed of an LFO or the period of a pulser related to the selection or control of another function?
   d. What are the relationships between the behavior of any audio sources and processing and a voltage controlled function? Is the gain of a VCA related to the decay time on an EG?
6. Now try to describe verbally what the instrument will do.

   This is a lengthy process but some configurations can become very complicated.

Miscellaneous Controllers. Another method of producing constant or varying control voltages is with "photosensitive controls." In electronic circuitry there are many components that are used to limit or block voltage. Their rating (how much voltage or current they are capable of blocking) may be permanently fixed or may be manually controlled as with a potentiometer. Photosensitive devices will vary their rating in relationship to an applied light source. In simpler terms, a photosensitive controller is a light-controlled pot. A "photosensitive oscillator" will usually generate zero Hz when no light is applied to its light controlled resistor (pot). The photo-oscillator will generate a maximum frequency when a maximum amount of light is applied. A photo-amplifier will provide signal amplification in direct relationship to the amount of light applied to its photo-controller. (Photosensitive controls are very applicable to spatial modulating devices and will be discussed in detail in chapter 13.)

Direct voltage can be controlled with light by using "photodiodes." An absence of light striking the photodiode may result in zero volts DC, while an increase in the amount of light (usually measured in lumins) will produce a proportional increase in DC voltage. The amount of light can be controlled in two different ways. A change in voltage to the light source will change the intensity, but this method is usually inadequate because the control of voltage is the desired outcome. The most useful methods of controlling light