Qualifying Examination – Fall 1998
Operating Systems

1. (50 points) During her many years of research in Africa, Ms. Dian Fossey discovered a most curious type of gorilla. In the deepest, darkest corner of a mountainous region, she discovered a group of these majestic animals that had learned the most basic concept of operating systems after thousands of years of trial and error, not to mention tremendous loss of life. Unfortunately, due to an epidemic of CFS (chronic fatigue syndrome) the current residents of the area have totally forgotten what it took their predecessors thousands of years to learn. Here then is the situation.

   The region discovered by Ms. Fossey is a kingdom of gorillas that is divided by a deep, wide ravine: actually 2,000 meters deep and 1,000 meters wide. The ravine is spanned however, by a stout rope. The rope would seem to be the answer, except for several complicating factors. First, gorillas are only able to cross the rope one at a time as they are only able to move in the forward direction while on the rope. If two animals were to meet on the rope travelling in opposite directions, they would both die as they are not able to change direction. After a few minutes they would tire and fall to a certain death on the canyon floor below. Second, the rope was originally designed under some low bidder program to only support the weight of ONE FAA standard gorilla. The answer to the problem would seem to be simple. All a crossing gorilla would need to do is to look out on the rope to check for gorillas crossing from the other direction before venturing out on the rope. Well, here comes the next problem: this particular part of the dark continent is always dark - no daylight hours.

   Interestingly, the ancients have left behind some support hardware that was intended to solve the problem. The equipment in place and still operational includes: an electrical switch on each approach path to the rope (about 100 meters from the rope entry point) that controls a red light at the entry point to the rope that can be seen from the other side. At the actual rope entry, there are three switches that control the red light just mentioned, the red light on the other side, and the lights on a giant precursor of the Goodyear Blimp that hovers over the canyon and can be seen from either side. The blimp has a giant array of lights that can, under control of the ground switches, show the numbers 1 or 2. Finally, somewhere between the first switch and the rope entry point there is a phone box that can receive, but not initiate, telephone calls. Keep in mind here that all of the equipment is identical on both sides of the canyon.

   Our friend Ms. Fossey hasn't the foggiest clue how to use the equipment to help re-unite the gorillas from the two sides. She doesn't understand the use of all the switches and lights and doesn't understand the importance of the phone box. Having had some experience with a computer scientist friend, she feels that our discipline holds the answer to her problem. Therefore she has issued an RFP (request for proposal) to you to help solve the problem.

Should you choose to respond to her RFP, and you had better do so, please include the following information in your proposal. First, associate the existing situation with some well known problem in the operating system literature. And second, outline the solution to the problem using the existing hardware identifying the relationship between the hardware and the algorithm we discussed. Be brief, use drawings and omit any BS from your answer. Ms. Fossey cares for CS, not BS.

2. (50 points) While visiting the lower east side in New York City several years ago, I noticed a very interesting phenomenon. Many of the poorest people in that part of the city had discovered an interesting technique for getting extra life (no pun intended) out of the few cigarettes they owned, or the butts they found on the street. For example, the leader of the group I had encountered, had discovered years ago, that if it took six average sized butts to make one whole cigarette, she could indeed make seven cigarettes out of thirty six buts. How could she do this you ask: well the answer turns out to be simple. The 36 butts certainly make six cigarettes, and after smoking those six, she discovered that she again had six butts (one more cigarette).

   Our friend was poorly educated but had a fine analytical mind in solving intuitively complex problems. After years of research, she decided to give a colloquium series in order to share her research findings with others in the neighborhood. In general, her theories dealt with using and reusing cigarettes. She had come up with three interesting analytical measures describing how the leftovers from the cigarette smoking process could be used to create more smoking material. Unfortunately, as fate would have it, she was tragically run over by a truck carrying Virginia Slims (before she was able to come a long way baby), and died before she could share her findings with her friends.

   In her room the authorities found some fragments of the research notes she had been working on before her tragic demise. All that could be discerned were fragmentary notes that referred to the size of the cigarette butts found, or retained, and their usefulness in making new cigarettes. The notes sketched out ways of using different size butts as well as insights relating to the amount of cigarette to be smoked to leave a useful size butt for later use. Her work even included notes on how to keep track of the thousands of butts normally accumulated by the average smoker in the neighborhood. Indeed, she had uncovered basic notions of how best to manage and use the butts. Unfortunately, her colloquium series has been scheduled, and thousands of our less fortunate brothers and sisters anxiously await the results of this lifetime of study.

   You are hereby commissioned to use the information at hand to finish her vital work and prepare an outline of the colloquia she will never be able to give. As mentioned, she had found three basic theories to govern the use of smoking materials, so be certain that you colloquium covers these three areas. As her notes don't exactly tell us what the theories were, it is your job to follow her train of logic and arrive at the same set of theories.

In your answer, please list the three probable theories and present discussion on the pros and cons of each. In the end, select one of the approaches that offers the best cigarette reutilization level and tell why it is the best. Remember, there are thousands of people eagerly awaiting your results.