Judging Pace Cross-Country

BY STEPHANIE GUERLAIN

How cognitive task analysis yields insight into an apparently simple, yet complex horse-rider activity.

THE PURPOSE OF THIS ARTICLE IS TO GIVE AN EXAMPLE OF THE challenges and benefits of conducting a cognitive task analysis (or CTA; see Hutchins, 1995; Olson, 1986; Rasmussen, 1986; Roth & Woods, 1990; Vicente, 1999). CTA seeks to identify what is important in a particular domain from the user's perspective, given the goals and constraints of the user, the environment, the organization, and the tools available. It provides a means to understand why people behave as they do in a particular domain, given that human behavior is often largely a reflection of the environment in which people work.

Many methods can be used to gather data for a CTA, including observing, conducting structured interviews, analyzing critical incidents, conducting a strategy analysis, examining the artifacts and tools in use, and examining the organizational objectives and rules (Woods, 1993). The results of a CTA can be used to document current practices (e.g., Hutchins, 1995; Roth & Malsch, 1998; Vicente & Burns, 1995), improve training (e.g., Smith et al., 1999), develop job aids (e.g., Guerlain & Bullemer, 1996), or redesign a task.

The activity examined here is how riders judge and adjust their horse's pace cross-country in the sport of eventing. By following this example, one can see how the tools available (or not available), the constraints on the task, and the rules set forth by a governing organization can affect the mental complexity of a task. This in turn allows us to understand why people adopt certain strategies and make certain kinds of errors in response to the task demands, and helps us to predict how changes to the design of the task, constraints, or tools might enhance or eliminate some of those errors.
Judging Pace Cross-Country

Eventing is a horse-and-rider sport that consists of three phases: dressage, cross-country, and stadium jumping. For this example, the focus is on the speed requirements of the cross-country phase. This phase is an endurance test that requires the horse and rider to gallop over a predefined course with jumping obstacles that are representative of what one might find in the hunting field. The course may go through fields and woods over naturally undulating terrain. Each required obstacle is flagged and judged to be sure the horse/rider team negotiates the obstacle without a refusal or fall. Any refusals or falls will incur jumping penalties.

In a cognitive task analysis, one looks at the intrinsic task requirements imposed on the practitioner (in this case, the competitor riding the course).

The horse/rider team is also timed from start to finish. In addition to jumping penalties, riders might incur time penalties if the total time to complete the course is not within the allowable time window for the course. This time window is set by the governing body of the sport, the American Horse Shows Association (AHSAA), for events sanctioned in the United States. (See the table below for the distances, speeds, and jumping efforts required for the different levels.)

Lower levels of competition are set at a much slower rate of speed than higher levels (300 to 520 meters per minute, or mpm), and the time window is fairly wide. The competitor may come in as much as 1 minute below the optimum time at the novice level and 30 seconds below optimum time at the training and preliminary levels before incurring speed faults. A course at the intermediate or advanced level, on the other hand, can be set anywhere from 550 to 600 mpm, and the time window is narrowed to 15 seconds below optimum time before speed faults are incurred. Both time faults (coming in over the optimum time) and speed faults (coming in under the optimum time minus the allowable time window) incur 0.5 penalties for every second outside the allowable range.

One might begin a task analysis approach by defining the minimal set of tasks that are normally performed. A sample list of tasks for competing in the cross-country phase of an event follows:

1. Walk the course on foot, several times if necessary, to plan a route.
2. Identify the optimum time for the course, as well as total length of the course as posted on the course map (see Figure 1 for a sample map provided to competitors).
3. Set watch to countdown mode. Set time for countdown to be the optimum time plus 5 seconds. Alternatively, set watch to countdown mode.
4. In the start box, as the starter counts down from 10 to “Go,” hit the start button on the watch as the starter says “10” or “5.”
5. Leave the start box on “Go.” (Official timer notes exact time on his/her watch.)
6. Ride the course as planned.
7. Adjust horse’s pace as necessary to finish within the time window (between the optimum time minus the allowable window and the optimum time).
8. Stop the watch when crossing finish line. (Official timer notes exact time on his watch.)
9. Within 30 minutes of scores’ being posted on the official score board, check to confirm that the official posted time is not drastically different from the time the rider calculated.

CROSS-COUNTRY DISTANCES, SPEEDS, AND JUMPING EFFORTS

<table>
<thead>
<tr>
<th>Level</th>
<th>Novice</th>
<th>Training</th>
<th>Preliminary</th>
<th>Intermediate</th>
<th>Advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance of course (meters)</td>
<td>1500 to 2000</td>
<td>2000 to 2500</td>
<td>2000 to 3000</td>
<td>2400 to 3500</td>
<td>3250 to 4000</td>
</tr>
<tr>
<td>Rate of speed required (mpm)</td>
<td>300 to 400</td>
<td>400 to 450</td>
<td>520 to 550</td>
<td>550 to 570</td>
<td>570 to 600</td>
</tr>
<tr>
<td>Number of jumping efforts</td>
<td>12 to 20</td>
<td>16 to 22</td>
<td>18 to 28</td>
<td>22 to 32</td>
<td>25 to 40</td>
</tr>
<tr>
<td>Seconds below optimum time</td>
<td>60</td>
<td>30</td>
<td>30</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>when &quot;speed faults&quot; occur</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time faults (per second outside allowable window)</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
</tbody>
</table>
Figure 1. Sample cross-country course map. Drawn by Lena Warner.
In a cognitive task analysis, one looks at the intrinsic task requirements imposed on the practitioner (in this case, the competitor riding the course), paying particular attention to the mental demands or cognitive workload of the tasks performed. Riding a horse over undulating terrain at speed while negotiating various obstacles takes quite a bit of mental and physical effort.

**A Detailed Look at Rider Tasks**

In preparation for riding the course, the rider walks the course several times, first to learn the required route, and the second and third times to imagine what the course will ride like at speed. Often, there are alternative ways to take an obstacle, which the rider must choose depending on the strengths and weaknesses of the horse and rider.

This CTA clearly reveals that what seems like a simple task—finishing the course within the time allowed—is actually complex.

For a couple of reasons, it is difficult for riders to judge how fast they are going. Different horses “feel” faster or slower, even if they go the same speed. Different courses can also “feel” faster or slower. Furthermore, certain parts of the course can be completed quickly, whereas other parts of the course require slowing down (e.g., because of terrain or obstacles). There is no speedometer to tell the rider that the horse has been averaging 425 mpm, which would be the ideal average speed in order to guarantee finishing within the time window on most training-level courses. Riders also ignore the time factor because it is too difficult to think about while riding the course.

Those riders who pay attention to time generally use a wristwatch as a primary means to check their progress. If the optimum time is 5 minutes 20 seconds, one might set one’s watch to count down from 5 minutes 25 seconds, or 5 minutes 30 seconds. Riders add 5 or 10 seconds to the optimum time to account for the fact that it is too difficult to start the watch on “Go” because they need to be holding onto the reins, looking up and ahead, and moving their horses into a gallop toward the first jump, not looking down and pushing buttons on a watch. On course, riders look at their watches periodically to get a sense of how much time is remaining.

Even with this method, it is difficult for riders to determine if they are going to be within time or not, because they still have to judge how much distance is left on the course and determine if the time is sufficient to cover that distance at the current rate of speed. If, for example, a rider is still three or four jumps from the finish and has only 20 seconds left, it is obvious that the course has been ridden too slowly. This tempts some riders to try to make up speed and minimize the time penalties for being too slow. Alternatively, it is sometimes obvious that a rider is coming in too fast (e.g., with just three or four jumps to go and 2 minutes left). In this case, most riders will slow down significantly, or even circle their horses several times in order to kill time. Even this strategy can backfire; some riders waste too much time and then frantically speed up at the end of the course!

All of these techniques defeat the purpose of the AHSA’s having set a time window to begin with. The purpose of the time window is to encourage riders to ride at the correct rate of speed for their level (training, intermediate, etc.). At the lower levels, the jumps are designed to be ridden at a slower rate of speed, and it can be dangerous to ride them too fast.

Why is it so difficult for riders to judge whether they are riding at the correct rate of speed? Judging the time remaining is feasible with a wristwatch, but judging the distance remaining is much more difficult, and it is the relationship between these two factors that determines one’s pace. Some riders use a tool called a meter wheel (see Figure 2) to measure the course when they walk it before the event. Pushing the meter wheel over terrain will cause a gauge to tick off the number of meters that have been covered. If the optimum time is based on a desired rate of speed of 425 mpm, then when the meter wheel reaches 425, one minute should have passed. At 850 meters, 2 minutes should have passed, and so on.

![Figure 2. A meter wheel used by some competitors to measure distance on a course.](image)

Doing all these calculations while walking the course can be difficult. (“Hmm, the required rate of speed is 425 mpm, so at 4 minutes, I should have traveled 425 times 4 equals, uh, let’s see, 425 times 2 is, um, 850, so 425 times 4 is 1600, no 1700... OK, 1700 is my next target!”) In addition, while walking and pushing the meter wheel, the rider has to remember to check it periodically to see if it has reached 1700 (generally, one looks where one is going, not down at the meter wheel). Riders often need to back up because they discovered they walked past the next target point on the meter wheel gauge.
Once the desired set of meters has been located, the rider needs to calculate the optimum time for that point on the course ("OK, how many minutes was I supposed to be at at this point? Oh yes, 4 minutes.") Then the rider looks for a landmark, such as a tree stump, to watch out for while riding the course, as a reminder to check his/her watch at that time to see whether 4 minutes have passed. Often, however, the minute marker is at a point on the course that is not conducive to looking at the watch (in a turn, right in front of a jump, etc.), so ideally, one would like to know how much time should be on the watch at a location on the course that is more amenable to taking the time to look down at the watch.

If the rider prefers to set his/her watch to count down rather than up (it may be easier to figure out how much time is remaining if one sets the watch to count down), then he/she needs to subtract 4 minutes from 5 minutes 20 seconds (the optimum time) to realize that the watch should be at about 1 minute 20 seconds when passing a particular landmark. Of course, if it's not exactly at that time, one needs to know if it is necessary to speed up or slow down. If the watch says 59 seconds, what would the rider have to do?

To check minute markers on the course more easily, the rider can set the watch to count up, but then he/she needs to remember that the optimum time is 5 minutes 20 seconds (plus 5 seconds for starting the watch early), so that when looking at the watch, he/she can figure out that 4 minutes 32 seconds really means about 48 seconds remaining. There is a 30-second grace period, meaning that the rider has between 48 seconds and, "Let's see, is it 48 seconds plus 30 or 48 seconds minus 30...?" Meanwhile, time is passing, the horse is galloping along, and there is a jump coming up that needs the horse's and rider's full attention.

**Applying CTA**

This CTA clearly reveals that what seems like a simple task – finishing the course within the time allowed – is actually complex. It does not merely mean looking at a watch periodically. Having a watch read out "3 minutes 12 seconds" means nothing to a rider unless he/she knows how that time compares with the required time for that location on the course and then can convert this knowledge into a decision to speed up or slow down. Further, the results of a task analysis enable one to examine the appropriateness of the tools that are available and determine how one might change the task or the tools to make things easier.

For example, the meter wheel merely ticks away meters on the course. If it were possible to set the rate of speed on the meter wheel (i.e., 425), then it could do the calculation for the rider. At each minute marker, for example, it could beep an alert to indicate the rider has reached the minute mark, eliminating the need to look down at the meter wheel all the time when the rider should be watching where the horse will be going. No one is particularly interested in meter 1024 except to be able to calculate how many minutes should have passed given the current location on the course.

A second option would be for the course designer to measure the course and display minute markers or distance markers. This would eliminate the need for riders to use a meter wheel. This may seem like cheating, but one must remember that the purpose for having set the time windows in the first place is to encourage riders to ride at the correct rate of speed. It is not a test of people's mathematics, watch manipulation, and mental calculation skills, when they are supposed to be concentrating on the primary task at hand, which is to ride the course safely and as planned. Cross-country courses used to show the halfway point, but this practice was discontinued. Further, merely displaying the halfway point is not sufficient to prevent the scrambling and stalling at the end of the course.

It is not necessarily easy for a novice analyst to determine the cognitive challenges faced by practitioners in an environment in which he or she is not an expert.

A third option, now under consideration by the AHSA, is a proposed rule change that would make "[t]he use of any timing device (watches) by [lower-level] competitors to determine their time on course" illegal. The issues uncovered by the foregoing CTA enable one to predict the problems with this kind of "solution," many of which have been voiced by competitors. One rider asked, "What is the logic or fairness in telling people they must accomplish a task within a set time period, then denying them the basic equipment they need to assess their performance?" Another rider concurred: "At the lower levels the riders need help establishing and learning pace, not making it a guessing game." In other words, having watches is not what is causing people to ride erratically. Riders need more tools, not fewer, to accurately judge their pace. This is a basic premise of good design – give feedback. Without feedback, it is difficult for people to learn or adjust. Real-time feedback is much more useful than finding out an hour after completion that the course was ridden too quickly or too slowly.

**Challenges of Conducting CTAs**

The more one conducts cognitive task analyses, the more one sees similarities in task activities across domains. Predicting time/space relationships is a task that is inherent in many activities, including flying airplanes, driving cars, and conducting military movements. Once an analyst becomes attuned to the inherent challenges in these kinds of activities, he or she begins to recognize how people cope...
with those challenges based on the tools available, time available, and other task activities.

It is not necessarily easy for a novice analyst to determine the cognitive challenges faced by practitioners in an environment in which he or she is not an expert. It would be easy for an analyst to discover the need for riders to judge pace but difficult to realize the implications of this task requirement on mental workload. As proof of this, I have had all my students attempt to conduct a CTA of the task just described. I use this task because none of them had ever heard of eventing, but as a rider myself who competes in eventing, I know the challenges faced by riders, so I can judge how well the students are unraveling the difficulties associated with this task.

Students are given a week to conduct background research (usually on the Internet) of the basic rules and goals of eventing. During a 1.5-hour class, they first observe a brief video of cross-country riding and then spend the remaining hour interviewing two to three eventing experts, each of whom brings in course maps, watches, meter wheels, and other items to describe the activities and answer students' preplanned questions. The students are then given two days to write up their results. Only 5% of the students discovered the major set of difficulties associated with judging pace: using the meter wheel, having to calculate pace in one's head, being limited by watches (which tell only the time but not distance or rate of speed), calculating and adjusting for the time window, remembering optimum time, figuring out how to use the countup and countdown features on the watch, locating landmarks, adjusting for different parts of the course that take more time, seeing the time on the watch while galloping, and focusing on the course and the watch simultaneously, particularly at bad times (e.g., in front of a jump).

Thus, although conducting CTAs is important and useful, it requires skill to become a good analyst, to know how to enter a new domain, gain access, learn the language, discover what people are doing and why, and then identify the intrinsic constraints of the task, tools, and organizational policies that drive behavior and cause error-prone activities. No eventing rider will admit that timing is that difficult - no rider except me, that is, who is an expert at both riding and human factors. It does not occur to most people who are "in" a domain exactly what makes seemingly mundane tasks difficult or error-prone.

The analyst must therefore be able to recognize or infer the difficulties based on prior knowledge of human capabilities and limitations, by looking at the underlying physics of the problem, and by paying particular attention to how people tailor their environment or adopt different strategies. The analyst will not be told directly about intrinsic difficulties. This is the art and science of human factors - specifically, cognitive engineering - and what makes this field so interesting. Cognitive engineering is one of the few disciplines that makes it possible for one to make a living learning about other disciplines (air traffic control, network operations, process control, aviation, transportation, health care, or horseback riding) and then applying generic techniques, such as cognitive task analysis, to enable people of varying skills to successfully practice in that discipline.

References


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