15-410

"What could possibly go wrong?"

"Paradise Lost"
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Outline

When to use `if()` vs. `while()`

Consider the lowly worker thread

```
/* note: not a thrgrp_*() worker thread */
void
worker(void *ignored)
{
  workitem *work;
  while (work = find_work())
    perform(work);
  thr_exit((void *) 0);
}
```

What's Wrong With This Picture?

```
workitem *
find_work(void)
{
  workitem *w;
  mutex_lock(&m);
  if (going_out_of_business)
    w = (workitem *) 0;
  else
    w = (workitem *) dequeue(q);
  mutex_unlock(&m);
  return (w);
}
```

Better?

```
mutex_lock(&m);
if (going_out_of_business)
  w = (workitem *) 0;
else {
  if (!(w = (workitem *) dequeue(q))) {
      cond_wait(&new_work, &m);
      w = (workitem *) dequeue(queue);
  }
}
mutex_unlock(&m);
return (w);
```

What We Hope For

find_work()	*queue_work()*
`mutex_lock(&m);`	
`if (!..dequeue(..))`	
`cond_wait(&new, &m);`	
	`mutex_lock(&m);`
	`enqueue(...)`
	`cond_signal(&new);`
	`mutex_unlock(&m);`
`w = dequeue(..);`	
`mutex_unlock(&m);`	

What Went Wrong?

What went wrong?

What Went Wrong?

What went wrong?

- **Nothing!**

What Went Wrong?

What went wrong?

- **Nothing!**

But what if there is *a third* thread?

Not Exactly What We Hope For

find_work()	*queue_work()*	*find_work()*
`lock(&m);`		
`if (!..deq(.).)`		
`cwait(&new, &m);`		
	`lock(&m);`	
	`enqueue(...)`	
	`csignal(&new);`	
	`unlock(&m);`	
		`lock(&m);`
		`if (!..deq(.).)`
		`unlock(&m);`
`w = deq(.)...`		`return(w);`
`return (0);`		

Have We Seen This Before?

What went wrong?

- Protected world state wasn't ready for us
- We blocked
- Somebody prepared the world for us to run
- We ran
  - We *assumed* nobody else had run
  - We *assumed* the world state was still ready for us

When have we seen this "happiness revocation"?

To “if()” Or Not To “if()”?

```
mutex_lock(&m);
if (going_out_of_business)
  w = (workitem *) 0;
else {
  while (!(w = (workitem *) dequeue(q)))
      cond_wait(&new_work, &m);
}
mutex_unlock(&m);
return (w);
/* XXX still wrong! - rewrite after class */
```

Summary

if() vs. while()

- If somebody can revoke your happiness, you'd better check

Related Work

TOCTTOU

- This is “just a sub-case of 'TOCTTOU bugs'”, but...
  - Many people think TOCCTOU bugs are always security bugs
  - Fundamentally, we expect the revoked condition to become unrevoked again (soon!)
  - Unlike the general case, this can be fixed in less than a line of code!