# Exercises werkcollege 7

## Exercise 1

A self-service gas station has a number of pumps for delivering gas to customers for their vehicles. Customers are expected to pre-pay a cashier for their gas. The cashier activates a pump to deliver gas.

a) Provide a model for a simple system with 2 customers and a gas station with 1 pump and a cashier. Include into the model a range for the different amounts of payment and corresponding amounts of gas. A customer is not satisfied if an incorrect amount of gas is delivered; this should be reflected by an ERROR state of the model.

```
const N = 2
range C = 1..N
range G = 1..3

CUSTOMER = (prepay[a:G] ->
              pump[b:G] ->
                if a==b then CUSTOMER
                        else ERROR).

||CUSTOMERS = c[C]:CUSTOMER.

CASHIER = (c[i:C].prepay[a:G] -> c[i].deliver[a] -> CASHIER).

PUMP = (c[k:C].deliver[x:G] -> c[k].pump[x] -> PUMP).

||STATION = (CUSTOMERS || CASHIER || PUMP)
              \{c[C].deliver}.
```

b) Check the safety and progress properties for this system.

```
No deadlocks/errors
No progress violations detected.
```

c) Extend the model to cater for 2 customers and 2 pumps. Specify and check a safety property FIFO that ensures that customers are served in the order in which they pay.

Add and modify as follows:

```
const M = 2
range P = 1..M

CUSTOMER = (prepay[a:G] ->
              p[P].pump[b:G] ->
                if a==b then CUSTOMER
                        else ERROR).
```

```
||CUSTOMERS = c[C]:CUSTOMER.

CASHIER = (c[i:C].prepay[a:G] ->
             p[P].c[i].deliver[a] ->
                CASHIER).

PUMP = (c[k:C].deliver[x:G] -> c[k].pump[x] -> PUMP).
||PUMPS = p[P]:PUMP.


||STATION = (CUSTOMERS || CASHIER || PUMPS)
        /{forall[m:C][n:P] {c[m].p[n].pump/p[n].c[m].pump}}
          \{p[P].c[C].deliver}.
```

d)
```
property FIFO = (c[i:C].prepay[G] -> FIFO[i]),
FIFO[i:C] = (c[i].p[P].pump[G] -> FIFO | c[j:C].prepay[G] ->
FIFO[i][j]),
FIFO[i:C][j:C] = (c[i].p[P].pump[G] -> FIFO[j]).


||SAFE_STATION = (STATION || FIFO).
```

The FIFO property does not hold (which is a fortunate thing. Imagine a customer who pays, and then first takes a nap before pumping…. ) The FIFO property does hold w.r.t. the deliver actions.