The Human Exposure Model (HEM)

Product Use Scheduler Module

Technical Manual

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Table of Contents

ACKNOWLEDGMENTS AND DISCLAIMER

1. Introduction

1.1 Overview

The Product Use Scheduler module provides schedules of usage of consumer products based on behavior diaries defining general behaviors (eating, sleeping, working, commuting, and 'idle' time) for different demographic groups. Product usage is defined for each member of a household, for 364 days (four seasons consisting of 13 weeks each), such that bystander exposure (exposure to a product which you are not the user of) can be taken into account. The Product Use Scheduler takes as input the pophouse.csv file output from the RPGen module, in addition to other required input files. Diaries of product usage output from the Product Use Scheduler are provided as input to the Source-to-dose module.

Notes: Throughout this manual, 'product' and 'product category' may be used interchangeably. Note that any use of the term 'product' does not refer to the specific formulation of a product, rather 'product' and 'product category' are used interchangeably to refer to the use of a generic product type (e.g. toothpaste, surface cleaner) by an individual.

1.2 Purpose of this Technical Manual

This Technical Manual is intended for use by scientists to understand the logic and scientific rationale implemented in the Product Use Scheduler. Included as appendices are data dictionaries for required input files, and a data dictionary for module outputs. Detailed instructions on how to run the Product Use Scheduler module in R are provided in the HEM User Guide.

1.3 Organization of this Technical Manual

The functions which constitute the Product Use Scheduler have been grouped conceptually for the purposes of organization in this Technical Manual.

Section 3: Functions for formatting data and set-up.

Section 4: Selection of products.

Selection of products can be further broken down into three subcategories.

Identification of the product categories which have a potential for use by the households and individuals in the population being modelled. Product categories with a 'potential' for use are defined by the ever/never rules for product use, which identify products which are 'never' used by a household or individual, vs. products which have a 'possibility' of use by a household or individual.

Actual product use. Based on the set of product categories with a potential for use in each household, the individuals are assigned a list of actual products used.

Communal activities and associated product use. Within a household, certain activities are identified as 'communal' activities (e.g. cleaning the kitchen). Communal activities are distinguished by their completion fulfilling the needs of more than one individual, e.g. one individual cleaning the kitchen satisfies the need for all individuals in the household to have a clean kitchen.

Section 5: Assignment of product use.

Functions which select appropriate behavior diaries for each individual, and assign activities and associated product use to specific times of the day.

Section 6: Clustered activities.

The use of certain categories of products is often clustered together in time. The use of many different categories of personal care products (shampoo, soap, toothpaste) is often clustered together in an individual's day, or the use of laundry related products is clustered (laundry detergent, fabric softener, stain remover).

2. Overview of Product Use Scheduler

A detailed description of file structure, system requirements, and instructions on how to run the Product Use Scheduler module can be found in the HEM User Guide.

For reference, the Product Use Scheduler module code, along with default input files, are available at: https://github.com/HumanExposure/ProductUseScheduler.

3. Formatting and set-up

3.1 Formatting of population and household characteristics

The **Household Characteristics Processor (HCP.r)** function re-formats the output of the RPGen module (pophouse.csv, see Technical Manual for RPGen module for details) for use in the Product Use Scheduler. The function creates a unique row for each household member, identifies the primary individual in the household, and drops unnecessary variables.

Within HCP.r, for each household, the primary (or "main") person is identified. In subsequent modules of HEM, direct exposures are calculated for the primary individual only. Product use by other members of the household is used to contribute to indirect exposures for the primary individual.

The output of RPGen includes many variables defining characteristics of individual's and their homes. Only variables used in subsequent modules of HEM are retained. These include:

- Region where the household is located, if provided
- House size in square feet
- Number of bathrooms in the house
- Number of other people in the household, including individual characteristics (e.g. age and gender) for each of these people; note ages are provided as two digit numbers. Gender is converted to a character in HCP.r, and the primary person's age and gender are moved to appear first in the list of ages and genders for all household members.
- Number of cars owned by the household
- Presence of a dishwasher, clothes washer, and/or clothes dryer in the home
- Presence of a swimming pool or hot tub at the home
- Ownership status (rent vs. own); household members may also be identified as staying in a location without paying rent

- Ethnicity of household members. All household members are assumed to have the same ethnicity as the primary individual
- Type of housing. RPGen output characterizes housing type into many sub-categories; HCP.r condenses these housing types to three possible bins: 'single family homes', 'multi-family homes or apartment buildings', and 'mobile home or other.'

4. Selection of products

4.1 'Ever/Never' rules and identification of universe of possible product use

A fundamental component of assignment of consumer product use within the Product Use Scheduler is the application of 'ever/never' rules, and defining parameters for habits and practices (i.e., use patterns). Ever/Never rules act as binary filters to define the possibility of use of a product by an individual or household. These rules are developed using the generalization that, for certain categories of products, the possible use of the product can be predicted based on characteristics of the household. For example, if there is no pool at your home, you will 'never' use pool treatment chemicals. If there *is* a pool at your home, you have the possibility of using pool treatment chemicals. It is important to note that in the latter case, you may still be a non-user of pool chemicals – if you are a possible user, your *actual* use of pool chemicals is defined by the habits and practices parameters. These binary rules allow for narrowing down the universe of possible products used by a household or individual based on their individual and household characteristics. We note that such binary rules capture general trends in the population, but do not account for exceptions (e.g., you do not have a pool at your home, but your job involves using pool chemicals at a different location, or you do not have a pool at your home but you are responsible for caring for a pool at your parents' home). It is important to note that rules have been designed to define use of products in the home, and do not account for use of products at your job site (i.e., occupational exposures), or at other non-residential settings (e.g., schools, gyms, playgrounds, shops, in-vehicle, etc.).

It is important to note that assumptions described below represent the parameter values detailed in the provided example **FullENT.csv** input file. The FullENT.csv file is provided as an example, and may be used as-is is default input parameters are desired. However, all assumptions detailed below can be modified by the user for a given model run by modification of the FullENT.csv input file. User should always review assumptions made to ensure that input parameters are appropriate for their application of model results.

The **Household Universe of Products (HUP.r)** function applies the Ever/Never rules to each household, using the characteristics of the household, to identify the universe of potential product use for a household. The following assumptions determine if a product category is, for each household, identified as 'never' being used, or if that product category is included in the list of categories of potential use.

- Households with zero cars are assigned 'never' use of all auto products (e.g. car wax)
- Household without a septic tank are assigned 'never' use of septic tank related products (e.g. septic cleaner)
- Households without an oven or grill are assigned 'never' use of oven cleaner
- Households without a printer are assigned 'never' use of related products (e.g. printer ink/toner)

- Households without a hot tub or swimming pool are assigned 'never' use of products related to pool maintenance (e.g. pool water treatment chemicals)
- Households by renters and not the property owner do not use home maintenance or yardwork products

Specific product category codes associated with Ever/Never rules described above can be found in the **FullENT.csv** input file. See appendix A.1 for details of the FullENT.csv input file.

The **Individual Universe of Products (IUP.r)** function further refines the universe of potential product use for a household by applying Ever/Never rules which define potential product use at the individual level. The following assumptions determine if a product category is, for each individual, identified as 'never' being used, or if that product category is included in the list of categories of potential use.

- Males are assumed to be 'never' users of most make-up and related products, as well as some hair care and nail care products (see FullENT.csv for a full list of product categories excluded for use by males)
- Females are assumed to be 'never' users of aftershave, and clipper lubricant/cleaner
- Children ages 0-18 are assigned to be 'never' users of a variety of product categories. For the purposes of assignment of 'never' use parameters in the FullENT.csv file, children have been grouped into the following age categories, determined on the basis of potential for use of consumer products: 0-5 years, 6-12 years, 13-15 years, and 16-18 years. A specific listing of the assignment of never use of product categories by children can be found in the FullENT.csv file. In summary:
  o Children ages 0-5 and 6-12 are assumed to be 'never' users of communal products (e.g., household cleaners).
  o Children ages 0-5 are assumed to be 'never' uses of most household products with the exception of general personal care products and products intended for use on or by babies and young children (e.g. sunscreen, baby shampoo, diaper cream, children's arts and crafts or toys). Note that this does not exclude the potential for bystander exposure for this age group when others in the home use various products.
  o Children ages 6-12 are assumed to be 'never' users of many household products typically utilized by adults, e.g. office supplies, fabric dyes and paint sealers, and a number of personal care products (e.g. make-up related products, sexual wellness products, etc.), and of products intended for use by or on babies or young children (e.g. diaper cream)
  o Children ages 13-15 are assumed to be 'never' users of sexual wellness products, some personal care products (e.g. hair coloring products), and products intended for use by or on babies or young children
  o Children ages 16-18 are assumed to be 'never' users of some children's arts and crafts products and toys, and products intended for use by or on babies or young children

4.2 Habits and Practices, and selection of actual products used

After identifying the universe of potential products used by a household and/or individual, habits and practices (or 'use pattern') parameters are incorporated to determine the list of <u>actual</u> products used by a household, and the patterns defining their use (frequency of use, mass used, etc). For example, for all

individuals above a certain age, surface cleaner spray may be a potential product used, however the prevalence of use of surface cleaner spray in the population may not be 100%, and the frequency and mass of surface cleaner spray varies across individuals in a population.

The **Individual Sample of Products (ISP.r)** function together with the function **Use Profile Generator (UPG.r)** implement a probabilistic sampling procedure to determine whether or not a product on the 'possible use' list is actually used by an individual, that is, whether the individual is a 'user' or a 'non-user' of each 'possible use' product. Random number generation is done in ISP.r, after which ISP.r calls the function UPG.r to compare selected random numbers against distributions of habits and practices parameters defined in the **PUC_use_data.csv** input file.

ISP.r uses probabilistic sampling together with the product category's overall prevalence of use in the population (defined in the PUC_use_data.csv input file, which defines the habits and practices parameters) to determine actual use or non-use of a product for each individual.

Within UPG.r, the generated random numbers are compared against the product category's age- and gender- specific prevalence of use in the population to determine actual use or non-use of a product for each individual. Similarly, probabilistic sampling is used to specify the frequency of product use, activity duration, mass used, exposure duration, and handling time duration using age- and gender-specific product category level distributions for each of these variables (all defined in PUC_use_data.csv).

Handling time, prevalence, frequency and mass are assumed to follow log-normal distributions; random numbers are also assumed to follow log-normal distributions. To avoid drawing extreme values from any distribution, distributions were truncated at a maximum of three times the arithmetic mean. Minimum threshold values (1 minute for time duration variables, and a function of square footage of the home for all other variables) are also set for each variable.

See appendix A.2 for details on the PUC_use_data.csv input file.

4.3 Product usage for communal activities

When modelling product use in the home environment, we must consider the use of products in the context of both individual and household, or 'communal' use. Certain products are used to fulfill the needs of an individual (e.g., toothpaste). Though toothpaste may be used by all individuals, my use of toothpaste does not satisfy your need to use toothpaste. However other products, when used, fulfill the needs of a group of individuals, though the product may only be used by one individual. If one individual in a household uses spray cleaner to clean the bathroom, the use of the product by that one individual benefits all individuals living in the household. As such, when considering scheduling of product use for each individual, we must take into account use of products by all individual's in a household collectively, so that we do not duplicate use of a product by multiple individuals in the household when the need may be satisfied by a single individual's use of the product.

The **Communal Product Selector (CPS.r)** function samples and assigns the use of communal products within a household. Individual versus communal product category designations are as defined in the **FullENT.csv** input file. A single individual in each household is chosen for each communal product used in the household. For example, the same person in the household will use bathroom cleaner for the entire year when the use of bathroom cleaner is needed, and that one person's use of bathroom cleaner

will satisfy the need to use bathroom cleaner for the entire household. A different individual in the same household may similarly be assigned to the use of kitchen counter spray for the full year. When communal products are part of a cluster (i.e., a group of products often used at the same time), the use of the full cluster of products is assigned to a single household member (see section 6 on clustered product use for more detail on clusters).

The CPS.r function first reads the list of eligible product categories for the household. For communal product categories which do not belong to an identified cluster, random sampling together with the household prevalence threshold provided in the **PUC_use_data.csv** input file is used to determine if the household has actual use of the product category. If applicable, the refined product type (e.g. spray vs. gel air freshener) is chosen based on random sampling, where all refined product types available for the product category in question are equally likely. This assumption is made due to the absence of data on the use of refined product types. At this point, the use of the product category would be assigned to one member of the household utilizing the family labor division rules, currently implemented as:

- Only household members 12 years of age or older are eligible for communal product use
- Males use 66% of outdoor-related communal products
- Females use 75% of indoor-related communal products
- If two or more adults of the same gender are present in a household, the usage is split equally amongst them.

The gender assumptions are based on the findings in the American Time Use Survey (2011-2015) that on average males spend less time doing housework than females, but more time doing lawn and garden care. It is acknowledged that these data are generalizations, and not necessarily true for individual product categories.

If more than one adult of a particular gender is eligible, the adult chosen for product use will be chosen at random. The UPG.r function is then called to assign a use profile for the product category and individual (i.e., frequency of use, mass of use, handling time, etc.).

For eligible household-level product categories which do belong to an identified cluster, all other household-level/communal product categories within the cluster are grouped together. The process for assignment of product use then proceeds as described above, in the same way as for a non-cluster communal product category.

See appendix A.1 and A.2 for details on the FullENT.csv and PUC_use_data.csv input files.

5. Behavior diary selection and time-based assignment of product use

Before assigning actual product use for each individual (i.e., day/time of actual product use), the product use scheduler must first identify the overall behavior patterns for each individual. A collection of behavior diaries for four behavior diary pools (adult (>18 years) working outside the home, adult not working, child of school age (6-17 years), young child (not yet school age, <6 years)) are supplied as input to the product use scheduler in the **activity_diary_pool.rds** input file. Each individual is matched

to a behavior diary pool based on their age and work status (working/not working), after which a specific behavior diary from the appropriate pool is selected at random for each individual.

Users should note that behavior diaries within each pool include behavior patterns for 364 consecutive days for an individual, representative of an individual's correlated behavior patterns over the course of one year; thus selection of a representative individual behavior diary from a pool represents selection of a year's worth of daily behavior diaries. In addition, behavior diaries specify specific daily times and durations for five main behaviors: eating, sleeping, commuting to and from work, working or going to school, and 'idle' time (i.e., time not spent in any of the 4 other activities). Seasonal patterns are represented within the behavior diaries (e.g., children do not attend school in the summer). Diaries distinguish between weekday versus weekend behaviors (e.g., working on weekdays and not working on weekends). This difference in weekday versus weekend behavior then inherently informs the subsequent difference in product usage (e.g., a consumer may use home improvement products more on weekends when there is more available time for such activities, compared to weekdays when the consumer's time is taken up by working). For further description on generation of the behavior diaries see (Brandon, Dionisio et al. 2018).

The **Read Individual Diary (RID.r)** function identifies the appropriate behavior diary pool for each individual, based on their age and work status. Individuals > 18 years of age are considered adults, with their assignment to the 'adult working outside the home' or 'adult not working' pool dictated by their work status, identified in the population and residential characteristics input file (pophouse.csv). For individuals 6-17 years of age, behavior diaries will be selected from the 'child of school age' pool, while children <6 years of age will have diaries selected from the 'young child' (i.e., prior to school age) behavior diary pool. The specific (year-long) behavior diary for each individual is selected at random from amongst all behavior diaries available in the appropriate pool.

The **Identify Idle Time (IIT.r)** function identifies idle time slots in the behavior diaries of each individual to accommodate a specific product category or cluster of product categories. The first time slot for a given product category or cluster is chosen at random within the first period of occurrence of the product's use in the year. Subsequent time slots are then assigned according to the frequency of product use identified in the **PUC_use_data.csv** input file. All assigned time slots must accommodate the full duration of the associated activity within a single idle time slot. For product categories with a frequency of use greater than once per day, if the number of available idle time slots in a given day is less than the number of times the product should be used in that day, the activity is assumed to occur multiple times in succession within the available idle time slots. This is referred to internally as activity aggregation.

If activity aggregation occurs, the **Aggregated Activity Disaggregator (AAD.r)** function is later called to disaggregate the aggregated activities. The function ensures that each individual activity has the same duration, each though the activity may occur multiple times in succession.

The **Insert Activity (INACT.r)** function assigns activities within identified idle time slots, following on IIT.r. The IIT.r and INACT.r functions are called iteratively for each activity in an individual's list of activities, where activity may refer to a cluster of consecutively used product categories (such as product categories used together during a car maintenance event), aggregated product categories (as detailed in

11

IIT.r, and referring to consecutive occurrences of use of a product category due to lack of available time slots), or single, non-aggregated product use. The INACT.r function also introduces into the individual's diary data points related to the composition and duration of clustered product categories and aggregated activities, for later use in disaggregating clustered and aggregated activities.

See appendix A.2 for details on the PUC_use_data.csv input file and appendix A.3 for details on the activity_diary_pool.rds input file.

6. Clustered product use

The **Clustered Activity Aggregator (CAA.r)** function collapses individual product categories which are used in a cluster into a single 'clustered' product category, so that the cluster can be scheduled into the product use diary as a single entity.

The **Clustered Activity Disaggregator (CAD.r)** disaggregates a cluster by inserting the individual product categories contained within the cluster into an individual's product use diary. This function generates the final product use diary which includes information on a product category's final use profile (e.g. duration of use, exposure duration, handling duration, mass, etc.).

References

(2011-2015). American Time Use Survey, Table A-6, Bureau of Labor Statistics.

Brandon, N., K. L. Dionisio, K. Isaacs, R. Tornero-Velez, D. Kapraun, W. Setzer and P. S. Price (2018). "Simulating Exposure-Related Behaviors Using Agent-Based Models Embedded with Needs-Based Artificial Intelligence." Journal of Exposure Science and Environmental Epidemiology **In press**.

Isaacs, K. K., W. G. Glen, P. Egeghy, M.-R. Goldsmith, L. Smith, D. Vallero, R. Brooks, C. M. Grulke and H. Ozkaynak (2014). "SHEDS-HT: An Integrated Probabilistic Exposure Model for Prioritizing Exposures to Chemicals with Near-Field and Dietary Sources." Environ Sci Technol **48**(21): 12750-12759.

Appendices

A. Input files

A.1 Ever/Never rules (FullENT.csv)

The FullENT.csv file contains binary data defining if a product category will potentially 'ever' or 'never' be used by an individual or household, based on specific characteristics related to product usage, season, and other characteristics of the individual and/or household. The file also includes an indicator of product categories which are not currently considered in HEM model outputs. The FullENT.csv file provided serves as an example input file, and may be used as a default input. However, users may edit the values in the FullENT.csv file to suit their specific model application, as long as the file format is maintained.

Data dictionary

PUCID_producttype	General product use category and product type code
PUCID_PT_description	Description of the product use category
NO2017	Indicator of whether the product category is included in the current implementation of the product use scheduler, and HEM overall. '1' indicates the product category is *not* included in the current implementation, '0' indicates the product category *is* included currently in the model.
HUP	Indicator of whether the product category is evaluated against Ever/Never rules at the household level, in the HUP.r function. '1' indicates the product category *is* evaluated against Ever/Never rules at the household level, '0' indicates it is *not*.
IUP	Indicator of whether the product category is evaluated against Ever/Never rules at the individual level, in the IUP.r function. '1' indicates the product category *is* evaluated against Ever/Never rules at the individual level, '0' indicates it is *not*.
Seasonality	Indicator of whether use of the product category is associated with season of the year. '1' indicates there are seasonal differences in use of the product, '0' indicates there are not.
personal_communal	Identifier for if a product category satisfies personal or communal needs. 'personal' indicates the product satisfies personal needs, 'communal' indicates the product satisfies communal needs.

Remaining columns are characteristics of the household or individual associated with the implementation of Ever/Never rules as described in HUP.r and IUP.r. Binary indicators reflect if the presence of that household or individual characteristic excludes potential use of a product ('0') or allows for potential use of a product ('1'). If more than one characteristic determines the exclusion of potential

use of a product, only one characteristic must be present for the product to be excluded from potential use. Absence of a '0' or '1' indicator indicates the characteristic is not relevant to the product category in question.

M/F	Gender (male/female)
W/B/A/N/P/O	Race/ethnicity (White/Black/Asian/Native American/Pacific Islander/Other)
age#_#	Age ranges of relevance for product category use (0-5 yrs, 6-12 yrs, 13-15 yrs, 16-18 yrs, 19-49 yrs, 50+ yrs)
kownrent	Household is not owned by the occupants (i.e., household is occupied by a renter)
sewdis	Household does not have a septic tank
dishwash	Household does not have a dishwasher
stoven	Household does not have a stove/oven
cars	Household does not own any cars
pcprint	Household does not own a computer printer
swim	Household does not have a swimming pool or hot tub on the premises
yard	Household does not have an outdoor yard area
Hot_Warm	Product categories exclusively used during hot or warm seasons (with hot and warm seasons based on region of the country and season of the year)
Cool	Product categories exclusively used during cool seasons (with cool seasons based on region of the country and season of the year)
Cold	Product categories exclusively used during cold seasons (with cold seasons based on region of the country and season of the year)

A.2 Habits and Practices parameters (PUC_use_data.csv)

The PUC_use_data.csv input file defines the habits and practices parameters, or use patterns, for each of the product categories modeled in the current version of HEM. Parameters which define the use of a product are defined, including prevalence of use in the population, frequency of product use, and mass of product used, among others. Parameters included in the PUC_use_data.csv file are drawn from Table S8 of the (Isaacs, Glen et al. 2014) publication. The PUC_use_data.csv file provided serves as an example input file, and may be used as a default input. However, users may edit the values in the PUC_use_data.csv file to suit their specific model application, as long as the file format is maintained.

Data Dictionary

PUCID_producttype	General product use category and product type code
PUCID_refined	Refined product type code (more than one may be associated with each source.id)
New.Description	Description of the product use category
source.id	Old product use category code
Old.description	Old product use category description
new.old.match	Confirmation that the refined product type matches
refined	1 if the row contains information on a refined product category, 0 if the row contains information on product type only
personal_communal	Identifier for if a product category satisfies personal or communal needs
indoor_outdoor	Indicator if a product category is typically used indoors or outdoors
cluster	Clusters are groups of product categories that are often used in-tandem when performing a task (e.g. laundry products). Not all product categories belong to a cluster.
Prev_hh	Prevalence of product use across households for communal products
Prev_hh_yes	Prevalence of product use across households for refined product types, for communal products (prevalence is equally distributed amongst all possible refined product types associated with that product type)
Prev_M	*For personal products*: prevalence of product use for males age 13 – 99 years *For communal products*: prevalence of product use for males age 13 - 99 years who live in the household, given that the household uses the product
Prev_F	*For personal products*: prevalence of product use for females age 13 - 99 years

	For communal products: prevalence of product use for females age 13 – 99 years who live in the household, given that the household uses the product
Prev_child	Prevalence of use of the product for children (5 - 12 years); note children do not use communal products so prevalence applies only to personal products
Freq	Frequency of use of the product (defined as uses per year, with one year equal to 364 days)
Freq_CV	Coefficient of variation for frequency (lognormal distribution)
HT	Handling time (minutes)
HT_CV	Coefficient of variation for handling time (lognormal distribution)
AT	Activity time (minutes)
Mass	Mass of product used for a use case (grams)
Mass_CV	Coefficient of variation for product mass (lognormal distribution)

A.3 Behavior diaries (activity_diary_pool.rds)

The activity_diary_pool.rds input is an R object containing 1024 behavior diaries in a single R dataframe. This data is stored in an R object due to the efficiency of storing and retrieving such a large dataset. The behavior diaries were generated using the Agent-Based Model of Human Activity Patterns (ABMHAP), described in a publication by Brandon et. al., 2018 (Brandon, Dionisio et al. 2018). The object contains 256 example longitudinal behavior diaries for each of four groups, identified due to distinct differences in their behavior patterns which may affect chemical exposure: working adults, adults who do not work, school-age children, and young children (i.e., not yet school age). Each diary includes detailed behavior patterns for eating, sleeping, working/attending school, and commuting, with any 'other' time in an individual's day designated as 'idle' time (noting that an individual is not 'idle' during the idle time, rather idle time describes times during which the individual is not partaking in any of the four behaviors listed above which occupy much of one's day. Behavior diaries describe the time of day and duration for the above listed activities over the course of 364 days (representing one year).

Users may use any behavior diary suitable for their application as input to the Product Use Scheduler. The only requirement is that the behavior diaries maintain the same format as the provided default data.

Data Dictionary

Person.ID	Unique identifier for person, so that a single representative individual's year-long set of daily diaries can be extracted
Day.of.the.year	Integer indicating day of the year, from 1 to 364 (assuming 52 weeks of 7 days each)
Start.Time.hr.using.military.time	Start time for the behavior defined in the Activity.Code parameter
Duration.hr	Duration of the activity (hours)
Activity.Code	Behavior performed during the time period -1: idle time 1: morning commute 2: evening commute 3: breakfast 4: dinner 5: lunch 6: sleep 7: work
Diary.category	One of four diary categories discriminating between individuals with widely varying behavior patterns (working adults, non-working adults, school-age children (ages 6-17 years) and children younger than school age (<6 years)

B. Output files

The product use scheduler outputs one file for each household included in the model run, titled 'Household_n.csv.' Household numbers correspond to the households as detailed in the pophouse.csv file. Each household's file includes the product use diary for each household member, for each day of the year.

Data Dictionary

Day.of.the.year	Integer indicating day of the year, from 1 to 364 (assuming 52 weeks of 7 days each)
Start.Time.hr.using.military.time	Start time for an activity corresponding to a product category (military time)
End.Time.hr.using.military.time	End time for an activity corresponding to a product category (military time)
Duration.hr	Duration of an activity (hours)

Duration.min	Duration of an activity (minutes)
Activity.Code	Activity performed during the time period -2: idle time with an activity assignment -1: idle time with no activity assignment 1: morning commute 2: evening commute 3: breakfast 4: dinner 5: lunch 6: sleep 7: work
Diary.category	One of four diary categories discriminating between individuals with widely varying behavior patterns (working adults, non-working adults, school-age children (ages 6-17 years) and children younger than school age (<6 years)
PUCID.producttype	Product type unique identifier
sheds.id.refined	Unique identifier for refined product type (e.g. spray, gel, etc.)
PUCID.PT.description	Product type description
Personal.or.Communal	Identifier for if a product category satisfies personal or communal needs
Clusters	Clusters are groups of product categories that are often used in-tandem when performing a task (e.g. laundry products). Not all product categories belong to a cluster.
Indoor.outdoor	Indicator if a product category is typically used indoors or outdoors
household.index	Unique household identifier corresponding to distinct rows in the pophouse.csv file
person.index	Unique identifier for person, representing the individuals within a household; person number is assigned based on the order in which individual's within a household are listed in the pophouse.csv file
person.gender	Gender of the individual (Male = M; Female = F)

person.age	Age of the individual (years)
use.ht	Handling time (minutes)
use.act	Activity time (minutes)
use.mass	Mass of product used (g)
Primary.person	Binary variable to identify the primary person in each household where the primary individual is designated in the pophouse.csv file