RAMSIS is a CAD tool for the ergonomic design of vehicle interiors. It has been developed by Human Solutions on behalf of the entire German automotive industry. Today, RAMSIS is the leading ergonomics system in the vehicle development sector.

While RAMSIS functions are mainly optimized for the car development process, the application of RAMSIS in truck and bus design brings up some new specific requirements regarding vision analysis, task analysis and anthropometrics.

The module **RAMSIS Bus & Truck** contains new functions fitting to the specific truck and bus design requirements. The objectives and specifications have been elaborated with the support of several truck and bus manufactures. The functions were developed in three milestones which are specified in the subsequent sections.

1 Milestone Version 1

The milestone version 1 of the module RAMSIS Bus & Truck includes functions for vision analysis, task analysis and anthropometrics as follows.

1.1 Vision Analysis

The vision properties of humans in the vehicle can be analyzed by the following functions:

- Reflection Analysis

  Vehicle ergonomics have also to consider problems coming from reflections. When glaring surfaces of application elements or cover glasses reflect incoming sun light into the driver eyes, the driver is strongly disturbed. Moreover, the view conditions through mirrors play a important security role.

  General reflection problems can be analysed by this function. This includes the analyse of mirror view (indirect vision) and the analyse of reflections of sun light on glaring surfaces in the vehicle.

  In essential this function provides information which objects in the vehicle produce which shadowing effects of the reflected ray path. Starting from the manikin eye (left, right, mid-eye, binocular), the reflection of objects is calculated on the reflection surface (mirror, display glass). Moreover, sight cones from the eyes to the reflection surface and from there to objects in the vehicle are generated.

  In addition a sight cone is generated with respect to the edge of the reflection surface (standard mirror view) and the object projections on the reflection surface are projected along the corresponding cones on an additional surface (e.g. ground).

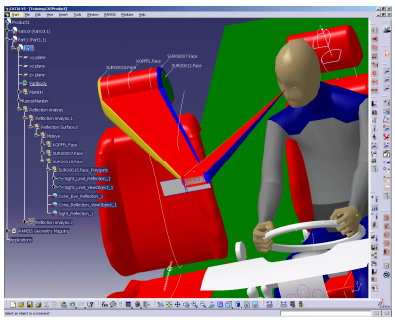

Figure 1.1 Reflection Analysis

- Analysis of readability

  The assembly position of characters and figures of displays as well as on instrument dials or switch labels has a strong influence on the readability through the distance and orientation to the driver's eyes.

  Different readability aspects can be analysed with the following functions:

  - Acuity Analysis

    This function checks the readability of characters and symbols from the occupant's point of view. It provides in essential ergonomic minimum figure sizes with respect to the distance to the occupant. Starting from the vision line of the manikin, selected figures with specific sizes are generated onto the environment.

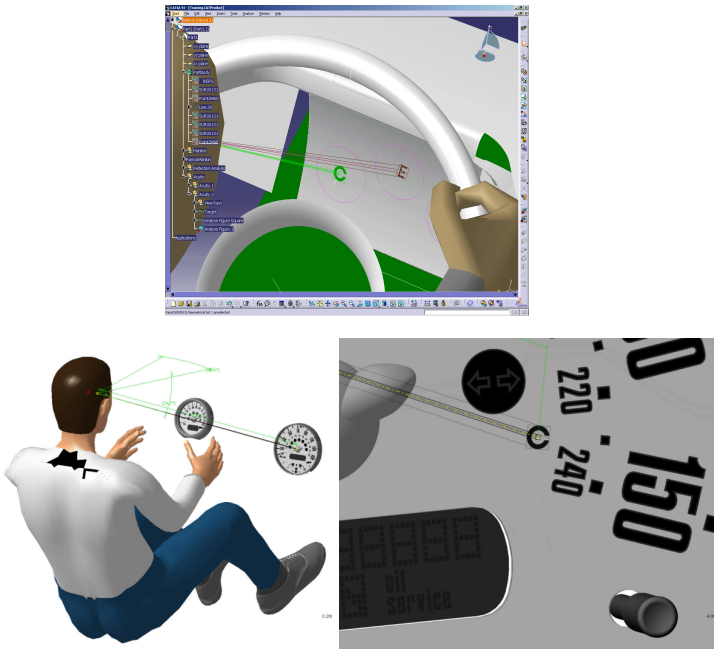

Figure 1.2 Acuity Analysis

  - Minimal Visual Range Analysis

    This function analyses the minimum distance of characters and symbols to the occupant for readability. It provides essentially minimum view ranges depending on the manikin's age. Starting from the head position, 3-dimensional view ranges are generated into the environment.

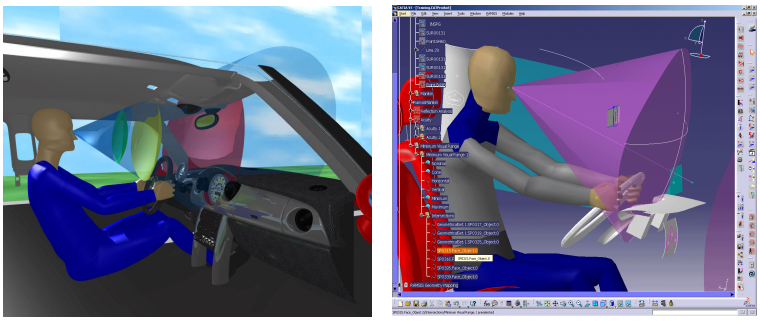

Figure 1.3 Minimal Visual Range Analysis

- Advanced Sight Analysis

  This function provides several sight cones to be analysed with respect to figure positions. It generates different sight view limits (gaze, vision, small and big glasses).

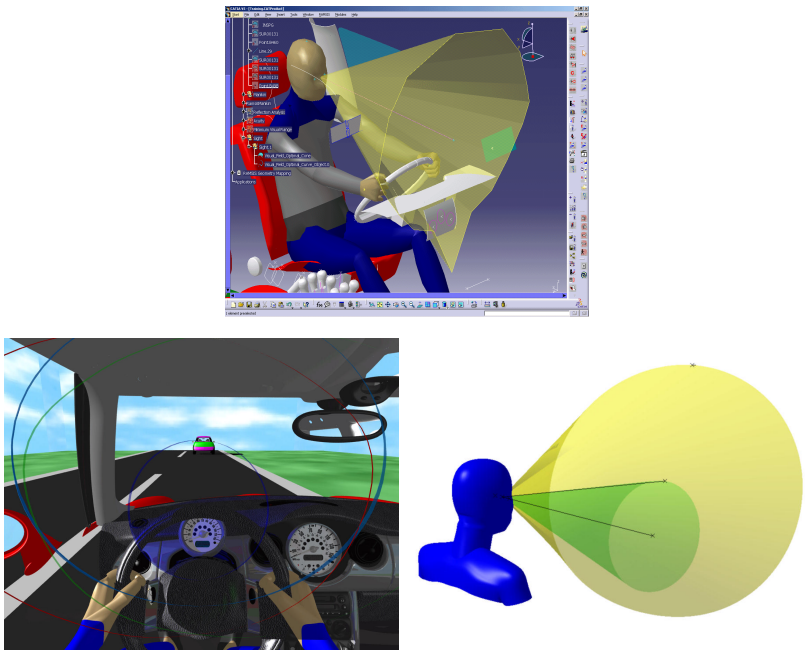

Figure 1.4 Advanced Sight Analysis

1.2 Task Analysis

The vehicle environment can be analyzed with respect to given tasks by the following functions:

- Lying posture models

  RAMSIS already provides posture models and posture simulation tools to calculate manikin postures regarding user-defined tasks. The posture models are valid for standing and sitting situations.

  In order to analyze lying situations two lying posture models are provided, which can be used in the usual posture simulation. The models address two different situations: lying on the back and on the side (see Figure 1.5). The models are provided as specific configuration files, which can be loaded and used through the user-defined posture model feature in RAMSIS.

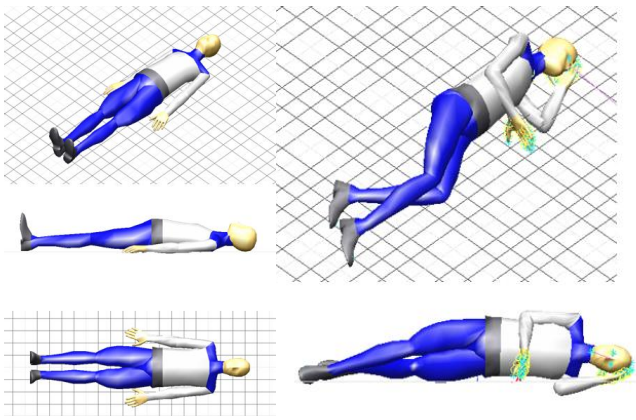

Figure 1.5 Lying Posture Models

1.3 Anthropometrics

The following function supports the anthropometrical definition of manikins:

- Generation of arbitrary Manikins

  Currently RAMSIS manikins are created on base of anthropometrical databases. On the one hand missing body dimensions are predicted making use of database information, but on the other hand manikin dimensions exceeding the data range cannot be generated.

  This function creates manikins of arbitrary anthropometrics especially ignoring percentile limits of databases (e.g. extreme corpulent manikins). The function is included in the RAMSIS/BodyBuilder and creates on base of user-defined dimension values (keyboard input or file import) corresponding manikins.

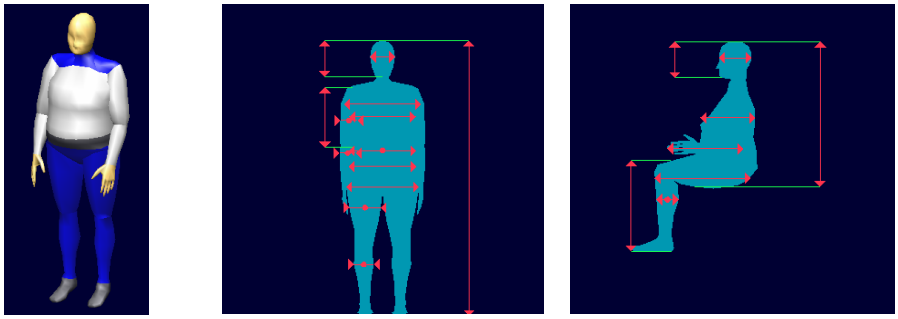

Figure 1.6 Generation of arbitrary Manikins

2 Milestone Version 2

The milestone version 2 of the module RAMSIS Truck & Bus includes functions for vision analysis, task analysis and anthropometrics as follows.

2.1 Vision Analysis

The vision properties of humans in the vehicle can be analyzed by the following functions:

- Direct Vision

  This function analyses the limitation of the human vision through objects in the vehicle.

  It generated sight cones from the manikin eyes (left, right, mid-eye, binocular) to limiting objects (e.g. steering wheel) and form there to given surfaces. On these surfaces (e.g. instrumental panel) the area is calculated, which is hidden from the eyes by the limiting objects. These areas have to be considered for the position of information systems as displays and instrumental devices.

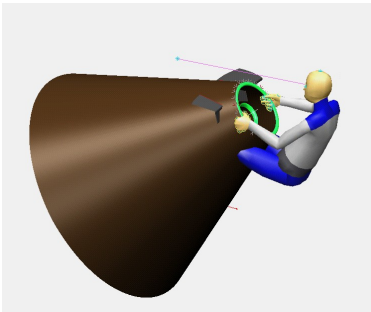

Figure 2.1 Direct Vision

- Vision Motion Analysis

  This function analyses vision shifts with respect to the required time.

  Based on a start and end fixation point of the vision shift, the corresponding motion time is calculated. In addition isochrones are displayed, which give positions of the same required time for a vision shift from the current fixation.

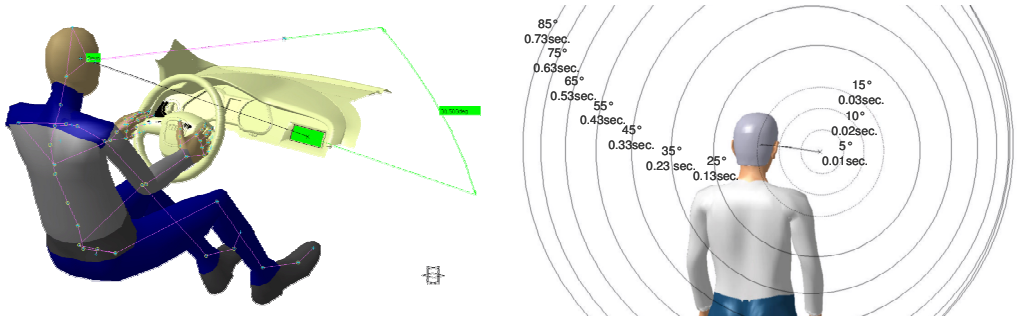

Figure 2.2 Vision Motion Analysis

- Display Property Analysis

  This function assesses optical display properties with respect to the manikin's eye location.

  Based on user-defined display opening angles a corresponding view cone onto the display surface is generated, which can be analyzed with respect to the manikin's eye location.

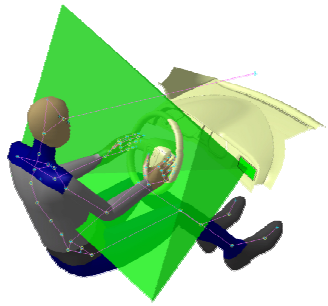

Figure 2.3 Display Property Analysis

2.2 Task Analysis

The vehicle environment can be analyzed with respect to given tasks by the following functions:

- Quasi-dynamic Force Analysis

  This function provides a force analysis of ingress motions onto a truck. The consideration of the motion is focused on critical (key) postures within the motion. On these postures a static biomechanical joint load assessment is performed.

  The function supports the following process

  1. User definition of foot- and hand-steps (path) on the truck ingress geometry
  2. Calculation of static key postures
  3. Assessment of joint loads in static postures

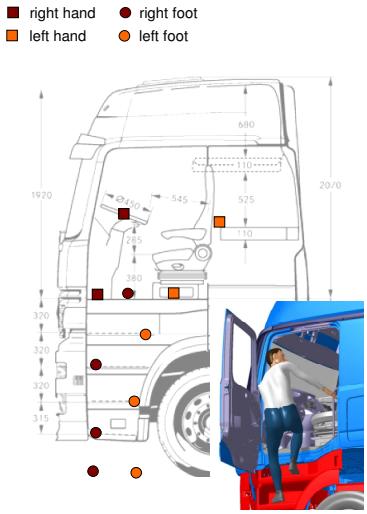

Figure 2.4 Definition of foot- and hand-steps (path)

The calculation of the static key postures takes 2 hand and 2 foot restrictions at the given hand- and foot-steps into account. In addition it is based on a static, probability based posture model, which is manually adjusted and provided especially for that application. In order to deal with the different possible joint rotations for the hips, knees and shoulder, clavicle these joints are equipped with specific wide joint ranges in the posture model.

Figure 2.5 Static posture model for key postures

The assessment of the joint loads makes use of a external force calculation with respect to a equilibrium. This calculation based on the assumptions that the feet compensate the manikin weight and the hands prevent the manikin from tilting (Figure 2.6). Finally the relative joint loads are calculated as ratio between applied external load and maximum possible load in each joint. The maximum joint load data come from the existing RAMSIS Maximal Force module.

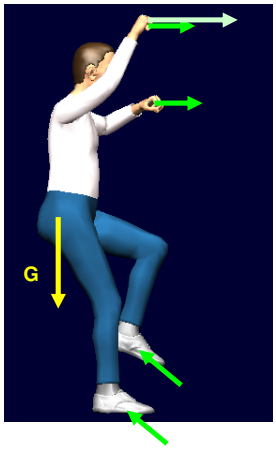

Figure 2.6 External force calculation

The joint load assessment considers two situations.

- All hands and feet hold manikin at truck.
- One or two links (hand/foot) releases from truck to move to next step.

  In this case all other links have to compensate release and hold the manikin at the truck.

Finally the function provides joint loads for each key posture, grouped in arms, legs and torso. These ratings are used to assess the feasibility of the ingress motion and to compare different concepts. All key postures are interpolated to fill a motion into them.

- Parametrical Posture Model

  Currently posture models base on posture experiments. It is time consuming for users to define a new or modify existing posture models on new data.

  This function provides an interface for the interactive definition of posture models. Starting on an existing model (e.g. truck model), the user can adapt the optimal posture to specific configurations (e.g. torso more upright). The result can be stored and reused as user-defined posture model.

  The interface supports the following adjustable parameter:

  - Distance H-Point to heel/ball (x,z)
  - Torso inclination
  - Head orientation (y-rotation)
  - Vision line orientation (y-rotation)
  - Distance H-Point to hand (x,z)
  - Distance hand to hand (y)
  - Distance heel/ball to heel/ball (y)
  - Hand orientation
  - Foot orientation

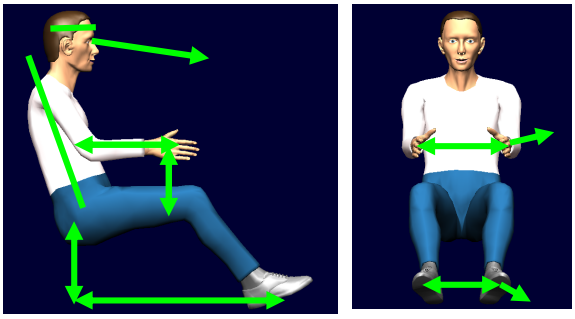

Figure 2.7 Parametrical Posture Model

- Advanced Vision Restriction

  Currently the posture simulation supports a direction restriction for the vision line and a target restriction for the fixation, but there is no link of the vision line to the environment. In many applications the need of a geometrical restriction for vision line comes up, which has influence on the posture (head, neck, body).

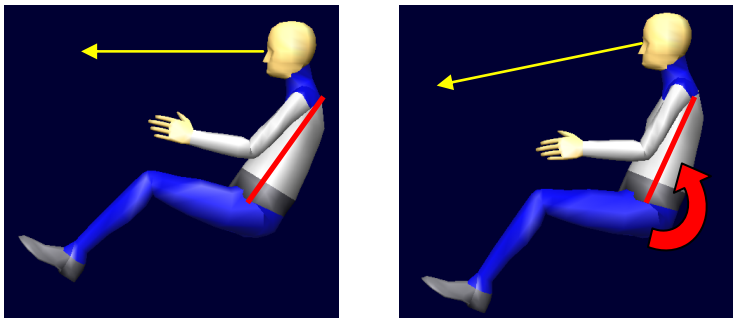

Figure 2.8 Influence of vision line on posture

Hence a new restriction in the posture simulation is provided. This restriction forces the manikin to look across an object (front lid) or through an object (window)

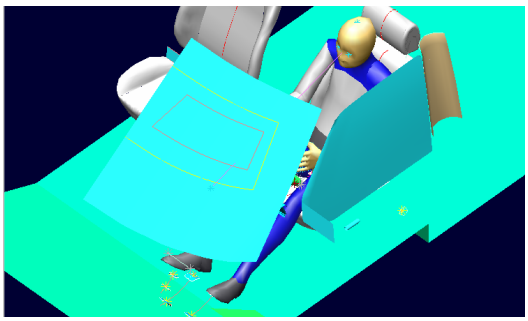

Figure 2.9 Advanced Vision Restriction

2.3 Anthropometrics

The following functions extend the anthropometrical features of manikins:

- Limited Joint Ranges

  Extreme corpulent humans have restricted motion flexibility due to collisions and frictions of limbs in the joint areas and due to larger limb weights.

  This feature supports the simulation of motion flexibility due to extreme limb volumes based on available data of joint ranges for the 5. percentile, i.e. 95% of the population has larger joint ranges. Corpulent humans are assumed to be close to that population segment.

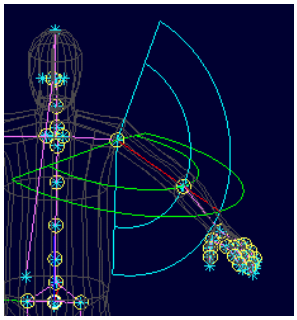

Figure 2.10 Limited Joint Ranges

- Adjustment of H-Point Model

  The current H-Point model is generated for average people and hence shows less accurate results for extreme corpulent manikins.

  In spite of average sized people corpulent human's pelvis moves further forward in the seat (x-direction) and the maximal seat penetration is reached, hence the pelvis stays vertically constant (z-direction) while sitting on the bony structure.

  The new adjusted H-Point Model based on the current model extended by the following modifications:

  - The horizontal offset (x) is not constant anymore, but is increasing with the pelvis depth (PD) of the manikin. Hence extreme corpulent manikins move further forward in the seat.

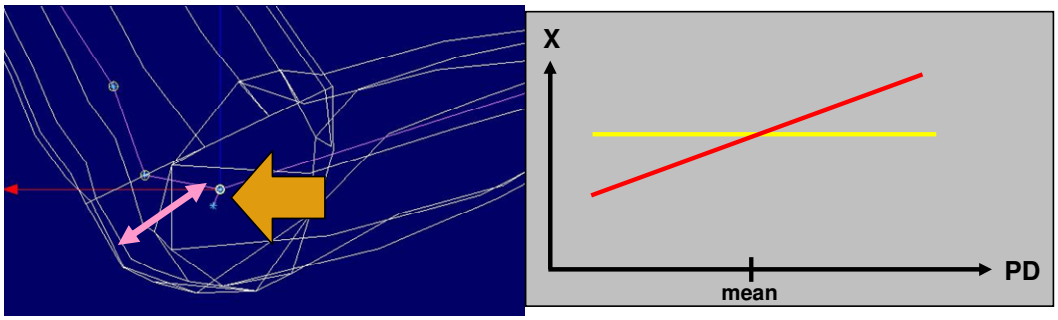

Figure 2.11 Pelvis depth (PD) and horizontal offset (x)

  - The vertical offset (z) is constant after certain range above lowest value. Hence extreme corpulent manikins stop moving upwards in the seat.

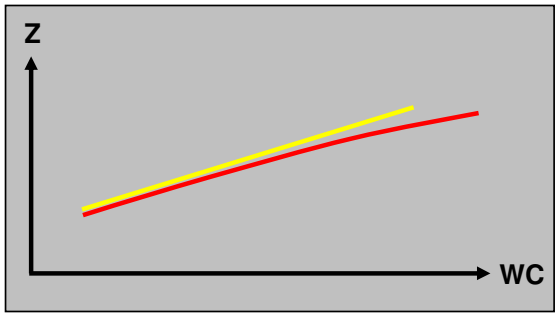

Figure 2.12 Vertical offset (z)

3 Milestone Version 3

The milestone version 3 of the module Bus & Truck includes functions for task analysis and anthropometrics as follows.

3.1 Task Analysis

The vehicle environment can be analyzed with respect to given tasks by the following functions:

- Stability Analysis

  This function analyses the stability of postures (sitting, standing and lying) under consideration of gravity.

  The usual posture simulation is extended by a new stability constraint. This constraint forces the manikin's center of gravity to be above a stability region. This horizontal region is determined by selected body element dimensions depending on the situation (sitting, standing and lying). For example hip and leg dimensions are considered for sitting situations.

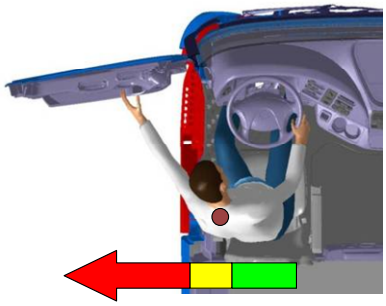

Figure 3.1 Stability Analysis

- User-defined orientation of posture model

  Currently the optimal orientation of the manikin is given in the posture model. In order to ease the handling of user-defined orientations the posture model is extended by a new orientation parameter. The user can give the posture model individual orientations, e.g. the manikin should prefer looking backwards.

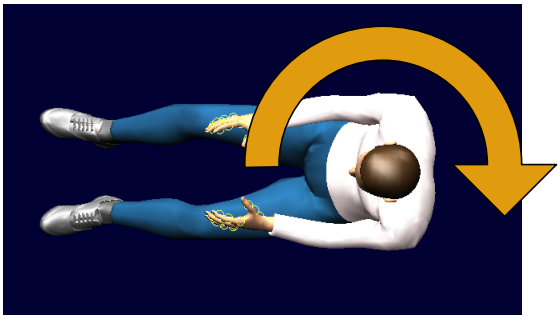

Figure 3.2 User-defined orientation of posture model

- New Truck Driver Posture Model

  This new model is based on the adjustment of current RAMSIS truck model, which is derived from a U.S. truck survey in 1983. The adjustment makes use of available posture data of the RAMSIS Bus & Truck Consortium members Daimler and Scania. The data contain:

  - Positions
    - Pedals, seat reference points, steering wheel adjustments
    - Eye points
  - Anthropometrics (Standard)
  - Tasks (overland, city and site traffic)

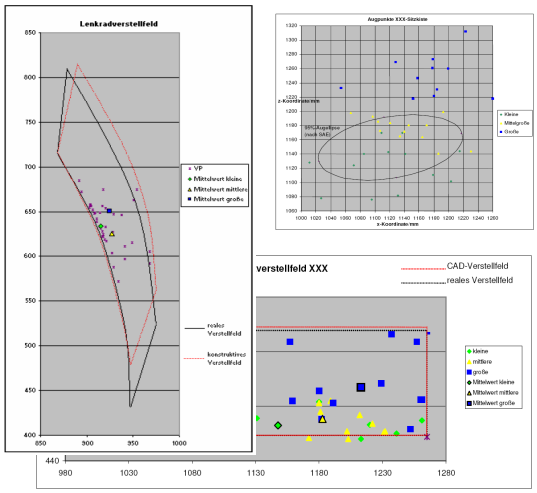

Figure 3.3 Available truck posture data

The adjustment procedure consists of the following steps:

1. Application of RAMSIS truck model to posture data
2. Validation and comparison of results (experiments and simulation)
3. Optimization
   - Adjustment of truck model using the parametrical posture model

- Introduction of new restrictions
- Simulation improvement

The adjusted posture model is provided as user-defined posture model.

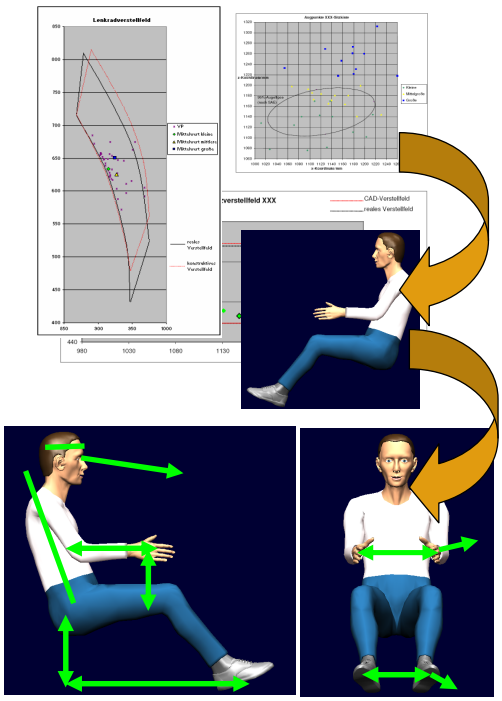

Figure 3.4 Posture model adjustment process

3.2 Anthropometrics

The following functions extend the anthropometrical features of manikins:

- Anthropometrical Truck Driver Database

  Currently RAMSIS anthropometrical databases represent average populations from different regions over the world. They are not suitable to represent occupational groups as truck driver, which body dimensions differ from average people.

  Hence a specific anthropometrical truck driver database for Germany is provided. The data come from the survey “Anthropometrische und biomechanische Untersuchungen an Fahrern und Fahrerinnen von Reisebussen und Lastkraftwagen” (Berufsgenossenschaft für Fahrzeughaltungen, 2000). In this study 495 male truck drivers (average age 41 and average work experience 16 years) were measured in 2000. The intellectual property rights regarding the access to that data are currently not known.

  Through this specific database the user can create manikins corresponding to the anthropometrical characteristics of truck drivers. Percentile manikins as well as specific body type manikin can be generated and used in RAMSIS for ergonomic evaluations.

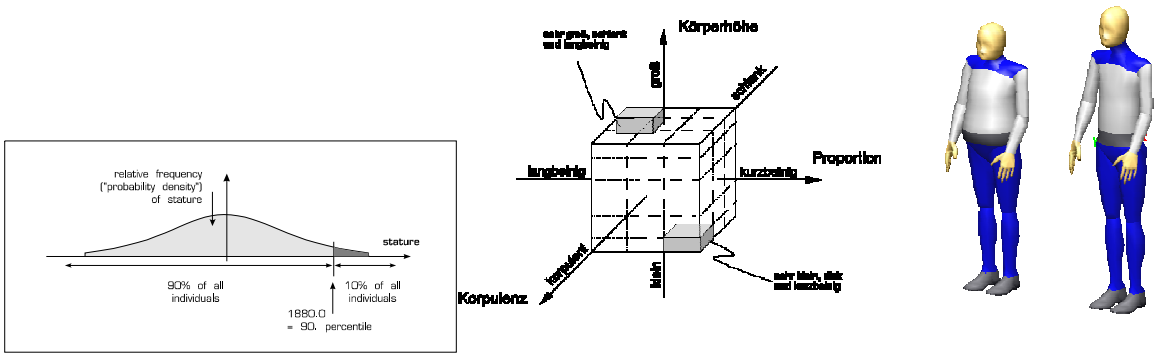

Figure 3.5 Truck driver database