

# 3D interaction and sketch-based surface modeling

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# Sketch-based modeling

**Definition:**

Sketch-based tools produce curves that suggest the contours of 3D shape. Automatically the system generates intuitively appealing piecewise smooth surfaces from such a curve network. 3DUIs: Smart 3D Sketch tools and Surfacing.



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The designer's work for the realization of object models is based on both the **perceptual** drawing and on the **conceptual** drawing.

# Sketch-based modeling

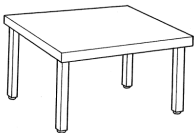
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## Perceptual Drawing

Drawing what you see, through observation and rendering a realistic image.



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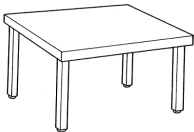
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## Perceptual Drawing

Drawing what you see, through observation and rendering a realistic image.



## Conceptual Drawing

Drawing what you imagine, allowing ideas to be expressed visually.



# Sketch-based modeling

The designer's work for the realization of object models is based on both the **perceptual** drawing and on the **conceptual** drawing.

The designer's work to the computer aided construction of virtual models is based both on **reverse engineering** and on **sketch-based Modeling**.

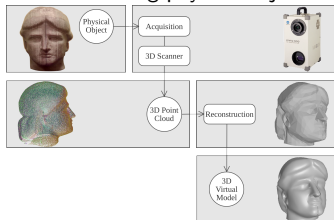
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## Reverse Engineering and 3D scanning

Building a 3D Virtual Model starting from an existing physical object

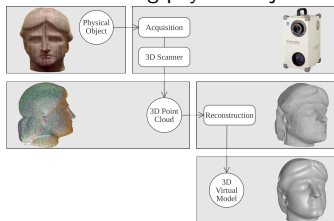


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## Reverse Engineering and 3D scanning

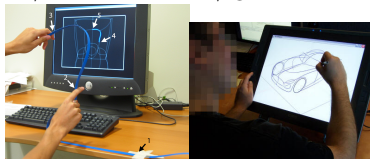
Building a 3D Virtual Model starting from an existing physical object



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## Sketch-based Modeling

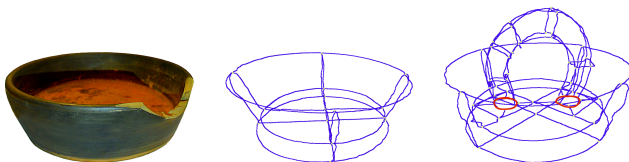
Generating a 3D Virtual Model by 2D/3D sketch strokes / gesture strokes



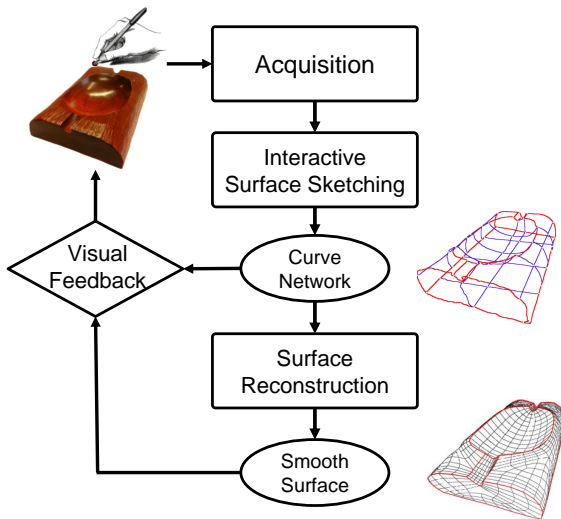
# The NEW Sketch-based Modeling Paradigm

Integrates perceptual and conceptual modeling.

- ▶ The user traces the 3D curves using a natural user interface that mimics the free-hands drawing, which most users are familiar with.
- ▶ The creation of the piecewise smooth surface representing the 3D model is automatically inferred from the 3D irregular curve network.
- ▶ The user-drawn strokes stay on the physical object but also free-hand strokes can contribute to realize the 3D curve network.

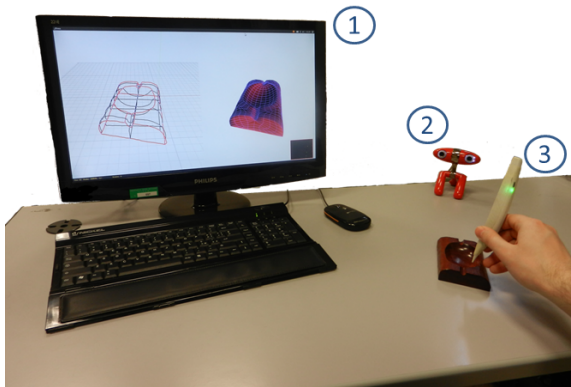


# The Sketch-based Modeling Framework



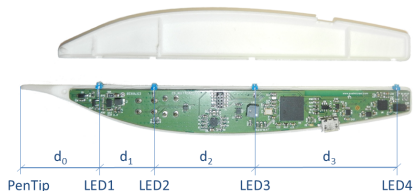


# System setup



1) host PC, 2) Minoru 3D webcam and 3) the SmartPen

# Acquisition - SmartPen



The circuit board and its enclosure



SmartPen with an extended tip

## Smart-pen Hardware

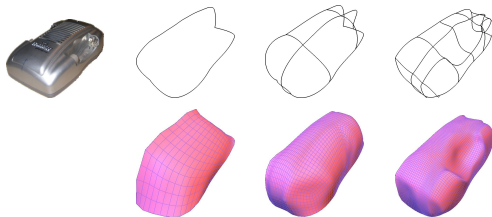
- ▶ 4 Infra Red LED Emitters
- ▶ Bluetooth transceiver
- ▶ 3-axis Accelerometer
- ▶ 3-axis Gyroscope
- ▶ magnetometer
- ▶ 4 Configurable Buttons

## Smart-pen properties

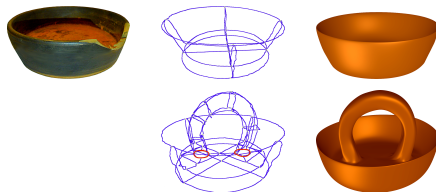
- ▶ Small & low-weight
- ▶ Wireless Communication
- ▶ Occlusion Robustness
- ▶ Easy Interaction
- ▶ Enhanced HCI

# Interactive Surface Sketching

The ISS represents the process that actively supports the user in drawing 3D curves to progressively construct the curve network



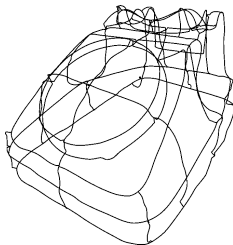
ISS tools: curve insertion, hole creation, border gluing, skinning, mirroring, etc.



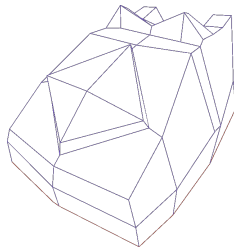
# Polyline Mesh



Physical object



Curve Network



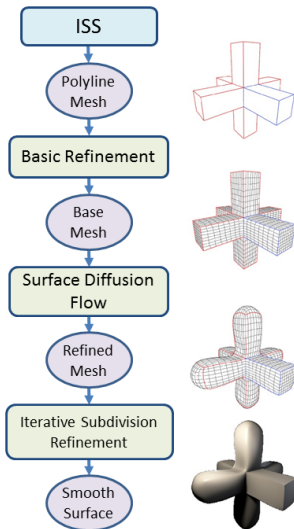
Polyline Mesh

The **Interactive Surface Sketching** process produces a **Curve Network** and an associated **Polyline Mesh**

- ▶ **Curve Network**: visual representation of the object
- ▶ **Polyline Mesh**: geometrical/topological information

The ISS process must guarantee in a natural way a unique topological structure on the polyline mesh according to the user actions.

# Surfacing: the multi-step reconstruction process

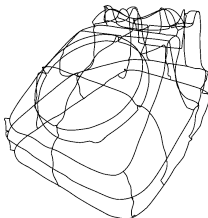


# Results: modeling real objects using the SmartPen

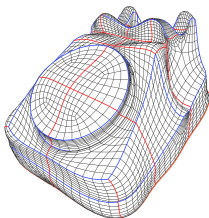
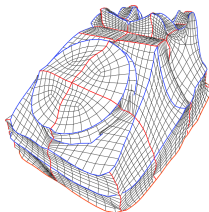
Physical Object



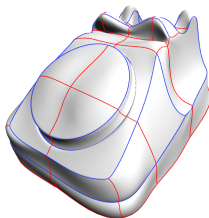
Curve Network



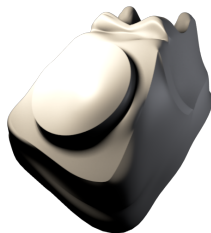
Base Mesh



Refined Mesh



Smooth Surface + CN



Smooth Surface

# Results: modeling real objects using the SmartPen

Physical Object

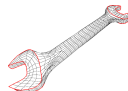
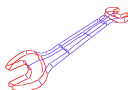
Curve Network

Base Mesh

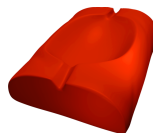
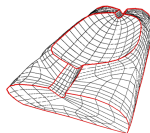
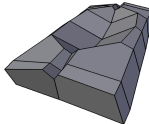
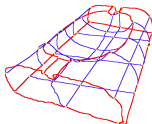
Refined Mesh

Smooth Surface

Spanner



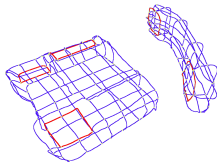
Ashtray



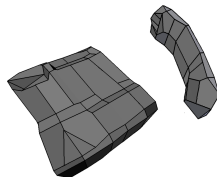
# Results: modeling real objects using the SmartPen



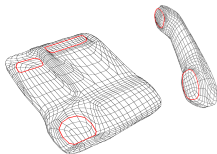
Physical Object



Curve Network



Base Mesh



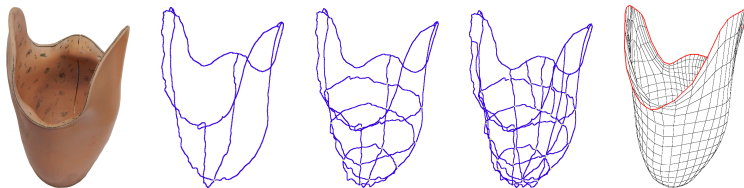
Refined Mesh



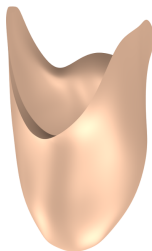
Smooth Surface



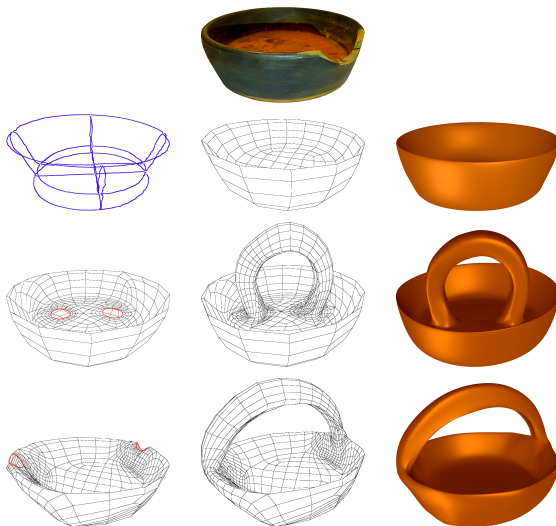
# Results: Iterative reconstruction of a prosthesis socket



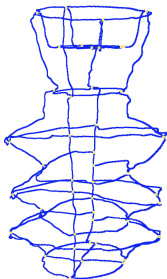
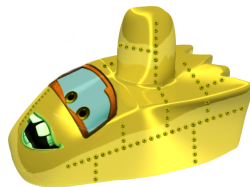
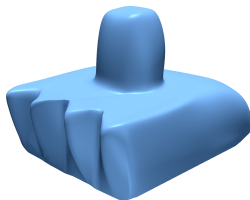
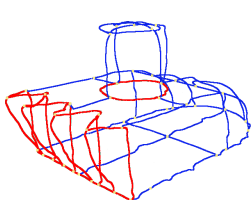
Physical Object three consecutive steps of curve insertion (CN) Resulting Mesh



# Results: freehand sketching capabilities

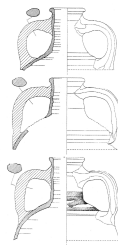
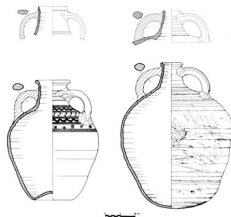


# Results: freehand design with the Smartpen



# Progetto: SMART CULTURAL HERITAGE

## Tecnologie innovative per la documentazione archeologica



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## Tecnologie innovative per la documentazione archeologica

Parte fondamentale della prassi archeologica è documentare i singoli reperti attraverso riproduzioni grafiche normalizzate, che permettano una comparazione con i repertori morfologici di riferimento, elaborati dalla disciplina nel corso dei decenni. I repertori sono in continuo aggiornamento, grazie all'enorme quantità di cantieri di scavo in Italia e all'estero. Oggi qualsiasi archeologo disegna manualmente i reperti del proprio scavo secondo i metodi convenzionali ed empirici adottati dalla comunità scientifica internazionale, comparandone poi la forma con i repertori di riferimento e proponendone in questo modo una datazione. Il metodo risulta affidabile nel caso della maggior parte dei manufatti di età storica, frutto di una produzione in serie. In genere, il disegno della ceramica viene effettuato considerando il modo in cui i recipienti erano utilizzati originariamente: la rappresentazione grafica deve comprendere la sezione verticale del recipiente (con lo spessore della parete) e il suo profilo. Questo procedimento richiede pratica e molto tempo: trattandosi di un'attività molto lunga (in ogni scavo archeologico vengono portati alla luce migliaia di frammenti), un'alta percentuale degli scavi moderni rimane sostanzialmente inedito per l'oggettiva difficoltà (di tempo e quindi di mezzi economici) di pervenire alla fase finale del lavoro archeologico, quello dell'edizione-pubblicazione delle ricerche sulla base dell'esame totale dei dati.

# Progetto: SMART CULTURAL HERITAGE

## Tecnologie innovative per la documentazione archeologica

PARTNER del Progetto: Dipartimenti di Storia Culture Civiltà, Dipartimento di Matematica, Dipartimento di Elettrica e dell'Informazione

OBIETTIVO: Fine del progetto è la messa a punto di uno strumento semi-automatico che permetta di rendere rapida ed efficace la procedura archeologica descritta (disegno del reperto e sua classificazione).

Il sistema è basato su un dispositivo innovativo digitale che aiuti l'operatore del settore nell'acquisizione di profili caratterizzanti, spessori, zone significative e permetta una automatica ricostruzione 3D, sezioni 2D, calcolo di volumi, aree e lunghezze di interesse e nel contempo permetta la classificazione del reperto mediante la comparazione con i repertori crono-tipologici sfruttando tecniche basate sul paradigma di matching tramite punti salienti. Il dispositivo innovativo, trasportabile e poco costoso, deve aiutare l'operatore del settore nel fornire sezioni e disegni real-time con una precisione controllata dall'operatore. Non si tratta di digitalizzazione ai fini di una mera ricostruzione 3D, bensì di acquisizione di linee significative ed estrazione e calcolo da esse di contenuti informativi ai fini della classificazione