Jost Bürgi visits classes

-

Classes visit Jost Bürgi

Roman Oberholzer, Teacher of Mathematics

High School of Lucerne

Jost Bürgi Symposium 2021

Abstract

If you take books from the shelves of a mathematical library to bibliographies of great mathematicians, you will only find **the name Jost Bürgi in a few cases**. This is not justified in view of the achievements that the watchmaker, astronomer, mathematician, instrument maker and metallurgist from the Toggenburg left to posterity.

I would like to correct this situation and make **Jost Bürgi better known** in Switzerland. As a teacher, the obvious place to start is **in schools**.

1. Current Situation

Why do we have to learn logarithms? We have a calculator which can solve the equation numerically!

Quotation of students, often heard

Int. Jost-Bürgi-Symposium Lichtensteig

How making J. Bürgi more popular in schools

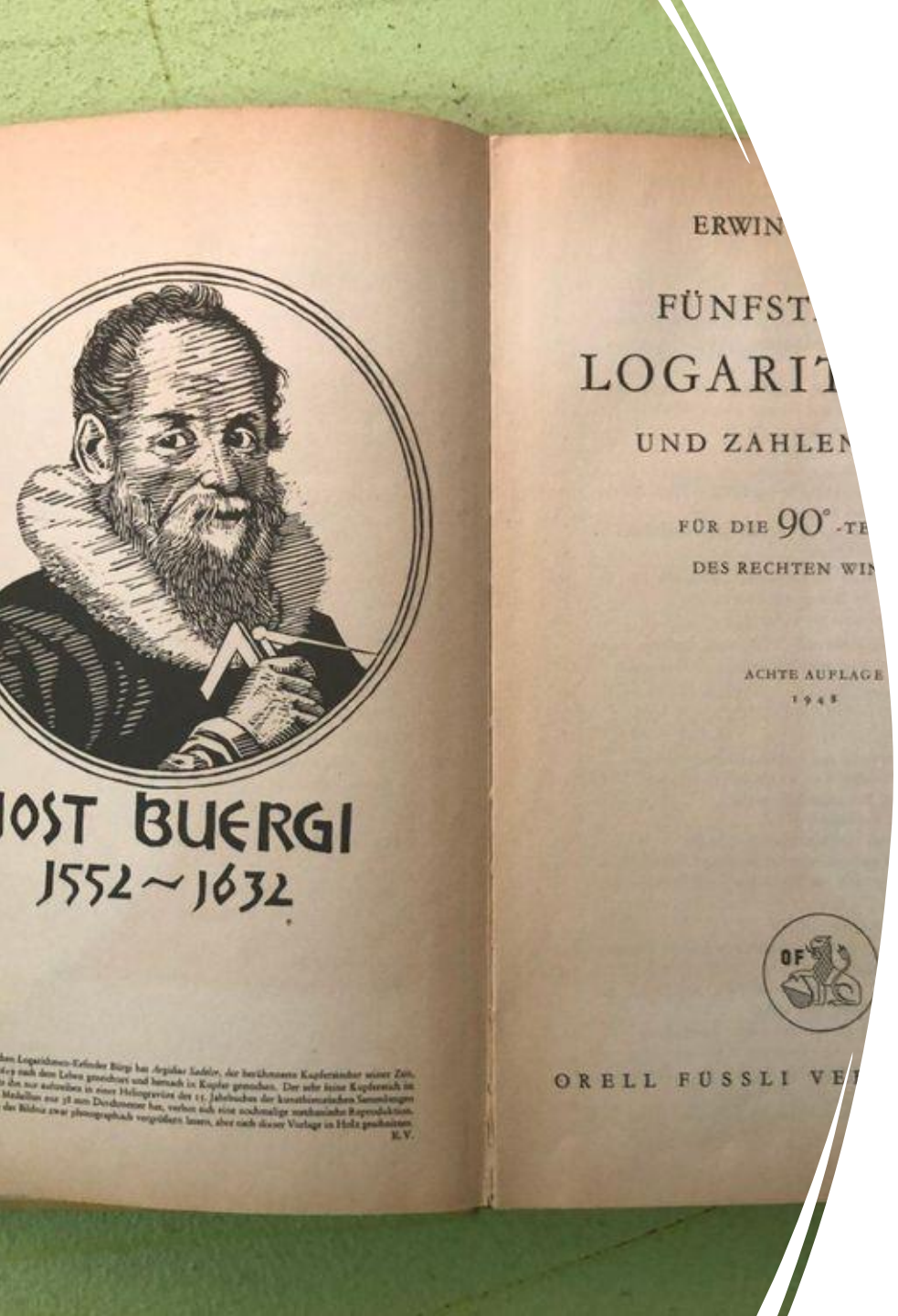
- How can we **reach the schools**, the teachers?

If we will have reached the schools/teachers,

- how can we **support the teachers**?
- how can we fascinate the students with Jost Bürgi?
- how can we bring Jost Bürgi into the school in a sustainable way?
- how can we bring Jost Bürgi into the students' life after school?

Content

1. Current Situation
2. Reason for the current situation
3. Questions: How can we reach the schools, teachers?
4. Answers: How can we support the teachers?
5. Difficulties in their realization
6. Questions/discussion



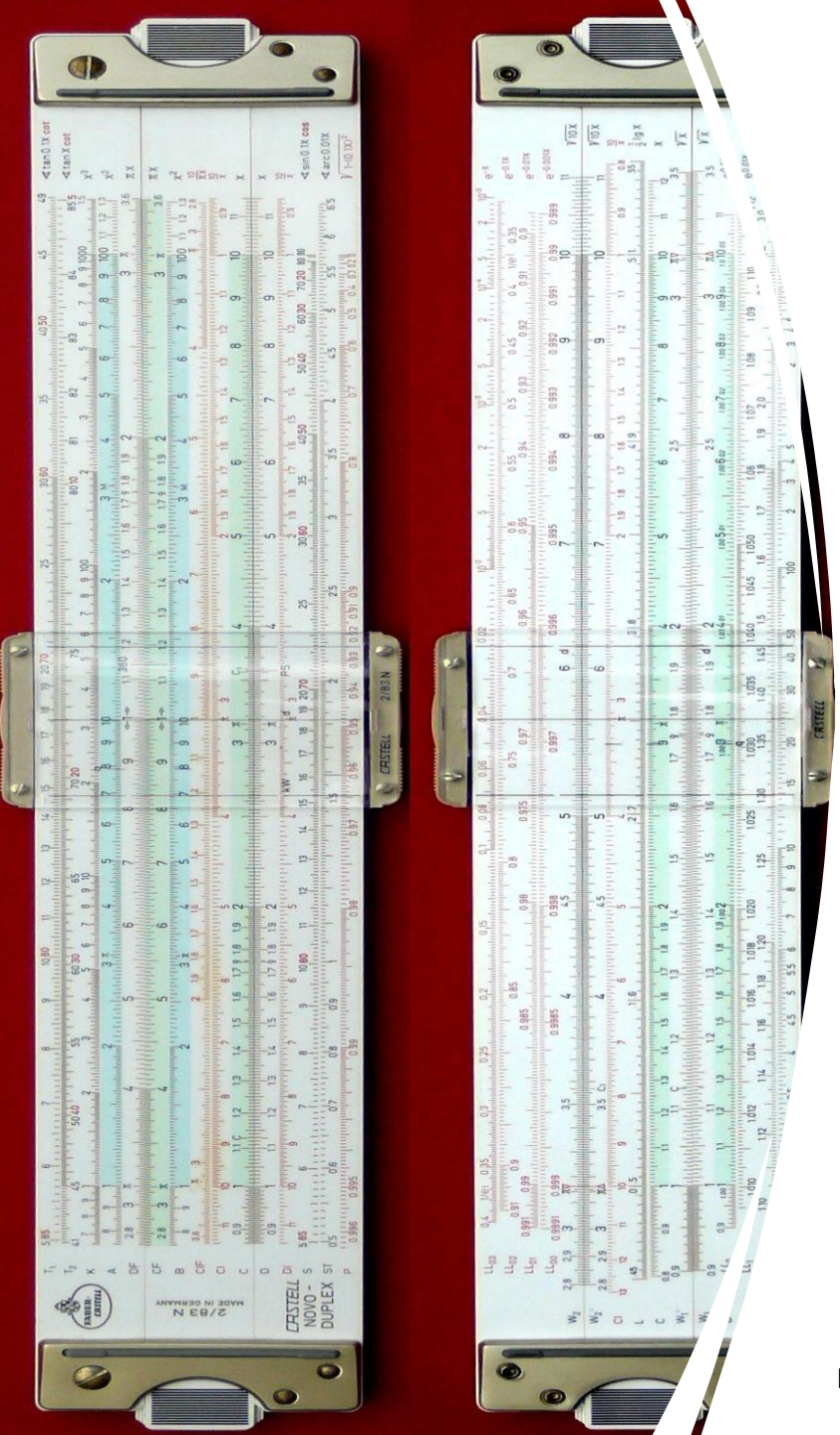
1. Current Situation in schools

- Elder “students” know Jost Bürgis portrait from the standard table book “5- digit Logarithms” from Erwin Voellmy.
- In the text below, E. Voellmy just **des-cribed the reproduction** of the medaillon – **nothing about Bürgi’s life and work**!
- I heard nothing of Jost Bürgi at the KS Wattwil.

2. Reasons for the current situation

- Jost Bürgi published his „Progress Tabulen“ in 1620, later than the Scot John Naper (1614).
- Jost Bürgi, the Swiss mathematician, between 1603 and 1611 independently invented a system of logarithms, which he published in 1620. But **Napier** worked on logarithms earlier than Bürgi and **has the priority** due to his prior date of publication in 1614.

www.britannica.com/biography/John-Napier



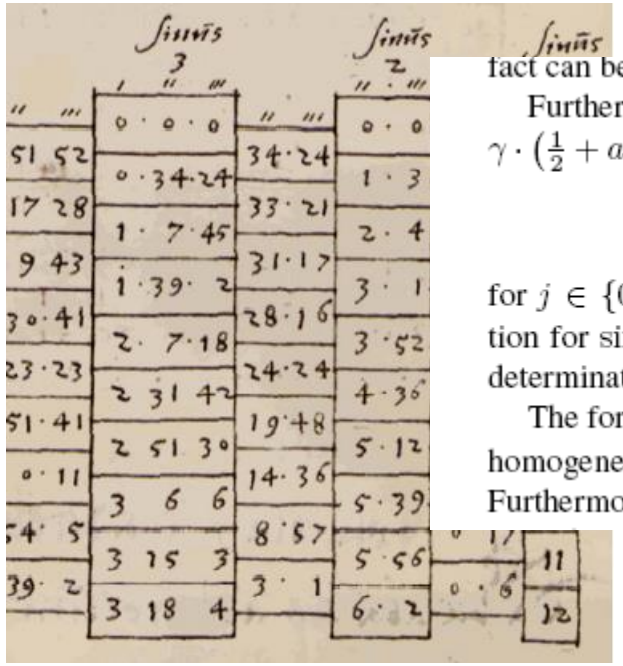
2. Reasons for the current situation

- Jost **Bürgi‘s achievement** to mathematics by the invention of logarithms are **replaced by** (faster) **calculators and computers** today.
- **Logarithmic tables** and sliderules are **not used anymore** in schools.
- Jost Bürgi‘s ideas are not present anymore.

Int. Jost-Bürgi-Symposium Lichtensteig

2. Reason for the current situation

- Logarithms as such and Bürgi‘s tables including their background is **hard to understand** (Artificium)



fact can be proven just by using elementary estimates (giving a sure reduction factor of at most 0.87).

Furthermore, the numerical calculations are considerably simplified: One gets $\cos\left(\alpha_2 - \frac{\Delta}{2}\right) = \gamma/2$ and therefore $b_j = \gamma \cdot \left(\frac{1}{2} + a_j + \cdots + a_{N-1}\right)$ and $a'_j = \gamma \cdot (b_1 + \cdots + b_j)$ for $j \in \{0, 1, \ldots, N\}$. Putting

$$b_j^{(0)} := b_j/\gamma = \tfrac{1}{2} + a_j + \cdots + a_{N-1} \quad \text{and} \quad a_j^{(1)} := b_1^{(0)} + \cdots + b_j^{(0)}$$

for $j \in \{0, 1, \ldots, N\}$ this implies $\lambda(a'_j) = a'_j/a'_N = a_j^{(1)}/a_N^{(1)}$. Therefore, one can take $a_j^{(1)}/a_N^{(1)}$ as the new approximation for $\sin(\alpha_1 + j\Delta)$ with $j = 0, 1, 2, \ldots, N-1, N$. which does not only avoid the multiplications with γ but even its determination.

The formulas for the $b_j^{(0)}$ and $a_j^{(1)}$ are just the added-up versions of the formulas in Bürgi's "artificium". They are (almost) homogeneous with respect to the input so that the normalization $a_N = 1$ can be dropped if one replaces $\frac{1}{2}$ by $\frac{1}{2} \cdot a_N$. Furthermore, if one iterates the composed procedure, one can exchange the order of the application of the prosthapharesis

2. Reasons for the current situation

- Jost Bürgi‘s developments in mathematics, astronomy and time measurement can be done **faster by modern technology today.**

3. How can we reach the schools, teachers?

- **Jost Bürgi‘s developments** were **as important/excellent** at his time **as the computer**, the bus or the mobile phone are **today** – so it is **definitely worth to know Jost Bürgi and his work** – HOW?
- Let's get Jost Bürgi **out of the technical corner** and make him accessible to all interests.
- See **Jost Bürgi in an interdisciplinary way**, as one of the three Swiss public characters, together with Huldrych Zwingli (reformer) and Conrad Gessner (doctor, encyclopaedist) of the Renaissance period.

3. How can we reach the schools, teachers?

- **Interdisciplinary view of Jost Bürgi**

  Astronomy, watchmaking (art, design), engineering, mathematics (logarithms, artificium, Bernoullis/Euler), computer science, history (Switzerland, Europe; Zwingli/Gessner), language (Ulrich Bräker “Der arme mann im Tockenburg”), philosophy

- **Material in a wide diversity**

  Different sources: document folder, video (M. Havas), modern technology

  Different places: at school, in Lichtensteig

  Different durations: short input (15’), one lesson (45’), one day, one week

4. How can we support the teachers? - ARTS

- Compare Jost **Bürgi** with Konrad **Zuse**, Steve **Jobs** and Elon **Musk**.
- Look at different clocks made by Jost Bürgi and try to design a modern clock in Bürgi‘s style.

4. How can we support the teachers? - MATHEMATICS

- **Surveying** with a **simplified triangulation** instrument from Bürgi
- Study the Jost Bürgi's **Progress Tabulen** und **Artificium**; try to write a **computer program** simulating it.
- Compare the three excellent mathematicians **Bürgi**, **Bernoulli**(s) and **Euler** (beginning of Calculus).

Int. Jost-Bürgi-Symposium Lichtensteig

Example:

(J. Waldvogel, JBS 2021)

Angles $\alpha_j = j \cdot 30^0$, $j = 0, 1, 2, 3$:

$\Delta_{1,j} = \sin\alpha_j - \sin\alpha_{j-1}$, $\Delta_{2,j} = \Delta_{1,j+1} - \Delta_{1,j}, j = 1, 2, 3$

j	α_j	$\sin\alpha_j$	Δ_1	$-\Delta_2$	$-\Delta_{2,j}/\sin\alpha_j$
0	0^o	0			
			0.500000		
1	30^o	0.500000		0.133975	0.267950
			0.366025		
2	60^o	0.866025		0.232050	0.267948
			0.133975		
3	90^o	1.000000			

(1)

To keep all values positive, the sign of Δ_2 is changed. The difference of two numbers is always noted in an intermediate line. Surprisingly, $-\Delta_2$ is proportional to $\sin\alpha$! Bürgi must have observed this too, but it is not known whether he had a proof.

4. How can we support the teachers? - LITERATURE

- Read the book "**Der arme Mann im Tockenburg**", written by Ulrich Bräker (1781-85) and summarize the life at that time.
- Jost Bürgi did not know Latin, the scientific language of his time. What is the **lingua franca** today, and are there parallelism to Bürgi's time?

Int. Jost-Bürgi-Symposium Lichtensteig

4. How can we support the teachers? - PHILOSOPHY

- Question: Is it worth **to learn old-fashioned knowledge**?
- Question: Does the **study of the past help to understand the future**?

Int. Jost-Bürgi-Symposium Lichtensteig

4. How can we support the teachers? - HISTORY

- Read the text „**Lichtenteig zu Jost Bürgis Zeiten**“ (written by Hans Büchler, 2016) and answer the questions at the end of the the text.

Jost Bürgis Lichtensteig um 1560

Dr. Hans Büchler, Wattwil, Jost-Bürgi-Symposium, 2016, Lichtensteig

Als Jost Bürgi am 28. Februar 1552 in Lichtensteig geboren wurde, waren gerade 53 Jahre seit dem Schwabenkrieg und dem darauf folgenden Austritt der Eidgenossenschaft aus dem Deutschen Reichsverband vergangen. 37 Jahre zurück lag die verheerende Niederlage der Eidgenossen bei Marignano und die Überzeugung, Nichteinmischung in fremde Händel sei die bessere Aussenpolitik als Raufereien in ganz Europa. 28 Jahre vor Bürgis

Work assignments

1. Describe the historical situation in Jost Bürgi's time
   a) in Switzerland b) in Europe.
   What was the Swabian War about? Who did the Confederation fight at Marignano and what influence did the defeat have on Swiss foreign policy? Who was Huldrych Zwingli and what was the course of the Reformation in Switzerland?

2. What historical events shaped
   a) in Switzerland b) in Europe.
   in the century before Bürgi's birth?

3. Which major Swiss bank originated in Lichtensteig? Which companies from Lichtensteig are known beyond Toggenburg?

4. How can we support the teachers? – SCHOOL TRIP

- **School trip** to Lichtensteig
- Walk to **historical places** in Lichtensteig referring to Jost Bürgi

4. How can we support the teachers? - SCHOOL TRIP

- School trip to Lichtensteig
- **Lunch at the Äulischlucht**

4. How can we support the teachers? - SCHOOL TRIP

- School trip to Lichtensteig
- Visit of the production place of **Kägifret**, a famous Swiss chocolate manufacturer

4. How can we reach the schools, teachers?

- Annual **Jost Bürgi Symposium** in Lichtensteig

  with a special part for schools/teachers: history, downsizing of the math to high school level, organization/info modules for teachers
- **Newsletter** published by the **Jost Bürgi Initiative** (4 times in a year)

  including didactic-pedacogical topics as well
- **Publications in the teachers‘ journals** and newsletters

  highly efficient, best placed information
- „**Self-Starter**“ speeches („Macher-Vorträge“)

  Talks about topics around Jost Bürgi and his work

5. Difficulties in their realization

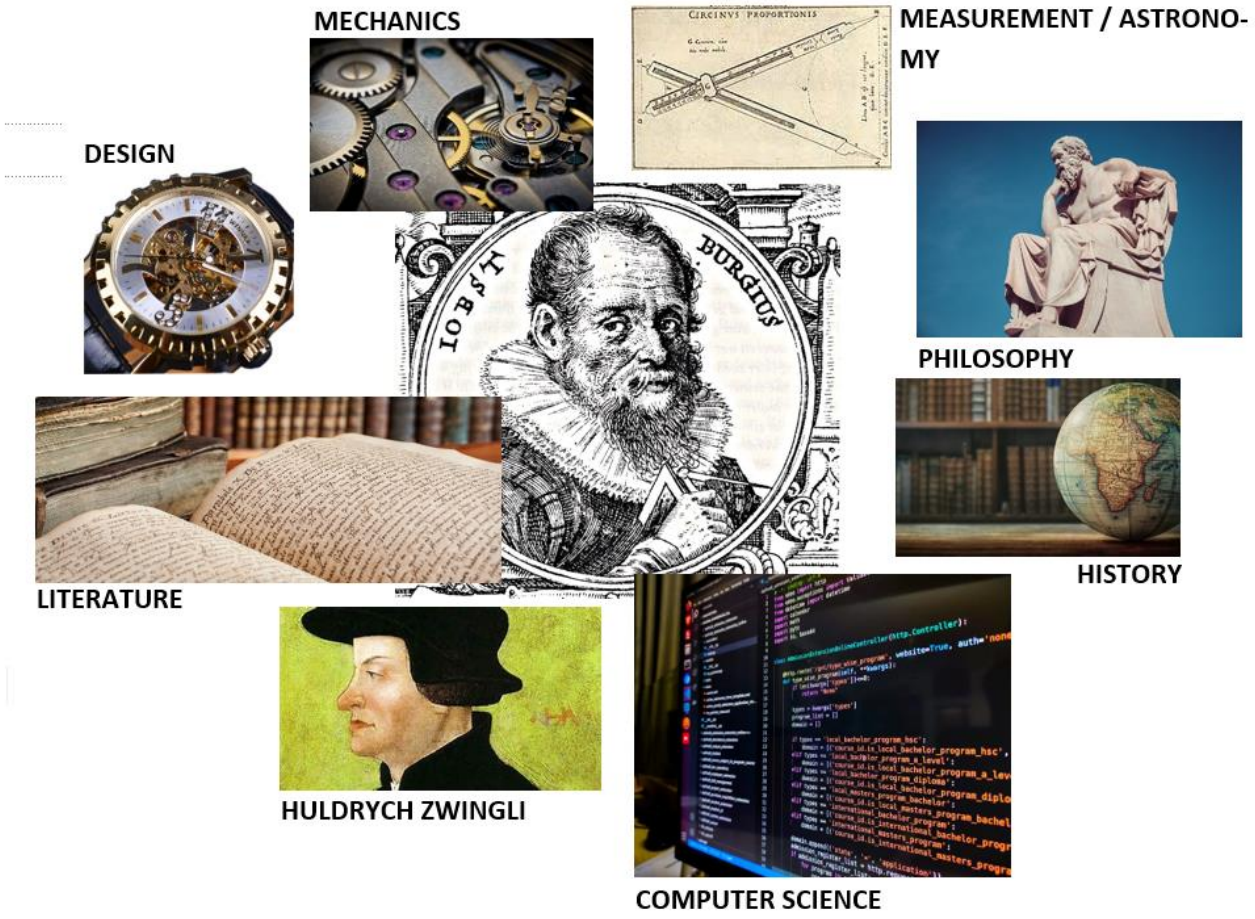
- **Publication rights** of the texts?
- **Distribution of the material** – online? How can we control this?
- **Fundings** of the ideas – movie?
- How can we make **Lichtensteig** an **attractive place**?

  Signposted trail in Lichtensteig to Bürgi‘s historical places, purchase of a triangular instrument
- Being present on **social media**?

  making short videos about Jost Bürgi, a facebook/instagram account

Questions –Discussion?

- Any objections?
- Any question?
- Any ideas?



Literatur

H. Büchler, „Jost Bürgis Lichtensteig um 1560“, Jost Bürgi Symposium, Apr 2016

P. Ullrich, „Reconstruction of the genesis of a Renaissance algorithm to calculate sine tables“, PAMM · Proc. Appl. Math. Mech. 2019; **19**

J. Waldvogel, “Jost Bürgi's mathematical tables of the sine function and of inverse logarithms“, Jost Bürgi Symposium, Apr 2021